THE ALPINE GARDEN SOCIETY
CENTRAL SUSSEX GROUP

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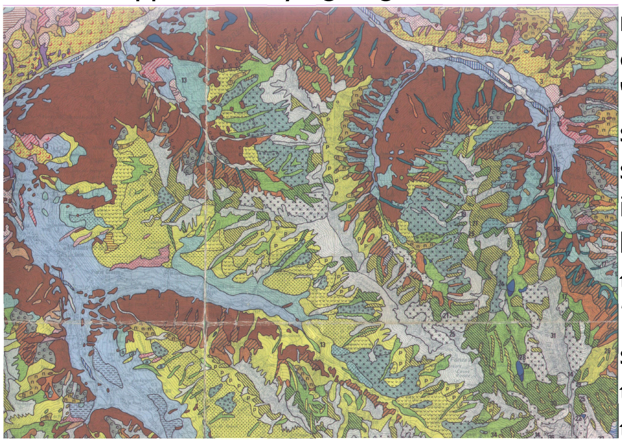
PLANTS AND THEIR ALPINE ENVIRONMENT

It will be familiar to all who travel to mountainous areas in any temperate region in the world, that the nature of the vegetation changes as one climbs upwards. These stages are now regarded as composed of a series of plant associations (biocenoses) which have general validity within a variable range of altitudes and are often designated in ascending order as the hill stage (zone or belt), montane, subalpine, alpine and nival stages. These provide convenient dividing lines although in reality there is a continuum. In many parts of Europe these have been described and to a lesser extent mapped in varying degrees of detail. Each plant community in each of these stages is first named after the dominant trees or grasses, sub-divided into a number of series and then often into 'modes' based on their humidity and calcareous or siliceous nature each containing characteristic plant species. Examples were shown from the Queyras in SE France – for example in the one above the brown is sub-alpine larch (usually north facing) and the light blue is hay meadow with the oat grass *Trisetum flavescens*. The yellow areas are four series of alpine stage grasses. (For web viewers, these can be distinguished by enlarging the map – this won't be apparent in the printed version, sorry about that!).

