What is an alpine plant?

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2 References: Körner, C. 2009. Alpine plant life, 2nd ed. Springer-Verlag; Nagy, L. & G. Grabherr. 2009. The biology of alpine habitats. Oxford University Press.
3 Alpine - above treeline (Saskatchewan Glacier from Parker Ridge)
4 Global occurrence - about 3% of Earth's terrestrial surface (Swiss Alps)
5 Alpine, but not necessarily mountainous (Tibetan Plateau, China: *Ligularia sagitta*)
6 Alpine, but not necessarily mountainous (Salinas Grandes, Argentina)
7 Why a treeline? (Cerro Catedral, Argentina)
8 Why a treeline? – Soil temperature and growing season at treeline (Körner & Paulsen 2004 Journal of Biogeography 31: 713–732)
9 Latitude and alpine zones
10 Tropical alpine (Mt. Kilmanjaro, Tanzania)
11 Tropical alpine (Mt. Kilmanjaro, Tanzania: *Dendrosenecio* [*Senecio*] *johnstonii*)
12 Tropical alpine (Mt. Kilmanjaro, Tanzania: *Lobelia deckenii*)
13 Temperate alpine (Andorra)
14 Global alpine flora - ~10,000 species of alpine plants, ~4% of all flowering plants (*Penstemon rupicola, Incarvillea zhongdianensis, Lewisia columbiana v. wallowensis*)
15 Are alpine plants unique? (Cerro Catedral, Argentina: *Armeria maritima*)
16 Are alpine plants unique? (Forth of Firth, Scotland: *Armeria maritima*)
17 Physical consequences of high elevation (Abra del Acay, Argentina)
18 Physical consequences of high elevation – Temperature (French Pyrenees)
19 Adaptations to cold growing temperatures – hairy foliage (*Sausseria laniceps*: Hengduan Mountains, China)
20 Physical consequences of high elevation - Temperature and height (Snowy Mountains, Australia)
21 Boundary layer as a thermal oasis (Volcan Copahue, Argentina)
22 Boundary layer as a thermal oasis (Volcan Copahue, Argentina)
23 Decoupling of atmospheric and plant conditions (*Jovibarba globifera*, Malá Fatra Mountains, Slovakia)
24 Decoupling of atmospheric and plant conditions – Cushions > Prostrate dwarf shrubs > Rosette herbs > Tussock grass > Tall herbs and shrubs
25 Erect herbs and shrubs (*Roscoea cautleoides*, Yulong Xue Shan, China; *Gentiana punctata*, Lomnicky štit, Slovakia)
26 Tussock grasses (Abra del Acay, Argentina)
27 Tussock grasses (*Chionochloa rubra*(?) Arthur's Pass, New Zealand)
28 Rosette herbs (*Calandrinia sp.,* Copahue, Argentina; *Celmisia coriacea*, Arthur's Pass, New Zealand; *Primula cuneifolia*, Mt. Hirayama, Japan)
29 Prostrate shrubs (*Phyllodoce glanduliflora*, Cavell Meadows; *Dryas* octopetala, Ptarmigan Cirque; *Cotoneaster microphyllus*(?), Hengduan Mountains, China)
30 Cushion plants (*Oxalis erythrorhiza*, Cerro Catedral, Argentina; *Azorella compacta*, Abra del Acay, Argentina; *Cumulopuntia boliviana*, Abra de Potrerillos, Argentina)
31 Growth form variation in the mustard family (*Wasabia japonica*; *Ptilotrichum spinosum*; *Smelowskia calycina*; *Draba polytricha*)
32 Zonation within the alpine zone (Lomnicky štit, High Tatras Mountains, Slovakia)
33 Zonation within the alpine zone – Lower alpine zone (Lomnicky štit, High Tatras Mountains, Slovakia: *Pinus mugo*)
34 Lower alpine zone (*Campanula alpina*, *Gentiana punctata*, Lomnicky štit, High Tatras Mountains, Slovakia)
35 Zonation within the alpine zone – Upper alpine zone (Lomnicky štit, High Tatras Mountains, Slovakia)

36 Upper alpine zone (*Campanula polymorpha*, *Ranunculus glacialis(?)*, Lomnicky štit, High Tatras Mountains, Slovakia)
