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SUMMARY : Vegetation and Habitats on Alpine Serpentine Near Davos

This work describes vegetation and habitats of one of the barely studied serpentine outcrops of the Alps and discusses their connexion with other serpentines. The 6 km2 of augite serpentine of Davos, 47°N/ 10°E, lie to the east of the ophiolite wreath of the alpine arc. The studied alpine 3.5 km2 between 2200 and 2600 m are marked by tourism. At 2400 m, the annual temperature is -2°C, during the 4 vegetation months +4°C, annual precipitations amount to 1200 mm with a maximum in summer. Covered by the pleistocene glaciations, the area has been recolonized from 15'000 years on.

Vegetation. Compared to the surroundings, vegetation is spare, the natural timber line lower, most of the area less than 1% covered, with sparse plants, on raw stony soils. The rare patches of turf lie in stable and fresh colluvial spots and the rare patches of dwarf shrubs on well exposed stable slopes, both on ± brownified alpine ranker. (At subalpine level there are mountain pine thicket and forest, on ± acid brown soil.) Physiognomically the vegetation on carbonates constitutes an intermediate state between those on serpentine and on silicates (p. 126).

The serpentine shelters 128 vascular species (of which 100 frequent) from the 327 alpine of the region, the silicates 225 (127), the carbonates 187 (143) (annex 7): without own alpine species (but 1 subalpine) serpentine assembles an original combination of species from the region, i.e. 53 ubiquitous, 46 silicicoles, 25 carbonaticoles, (4 preferential serpentinicoles). None of the proper alpine species of the region which grows well on silicates and on carbonates fails to grow on serpentine.

138 vegetation relevés, with 2 to 47 species, according to floristic differentiation, have been ordered along the great gradient of soil and vegetation development, and classified (p. 128): (1) debris upper alpine; (2) snow-beds; (3) semi-lawn; (4) sunny debris lower alpine; (5) dwarf herbous heath; (6) heath; (7) lawn. There is a clear floristic and pedochemical (p. 153) threshold between units 1-4 with scattered and discontinuous vegetation and some remarkably constant species, and units 5-7 with developped vegetation, distinguished by the additional presence of the constant lawn, dwarf heath and heath species (units distribution according to topography p. 131).

Sparsely colonized spots, a little humid, on basic mineral soil, bear a rather carbonaticole flora; heath, lawn, wet spots with a humous or already acidified upper horizon bear a narrow association of basicoles and of partly marked acidicoles (typical for serpentines). There is probably a specific rooting in the different horizons and fractions, differing in pH and N form.

The discerned vegetation units can not be assigned to any described phytosociological unit because the singular species which constitute them (there being no species unique to serpentine) find their principal distribution otherwise in associations diverging greatly in habitat and sociology. Given the local character of the relevés, creation of new associations is not proposed.

Davos belongs to the pole of the youngest vegetations on serpentine, from glaciated zones, with few or no taxons of their own or taxons of low-rank, and a visibly restricted biomass. The most related serpentine vegetations are first the alpine ones, e.g. of Oberhalbstein (nearly identical), then the one of Aosta, lastly those of Scotland and Scandinavia.

Soils. The soil sequence on serpentine, free from foreign influence and water saturation, ranges from widespread lithosols to a few ± brownified alpine ranker (profiles p. 98, UK and US equivalents p. 96). Compared to adjacent sites, pedogenesis is slow. All soils remain skeletal. It is suggested that the poverty in fine earth is due to discordance between the alterability of the rock and of its minerals in the more rapidly dissolved fine fraction. The basic alteration products curb acidification, desaturation remains weak, with Mg largely dominating exchangeable cations. Humification ranges from moder to mull. The sequence fits well in the more general brownification over ferromagnesian silicates rich in clay and poor in quartz, under mull, in cold and temperate climate.

Compared to adjacent silicates and carbonates, serpentine shows an own constellation of pedochemical characteristics (results p. 69) at the level of fine earth: as much C N P; unusually high exchangeable Ni and Mg/Ca; as low Ca as on silicates, similar granulosities; as low K and as high Mg as on carbonates, similar C/N and CEC; the other values either intermediate or as favorable as on one of the substrates.

Augite rock from Davos contains a little more Al and Ca, less Cr and Ni than average serpentine. Soil exchangeable Ca Mg K Ca/Mg fit well among those on serpentine in temperate climate. Relative values found in plants tend to confirm availabilities assessed in soils.

The great gradient along vegetation development is largely parallel to soil development, from raw to brownified soils, as it shows in the graphs of the similarities based on correspondence analysis of floristic (p. 146), pedochemical (p. 75) and combined data (p. 148). C N P K Ca Mg Ca/Mg Scat CEC H+ increase with soil development as well as with stability, colluviality, skeleton alteration, clay content, vegetation cover and number of species, whereas pH, V, skeleton and altitude decrease. With the process of development one witnesses accumulation, growing availability, an improving ratio between just those elements vital to plants that are absent or rare in the rock, partly thanks to effective mineralisation peculiar to mull (p. 104). These tendencies in the development are almost found again from bottom to top in the soil profiles (p. 103), which reveal a discreet differentiation of the horizons.

Chemical composition of whole plants. Comparison between serpentine silicates, carbonates (p. 170) reveals serpentine has its own status. Whereas N P K C/N and ash content hardly vary between substrates (contrarily to other serpentines) and are very specific to the species, chiefly K, the other elements reflect rather the substrate: on serpentine Ni Cr Co Fe are high (though lower than on other alpine serpentines), Ca/Mg far inferior to 1; on serpentine and silicates Ca and Mo are low, Si high; on serpentine and on carbonates Mg is high, Al P K are relatively low; the remaining microelements reflect the underlying rock. In regard to the rock it is K, then P, which plants on serpentine accumulate the most, whereas Ca and Ca/Mg improvement remains modest (p. 176).

Silicicoles, calcicoles and indifferent species on serpentine tend to differ: with Ca Mg Si, silicicoles/calcicoles tend to behave as if they knew best how to limit the elements in excess on their usual substrate; for K P and micronutrients, they tend to recall the composition they have on their usual substrate, reflecting this parent-rock; indifferent species tend to tolerate in their tissues the most unfavorable contents, in excess or in deficiency, possibly through ecotypic adaptation (p. 188; see rooting above).

Considered in regard to the rock, the alimentation of the studied silicicoles/calcicoles seems primarily to turn around a certain necessary amount of K and P, even at the price of absorbing, in ± forced accompaniment, high rates of Ca Mg Si, according to whichever of these elements predominates in the initial substrate.

Conclusions. The original response of vegetation to (non-tropical) serpentine is conceived here as a strategy of stress-tolerance (p. 235). Now the responses to different stresses, such as dryness, nutrient deficiency, heavy and toxic metals, alpine and arctic climate, converge toward a slowing down of life (and of pedogenesis). This multiplicity of stresses on serpentine, to mention only modesty in essential nutrients and excess in elements with toxic tendency, reinforces the vegetation response and leads to the great contrasts between vegetation (and soils) on serpentine and on other substrates. Contrasts, however, less extreme in Davos than on lower sites because of the common stress of alpine climate and of the post-glacial recolonization history. The various stress factors are considered as specific resistances leading to the slowing down of life; this slowing down as the energetic price for adaptations and tolerances, i.e. specializations (to only mention the inherent slow growing rate). Moreover, this slowing down corresponds to an extraordinary knowledge, a unique richness, hidden behind what is easily called the sterility of the serpentine.