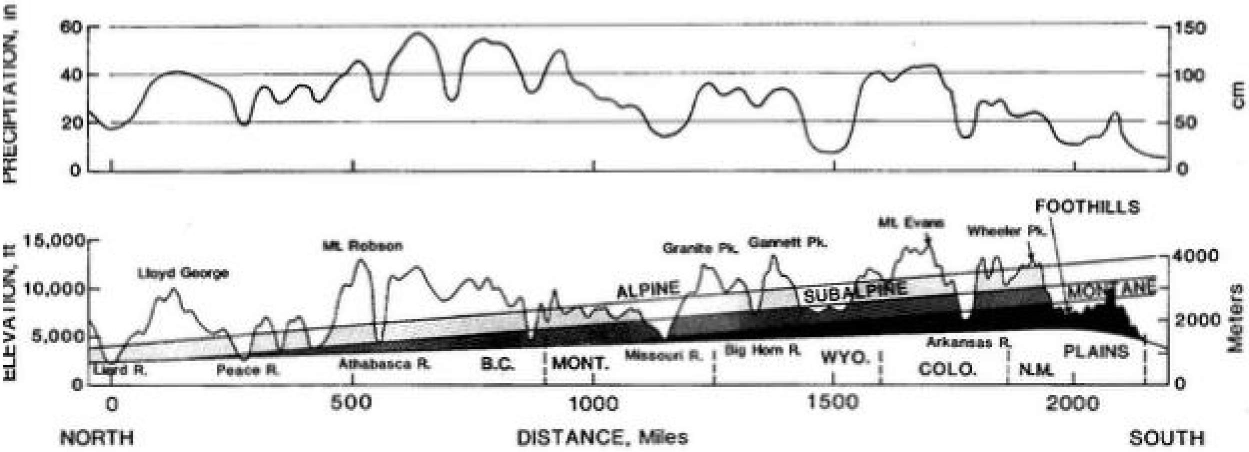


Section of Queyras plant community map - Molines & Aigue-Agnelle valley

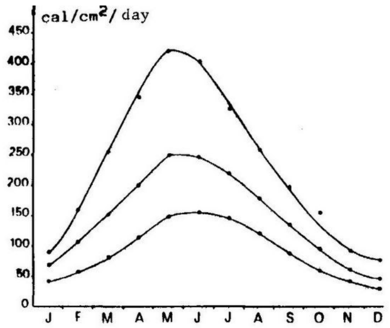
What is of particular interest is that whereas the brown (larch) and the yellow (grasses) grow at the same height, the former is sub-alpine (i.e. below the tree line), the latter is alpine (above the tree line), so clearly altitude is not the controlling factor in determining whether a plant is a sub-alpine or an alpine. It is temperature – why so? Of greatest significance is the nearly worldwide regular linear decrease in temperature of 0.560 C./100 m. 1.00F/330ft., but closer to 0.80C (1.4F) where there is a maritime influence as on the Pacific coast of North America. It also varies from 0.7 C. in summer to 0.4 C. in winter and is slightly higher on south facing slopes. In the European Alps, the temperature range within which each stage develops is about 4 C. so that each has an average amplitude of 700m. (4°/0.56°C x 100m.) The vegetation stage then ceases to be a concept related to height above sea level and is instead associated with a particular range of temperatures. In other words, where the same plant communities are present irrespective of their location, they may be identified by reference to the mean annual temperature scale and not specifically to altitude.

That a 1° (111km. or 70 miles) shift in latitude north has roughly the same effect as 111m. (360ft) elevation, explains for example, both the average level of beech forest falling from 1800m. in Corsica to 1200m. in the Vosges, the timberline in the Rockies falling from 4000m. In New Mexico to 1000m. in northern British Columbia and conversely in lower latitudes of rising from 10-

12,000ft. in the Eastern Himalaya (25N) to 15-15,000 in SW China (280N) in China. It also explains the descent of plants like *Dryas octopetala* and *Silene acaulis* from around 2000m. in the Alps to around 100m. in Scotland.



Of less but still significant importance, is the increase in solar radiation with altitude and variations in the amount and nature of precipitation.



Solar radiation intensity in relatin to altitude

The intensity of solar radiation increases at higher altitudes because the thickness of the atmosphere through which this radiation travels is reduced (it is more than twice as strong at 1800m as at sea-level), but of course varies according to the season and the amount of cloud cover. Nocturnal re-radiation, however, does have an effect since it leads to rapid cooling especially in summer. Sunny slopes benefit from the warmth accumulated during the day which to some extent ameliorates their greater nocturnal radiation. The orientation of slopes in relation to the sun has long been understood, all mountain regions having terms to denote sunny slopes with their hours of insolation and the shady ones - soulane and ombrée in the Pyrenees, adret and ubac in the S.W. Alps, Sonnenhalb and Schattenhalb in the E. Alps etc. Plants growing on south-facing slopes nearly always climb much higher and the difference between sun and shade may exceed 50^0C above 2000m. The differences between the extremes of north east and south west orientation are of the order of 3 to 4^0 C with the altitude of the upper limit of forest varying from 100 to 200m. and the level of the snowline varying from 150 to 600m. on the opposing slopes. There is greater humidity on forest covered shady slopes where with daytime ascending winds, condensation forms mists or low cloud which favours the development of, for example, beech and spruce in the C. Pyrenees at between 1100m. and 1800m. or fir rather than Scots pine in the Alps. The differences between sunny and shady situations were shown in the slides of the Nedertal in Austria's Otztal, the valley of the Aigue Agnelle east of Molines-en-Queyras and the diagram across and up the Grodner Tal (Val Gardena) in the N.W. Dolomites.


Molines-en-Queyras & Aigue Agnelle valley

Although there is a general increase in precipitation with altitude, it is altogether a more complex feature than temperature. In the Alps, for example, it tends to decrease from the external to the internal, from west to east and north to south, while in some intra-alpine valleys it is practically independent of altitude, even sometimes as in the valley of the Upper Durance (Embrun to Briancon in the French Alps) decreasing with altitude. Much more important is snowfall - in the

French Dauphiné Alps, the percentage of precipitation falling as snow is of the order of 20 to 25?o at 1000m.; 50 to 60% around 2000m.; 80 to 90% about 3000m. and reaches 100% around 3800m. Its duration, lasting perhaps for 6 months at 1500m. and 9 months at 2500m. is more significant for plant growth than its depth, since vegetative growth (but not photosynthesis) can take place only in the snow free period. It does, however, constitute a reserve of water on which it can call with the onset of thaw and it insulates plant life against winter cold - 20 to 30cm. of snow is sufficient to even out diurnal fluctuations of temperature and 50cm. ensures temperatures rarely falling below zero.