37 Zonation within the alpine zone – Nival zone (*Saxifraga carpatica*, Lomnicky štit, High Tatras Mountains, Slovakia)
38 Physical consequences of high elevation – Temperature and aspect (French Pyrenees)
39 Maximum leaf temperature
40 Leaf tolerance of high temperatures
41 Unfamiliar neighbours (*Phlox kelseyi*, *Clematis columbiana* var. *tenuiloba*, *Penstemon debilis*, *Townsendia condensata*, *Dianthus haematocalyx*, *Vitaliana primuliflora*, Opuntia polyacantha)
42 Alpine adaptations – freezing resistance (*Silene* acaulis, Sunshine Meadows)
43 Alpine adaptations - meristems below ground (*Perezia* sp., Cerro Otto, Argentina)
44 Physical consequences of high elevation – Precipitation (Iruya, Argentina)
45 Precipitation dominated by location (Tibetan plateau, China)
46 Precipitation dominated by location (Puna, Argentina)
47 Precipitation dominated by location – Precipitation and exposure (Plateau Mountain facing west and east)
48 Precipitation dominated by location (Leeward, Mt. Hirayama, Hokkaido, Japan; *Caltha fistulosa*, *Pennelianthus fructescens*)
49 Precipitation dominated by location (Windward, Mt. Hirayama, Hokkaido, Japan)
50 Precipitation dominated by location (Windward, Mt. Hirayama, Hokkaido, Japan; *Dicentra peregrina*)
51 Local hydrology – Water is fluid
52 Local hydrology (Asahi-dake, Hokkaido, Japan)
53 Physical consequences of high elevation – Air pressure (Salinas Grandes, Argentina)
54 Physical consequences of high elevation – Ultraviolet radiation (*Cumulopuntia boliviana*, Abra de Potrerillos, Argentina)
55 Physical consequences of high elevation - UVB radiation during midsummer in the Alps (Nagy & Grabherr, 2009)
56 Flavinoids protect tissue against UV damage (*Arctostaphylos rubra*, Parker Ridge, Alberta)
57 Alpine soils – young and dynamic (Mt. Edith Cavell, Alberta)
58 Physical consequences of high elevation - Temperature and soil characteristics (Plateau Mountain, Alberta)
59 Soil development – (*Dryas drummondii*, Bow Summit and Athabasca Glacier)
60 Screes (Volcan Tronador (Chile) viewed from Cerro Catedral, Argentina)
61 Scree plants, Cerro Catedral, Argentina (*Nassauvia* sp., *Gaultheria pumila*)
62 Scree plants, Cerro Catedral, Argentina (*Loasa nana*, *Adesmia longipes*)
63 Scree plants, Cerro Catedral, Argentina (*Oxalis adenophylla*, *Azorella trifurcata*, *Oxalis erythrorhiza*)
64 Scree plants, Cerro Catedral, Argentina (*Calceolaria laguna-blancae*, *Viola sacculus*)
65 Active fine-grained soils (Cerro Chall-Huaco, Argentina)
66 Plants of fine-grained soils, Cerro Chall-Huaco (*Mulinum echinum*, *Mulinum leptacanthum*)
67 Plants of fine-grained soils, Cerro Chall-Huaco (*Nastanthus spathulatus*, *Tristagma nivale*)
68 Plants of fine-grained soils, Cerro Chall-Huaco (*Oreopolus glacialis, Viola columnaris*)
69 Developed organic soils – (Manrima, Tibetan plateau, China, 3500 m)
70 Meadow plants at Manrima, China (*Delphinium* sp., *Saussurea sp.*)
71 Meadow plants at Manrima, China (*Scutellaria* sp., *Halenia elliptica*)
72 Meadow plants at Manrima, China (*Gentiana* sp., *Gentiana* sp.)
73 Meadow plants at Manrima, China (*Pedicularis kansuensis*, *Pedicularis armata* var. *armata*)
74 Soil specialization (*Meconopsis horridula*, *Meconopsis punicea*: Tibetan Plateau, China)
75 What is an alpine plant? (*Helichrysum milfordiae*, Sani Pass, Lesotho)
76 The end (Salinas Grandes, Argentina)