Light intensity increases with altitude – at only 1600m. it is twice as strong in summer, in winter even 6x as at sea level. Intensity between sunny and shady places increases with altitude – at 3000m 6.5x higher in sun whereas at 2000m only 2x. Mean wind velocity increases with altitude, and although it diminishes close to the ground because of friction., alpines must be well anchored, resistant to mechanical damage and effectively protected against evaporation.

These general factors and therefore the precise level of the vegetation stages are subject to all manner of influences and that where the dividing lines are drawn may depend, for example, on exposure, slope, and on local climate.

In Europe the SUBALPINE stage has been defined as the space between the upper limit of beech (or Scots pine where beech is absent) and the upper limit of woody vegetation. Although often difficult to fix with precision, it occupies a belt of some 600 to 700m. whose limits are around 1600 - 2500m. in the C. Pyrenees, 1700 - 2400m. in the south-west Alps, 1400 - 2400m. in the Bavarian Prealps and 1200-2250m. in the Carpathians. In North America it is the space occupied by *Picea engelmannii* and *Abies lasiocarpa* which lies between 3400m and 4000m. in the southern Rockies and 600-1000m in the north. The average annual temperature of the stage lies between 0.5^0 and 4^0C with over 50% of the precipitation falling as snow. In Europe the climax of the stage is coniferous forest - spruce, fir, larch, Arolla pine and mountain pine with only local birch and green alder providing deciduous cover.

Within such forest one may find Wintergreens like *Pyrola chlorantha* and *Orthilia secunda*, the ericaceous Cowberry *Vaccinium vitis-idae* and in more open conditions, *Cypripediun calceolus*, *Daphne cneorun* with *Polygala chanaebuxus* and *Lilium martagon*. For various reasons the stage can be completely bare of trees as in the Massif Central and Vosges, while in the principal mountain chains it is the action of man with his flocks and herds and his logging activities which has often had the effect of eliminating trees and shrubs and the artificial development of pasture - in many areas the lowering of the tree-line is of the order of 200 to 300m. Under these conditions the forest/ grassland transition is usually quite clearly marked as seen in the view towards the Lavaze Joch and Eggental in the W. Dolomites. It is in these clearings that the subalpine grassland may be cut for hay and if you are early enough there may be *Campanula glomerata*, *Daphne cneorum*, *Veronioca spicata*. *Carduus defloratus* and in the Gang Ho Ba of China's Yunnan *Cypripedium flavum, C. franchetii, C. tibeticum, Arisaema elephas*, *Nomocharis aperta* and the bristly *Meconopsis prattii*. Sometimes there is almost a monoculture - of *Anemone narcissiflora* in part of the Melezat meadows of the Queyras or *Narcissus poeticus* in parts of the E. Pyrenees.


Meconopsis prattii

Heathland assumes far more importance in the subalpine stage than in any other, and its dwarf shrub and sub-shrub communities, often lying within a mosaic of other habitats, are particularly typical of the upper part. Favouring sunny positions, especially on calcareous rocks and convex slopes with little snow cover, the vegetation is frequently dominated by dwarf juniper and *Arctostaphylos uva-ursi*, while on shaded siliceous soils given snow protection, are communities of *Rhododendron ferrugineun* and *Vaccinium*. *Rhododendron* is poorly frost resistant and at higher levels requires winter snow cover such that it is more frequently found on north facing slopes as in the Fedare of the Dolomites. In the Beima Shan of western Yunnan, the dominant heathland consists of *Rhododendron hippophaiodes* and *R. russatum* and there is *Cassiope pectinata*, perhaps a natural hybrid between *C. fatigiata* and *C. wardii*. Prostrate shrubs characterised by *Empetrum hermaphroditum* and *Loiseleuria procumbens* and lichens occur on thin acid soils exposed to the most violent of winds. This Creeping Azalea can withstand coldness down to -40°C and dew is very important for the plants to survive. It is therefore adapted to take up water through its rolled leaves which have two hairy channels on the undersides running down from the leaf tips and from the numerous adventitious roots borne on the stems.

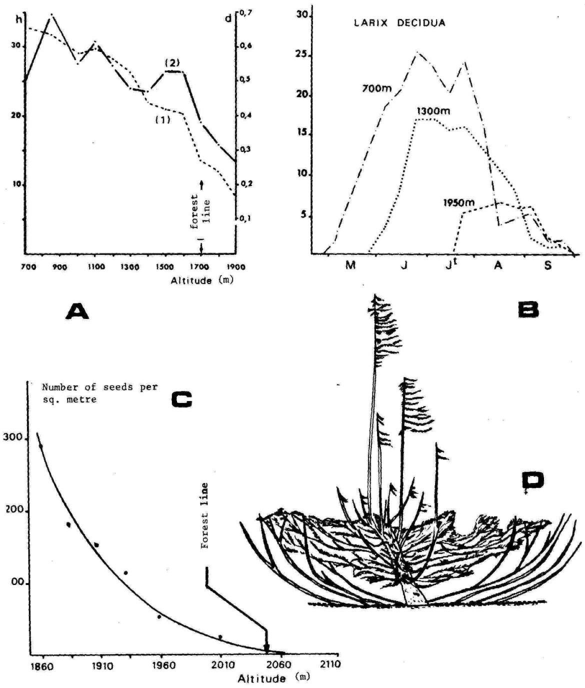

Beima Shan, NW Yunnan

Higher up trees become isolated. There are two forms of the European Mountain Pine,i which although found throughout the stage, are particularly characteristic of the upper part. These are *Pinus mugo* and *P. uncinata*. *P. mugo* is mainly a feature of the central and eastern Alps, the Appenines, Carpathians and Yugoslavian Dinarides where it often constitutes a low forest 2 to 3m. high, usually on limestone and unimpaired by steep slopes. It is accompanied typically by *Arctostaphylos alpina*, *Daphne striata*, *Lonicera alpigena*, *L. coerulea*, *Rhododendron hlrsutum*, *Rhodothamnus chainaecistus*, and *Saxifraga caesia*. *Pinus mugo* is often snow covered in winter unlike the taller *Pinus uncinata* which is characteristic of the calcareous peripheral mountains of the W. Alps, although it is equally at home on siliceous rock, one of its most spectacular sites being found around Lakes d'Aubert and d'Aumar in the Néouvielle Reserve of the C. Pyrenees where it reaches a record height of 2640m. Here it withstands the rigorous climate of violent storms, dryness and wetness, extremes of temperature, subsisting equally in bogs, wind-battered crests and screes - "the tree which more more than any other has the capacity to suffer without dying". In more favourable situations it can attain 15m. in height. Its associates include *Arctostaphylos uva-ursi* and *Juniperus nana* on dry slopes and on damper slopes, *Homogyne alpina*, *Listera cordata*, *Polygonum viviparum, Rhododendron, Rosa alpina* and *Viola biflora*.


Lakes d'Aubert and d'Aumar
Pinus uncinata

The sublalpine's upper limit is the timberline where the natural transition of some 100 to 200m. is marked with trees diminishing in density and size, the land between a discontinuous mosaic of trees, heath and grassland, the wooded areas becoming islands in which the individual trees take on a tortured appearance. This is known as the combat zone (kampfzone), where remaining trees termed krummholz (German for twisted trees) fight for the occupation of space in the lower part, simply surviving above. Such growth as there is is to the lee side of clumps so that some tree islands are mobile with a net movement downwind of 2 – 4 cm. a year (20m in 500 years) recorded in North America. The tops of those trees which extend above the snow are thrashed and ice blasted, bark on the windward side is abraded and polished such that growth occurs only downwind. The result a flag-like appearance, but at the same time the lower branches often spread out protected by winter snow cover - spruce is able to root its branches when in contact with the soil. The most severe form of deformity is seen in the size and shape of trees which may grow only inches high but may send out ground-hugging branches to great distances forming a sprawling cushion as wide as 20m. Some clumped trees produce multi-stemmed trunks at ground level, others clustering to provide wind shelter, mutual mechanical support, high humidity and commonly develop on hummocks or in parallel ribbon forest extending perpendicularly to the prevailing winds and function like snow fences. They do have benefits in that they provide cover for animals like voles and nests for hardy birds and they help stabilize snow and fragmented rock on steep slopes, reducing the risk of avalanches and landslides. Trees become polished and abraded by the wind and may huddle against any protective shield.

The factors that determine the upper limit of trees are probably multiple among them



Trees at their upper limit: A-Slowing down of growth with altitude (lower temperature), (1) height (2) diameter of spruce; B-Shortness of growth period of larch; C-Reduction of spruce fertility with altitude; D-Spruce growth at upper limit, at base branches protected by snow, above erect branches in wind-formed flag formation

Low temperatures which reduce photosynthesis, by as much as a half in a few hundred meters, while assimilation takes place only during part of the year although the loss by respiration, albeit reduced in the cold season, persists all year long.

Slower growth, essentially the result of low temperatures and hence short vegetative periods, the effects of wind and the nature of the poorly developed soil. With a reduced rate of assimilation, trees cease to transform and fix sufficient material for building a decent trunk and branches and annual growth, whether in height or diameter of trunk, decreases rapidly with temperature. The Cembra (Arolla) Pine can take a century to attain 10m. although longevity is the norm - in the the Swiss Aletsch Reserve there are trees over 1000 years old. The smaller alpine plants grow equally slowly, *Dryas octopetala* for example has a growth rate of only 2cm. over 10 years and a 15cm. mat may be 60 years old!

Regeneration difficulties in that the production and viability of seed, and therefore the chances of germination and survival, diminishes rapidly with temperature and altitude. Spruce will produce seed only every 3 to 5 years even in favourable positions and only every 9 to 11 years at the limits of growth. Moreover the existence of other vegetation militates against the growth of seedlings.

Soils and geology strongly influence rooting abilities in that moisture is less available in fine textured soils and competition from grasses and other plants is more severe. The chemical composition of the underlying rock often helps determine which species will inhabit a given site – the Brislecone Pine of the White Mountains extends to both higher and lower elevations on the alkaline dolomitic rock than on the slightly acidic sandstone – better availability of moisture, tolerance for low nutrient availability and lack of competing vegetation.

Permanently frozen ground (permafrost), hundreds of feet thick underline most of the arctic tundra, thawing confined to a thin mantle of surface soil restricting growth of all tree species, although not all to the same extent, depending on the depth of rooting. Repeated freezing and thawing damage roots of seedlings and leads to soil creep,

High elevation trees use less water, the stomata tending to be almost completely closed in winter preventing evaporation and there is a diminishing quantity of carbon dioxide, one of the key ingredients for photosynthesis.

The **ALPINE stage** lies between the upper limit of woody vegetation and the upper limit of continuous grassland. In general it extends to 3400m. in Spain's Sierra Nevada, 3000m. in the Pyrenees and S.W. Alps, 2700m. in the N. Alps and 2300m. in the Carpathians. Genera which have strong alpine affinities are *Androsace, Astragalus, Draba, Gentiana, Phyteuma, Potentilla, Primula,* *Saxifraga and Veronica*.

Environmental conditions are particularly harsh -
A large proportion of alpine plants are marked with the distinctive red colour of anthocyanin pigments (a product of carbohydrates stored in the roots from the previous growing season) in stems and leaves, especially marked in spring before photosynthesis and the making of chlorophyll becomes fully operative. They are capable of converting light into heat. You may recall arctic *Saxifraga flagellaris* in a recent talk

Some are so physiologically adapted to a short cold growing season that their survival at lower altitudes becomes a problem for growers. Many alpine plants are able to begin growing just above 0^0C in contrast to temperate ones 6^0C. Flower buds often begin early in the previous year's growing season or even seasons and are usually well formed before winter sets. Small size usually involves only the growth shoots, making the flowers seem larger in proportion. Most are perennial, so do not have to expend energy in producing stems, leaves, flowers and fruit in one short growing season. Plants assume dwarf size, most assuming ground hugging forms such as cushions and mats, with the underground parts often many times the size of the aerial parts. Snow cover provides thermal protection and a reserve of water following snowmelt, although often followed by water deficiency in summer.

Strategies against evaporation are dense hairiness, especially on leaf undersides, wax coating and succulence (both rather rare), leathery leaves – thick walled epidermis, leaves rolled under, bristle-like leaves

Cushion plants dot the ground, their streamlined shape allowing minimum exposure to the elements, but with maximum exposed leaf surfaces. Temperatures within may be several degrees higher than on the outside, Although often seen as mats, *Silene acaulis* is the prototype cushion, its stubby branch catching blown in particles, which with old leaves, contribute to soil building and stabilisation and absorbing moisture. For an alpine plant, it grows fairly rapidly, perhaps half an inch in five years, flowering by 10, 25 before it does so profusely when it reaches 6 or 7" across Then its roots will be a foot or more deep.

Mats are more spreading, often rooting at or just under the ground. A rosette may be even less exposed to desiccating winds and receiving both direct sunlight and reflected heat from the ground with little or no vertical separation between the leaves. Succulence provides even greater protection by having a waxy surface that prevents evaporation, while the taproot may go down several feet. The foliage of many alpine plants look grey-green, but are as green as lowland plants below their coatings of brown, silver or wool-like appearance - in reality all sorts of hairs - short and spiny, glandular, stellate, long and soft, crinkled, strigose, felty, attached in the middle, on the edge or scattered. Dark hairs absorb even more light than white ones, while some of the furriest species (eg. *Pulsatilla vernalis*) are the earliest flowering. They insulate, diffuse strong alpine light and protect the plant's stomata from water loss.

Vegetative reproduction does not depend on sometimes unfertilised or destroyed seed and allows rapid colonisation from a single parent plant. One of the most prolific plants is *Polygonum bistorta* whose bulblils fall from the parent stalk and are able to establish themselves during the same growing season as they are produced, sometimes sprouting before they separate. Other plants send strawberry-like runners over the ground.

Low temperatures, frosts and wind usually cause plants to assume dwarf size, most assuming ground hugging form - cushions, espaliers or mats, with the mass of the underground parts often many times the size of the aerial parts, but there are some giants like *Veratrum album*.

Where the ground remains snowfree, extremes of coldness are experienced, but snow cover provides thermal protection and a reserve of water following snow melt for early spring growth, followed however, by water deficiency in summer. Certain plants conserve their green parts under snow, some like *Soldanella alpina* forming their buds by the end of the the previous summer. No doubt the argument will continue over the reasons for the precosciouness of this genus, whether their buds liberate heat or whether it derives from the latent heat of fusion. What may be of more significance is that with strong early summer sunshine, all dark objects below snow are warmed by several degrees above zero and that when snow melts down to 11 - 18cm., there is sufficient light for photosynthesis to take place so that the growing period of such plants can be considerably than the time during which they are actually free of snow.

In spite of often very abundant flowering, seed doesn't mature every year and viability is very unequal, although it can remain dormant sometimes for years. Germination in some plants may require the action of damp cold, but in others an optimum temperature of 20^0C is required whatever the altitude. On the other hand, vegetative propagation is widespread.

Grassland in these upper stages can, depending on depth of soil, be quite luxuriant or patchy and threadbare. They may be the discontinuous nature or quite widespread (eg Aigue-Agnel part of the Queyras map – *Festuca vallesiana* and *F. violacea*). These grassland communities are highly diverse and no attempt was made to describe them in detail. Some pastures at alpine level are cut for hay as on the Seiser Alm, although this may be artificially largely below the tree-line. It is in these upper pastures with skeletal soils that the pH becomes a significant factor and one can begin to separate plants which have a calcareous or acidic preference, but caution is necessary in assuming alkalinity or acidity - for example, that of sandstones depends largely on the nature of their cement Moreover the pH of soils is much more complicated than is often assumed - in particular they may not be derived from the underlying rock, but have been transported over considerable distances as a result of erosion, sliding, water or glacial movement. In addition, slope, orientation, granulosity and the water regime will result in a complicated mosaic of diverse soils in a relatively small space. Where precipitation is high, soils tend to be highly leached and acidic and can lead to turf with a pH of about 5. However, where the soil is sufficiently acid to suit "acid-soil plants' they crowd out the 'lime soil plants' which could grow quite well here if competition were excluded. Where the soil is lime-rich on the other hand, the vitality of the acid-soil plants is so weakened that they die out in time, even without competition in places where they have managed to gain a footing in the first place. Here may be found lime loving species like *Dianthus pavonius* and the Alpine Sainfoin *Hedysarum hederaroides*, unexpected ones like the Cowslip *Primula veris* growing at 2230m. below M. Viso. In the eastern Alps *Primula wulfeniana* and over widespread areas of the Alps *Pulsatilla alpina,*, *P. vernalis*, *Ranunculus pyrenaeu*s, *Saxifraga oppositifolia*, *Soldanella alpina*, *Trifolium badium*, L*eontopodium alpinum* and in China *Androsace spinulifera* and *Stellera chamaejasme*.

Among the calcifuge preferring species – *Aster alpinus, Campanula barbata, Gentiana acaulis, Geum reptans, Linaria alpina, Saponaria pumilio, Soldanella pusilla and Nigritella cornelliana* and and on the Selle Pass in the Dolomites *Primula glutinosa* associated with patches of calcicole *P.minima* in good flower (and no doubt as a result hybrids between the two),

Where there is little competitive grass, *Campanula alpestris*, the far from easy to spot Moonwort Fern *Botrychium lunatum, Potentilla nitida*, *Ranunculus segueri, Alyssum wulfeniana, Campanula alpestris, Doronicum grandiflorum, Leucanthemopsis alpinum., Rhodothamnus chamaebuxus* and *Semervivum arachnoides*

Snow hollow vegetation is most often found below north facing banks or at the foot of cliffs and has the briefest of growing seasons - often only two or three months. Plants are of small stature with a predominance of underground parts, the species often differing according to their precise position within the depression. *Crocus albiflorus*, *Primula integrifolia, Pulsatilla vernalis*

Crocus albiflorus

and *Ranunculus pyreneus* are among the more conspicuous of the snow melt plants. Where cover is less than 8 months, *Salix* species, *Carex foetida, Luzula spadicea* and *Polygonum viviparum*.

The disintegration of cliffs as a result of differental expansion and freezing and thawing of the rock and root penetration, leads to the accumulation of debris at their base in cones and festoons of initially unstable scree seen on 2987m., Pietra Grande in the Brenta Dolomites and Pic Lastei above the Selle Pass. This carries vegetation intermediate between that of the cliff dwellers above and that of the turf below into which it grades with eventual stabilisation. It varies essentially according to the nature of the rock which remains predominantly without a true soil and its granulosity (size of particles) which in turn influences the circulation and retention of water. The plants are particularly adapted to the downward movement of the scree, being furnished with aerial or underground stolons which may run parallel to the surface taking root from place to

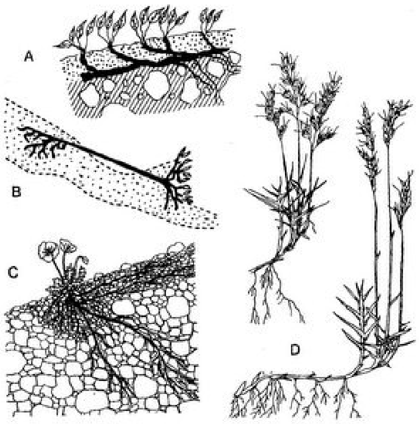


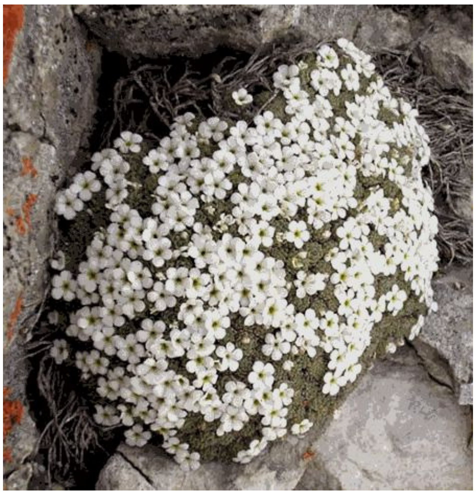
Illustration 1: Adaptation of plants to scree: A-Valeriana montana roots anchored below; shoots in mobile soil above; B-Salix retusa roots anchored from above, espalier forming new roots below; C-Papaver rhaeticum anchoring deep roots with elongating finer roots above; D-Oat grass with migrating stolons

Pietra Grande Brenta Dolomites

place in the fragments of soil at shallow depth, or the stems, anchored by a primary root system, may develop in a downhill direction. Typical species are *Petrocallis pyrenaica, Eritrichium nanum* and *Ranunculus glacialis*. Scree vegetation is always scanty as a result of germination difficulties, a dearth of water and the mobility which may partially or completely destroy plants. In calcareous screes composed of large and medium sized fragments and with a pH of 7.5 to 8, the most characteristic plant is *Thlaspi rotundifolium*, the most delightful of the Pennycresses, *Papaver rhaeticum*, *P. kerneri, Saxifraga oppositifoJia*, and a fascinating dwarf non-spiny thistle confined to the S.W. Alps, *Berardia lanuginosa (Onopordum rotundifiun)*. The screes of calcschists are always rather fine, more rich in their flora but having many species in common with other calcareous screes - eg. *Saxifraga oppositifalia*; on occasions a single species dominates whole scree slopes as in the photographs of *Ranunculus parnassifolius* taken towards the upper end of the Err valley in the eastern Pyrenees.

Berardia languinosa

Scree-like deposits whose slope angle can be quite low, may result not from the disintegration of cliffs, but rather from the blocky or fissile nature of rocks like mudstones, slates and schists and sandstones - often found in what are known as 'flysch' facies. Whole mountain tops may be so covered as in the 2872m. high Cime de la Bonnette which just below its summit carries the highest road in France. Here there are five different plant communities in the argillaceous blocky and slaty rock, much covered by *Ranunculus glacialis* with on its south western edge, scattered tufts of *Vitaliana primuliflora*.


Androsace helvetica


Androsace helvetica habitat, Col Agnel, Queyras

Perhaps the most specialised habitats are cliffs as in the Dolomite Averau and Lastrone Verde whose plants are subject to severe ecological restraints - great temperature changes, both seasonal and diurnal, and lack of water particularly in non-porous or little fissured rock. Fissure plants (chasmophytes) often adopt the form of cushions like *Androsace helvetica* seen on the frontier between France and Italy in the Queyras, or grow as mats as in *Eritirichium nanum* and the Pyreneean endemic *A. ciliata*. Most cliff dwellers, however, are to be found in crevices – such as the ferns *Asplenium septentrionale* and *Polystichum lonchistis*, *Primiula marginata, Arenaria purpurascens* and *Euphorbia chamaaebuxus* Others like *Globularia*, *Rhamnus pumilus* and *Salix ssp*. are plastered in espalier form across the cliff face. Cliffs (screes and water) are, of course not confined to the Alpine Stage, but can occur at many different levels with their own their own plant associations.

Water, whether beside waterfalls, streamsides, around springs and flushes or in marshes, have its own flora. Grasses, sedges and rushes like *Juncus filiformis* predominate, but of the more floriferous species one may find plants like Primula farinosa, the Marsh Marigold *Caltha palustris*, Butterworts like *Pinguicula leptoceras*, *Saxifrage aquatica*, and the yellow globes of *Trolius europaeus* or the dwarfer and deeper yellow Chinese *T. wardii*.

The uppermost stage is the **NIVAL** where on average the annual snowfall exceeds the rate at which it melts. Here on snow-free rock the number of species drops off extremely rapidly with decreasing temperature, especially the flowering plants. In the Otztal 102 species have been recorded above the snow line of 3000m., 60 above 3200m., 34 above 3400m. but only 3 over 3500m. *Ranunculus glacialis* may well be the highest flier having been found at more than 640m. above the snow line. Here too are lichens, liverworts, mosses and the microscopic algae *Haematococcus nivalis* which sometimes colours the snow pink.

It is hoped that this talk would have given you an additional understanding of the ways in which mountain plants (and for that matter those of the Arctic tundra), face up to their environment and grow where they do.

Six books with which to further your knowledge – 'The vegetation of the Alps' - Nature and Environment Series 29 Council of Europe; 'A guide to the vegetation of Britain and Europe – Polunin & Walters; 'Mountain flowers' – New Naturalist 33 Raven & Walters; 'Vegetation ecology of Central Europe' – Ellenberg; 'Timberline' - Arno & Hammerly; and 'Land above the trees' - Zwinger & Willard. If you read French: 'La végetation de la chaine alpine' – Ozenda (author of the Vegetation of the Alps above) and 'La végetation du Queyras' Revue Biologie-Ecologie méditerranéenne X No.3.

RM

NEXT MEETING

April 8 – Remember this is the second Saturday!

Chile – 'A long thin journey' ~ David Lang

and Spring Plant Sale. Please bring what your have (and money to buy!) and also for the Hassocks Show tombola - see Chairman's news last month.