

The study area

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2. THE STUDY AREA

2.1. GENERAL DESCRIPTION

The study area is located north of Davos in the Eastern Central Alps (Grisons, E Switzerland). The control plots are situated above the timberline, between 2200 m and 2600 m a.s.l. on slopes generally oriented to the south (Fig. 1, Table 1).

The climate in the study area is characterized by a precipitation of about 1100 mm/y. The mean temperature is about -1°C and the mean duration of the snow cover is from October to June; snowfall and frost are possible during the whole year (Fig. 2).

The study area is geologically very heterogeneous (Fig. 1), three main substratum types viz. dolomite, serpentine, and acidic silicate being quite distinct. For further information about the geological structure and tectonic layers see the Geological Map of the Grisons, 1:25000, part B (CADISCH et al. 1929). More details concerning vegetation and soil properties on dolomite and acidic silicate in the research area are given by GIGON (1971), the corresponding data on serpentine by EGGER (in prep.).

The ecological conditions within the study area are very variable: dense grassland, open scree slopes, and intermediate niches alternate on slopes of varying gradient. The duration of snow cover also varies: in wind-exposed areas the snow is often blown away in winter, while in sheltered depressions the snow cover is deeper and melts more slowly in spring.

Grazing animals occur frequently in some parts of the study area. The dolomite grassland is usually grazed by sheep and seldom cattle, but wild animals (Capra ibex, Marmota marmota, Rupicapra rupicapra, Lagopus mutus) occur within the whole area.

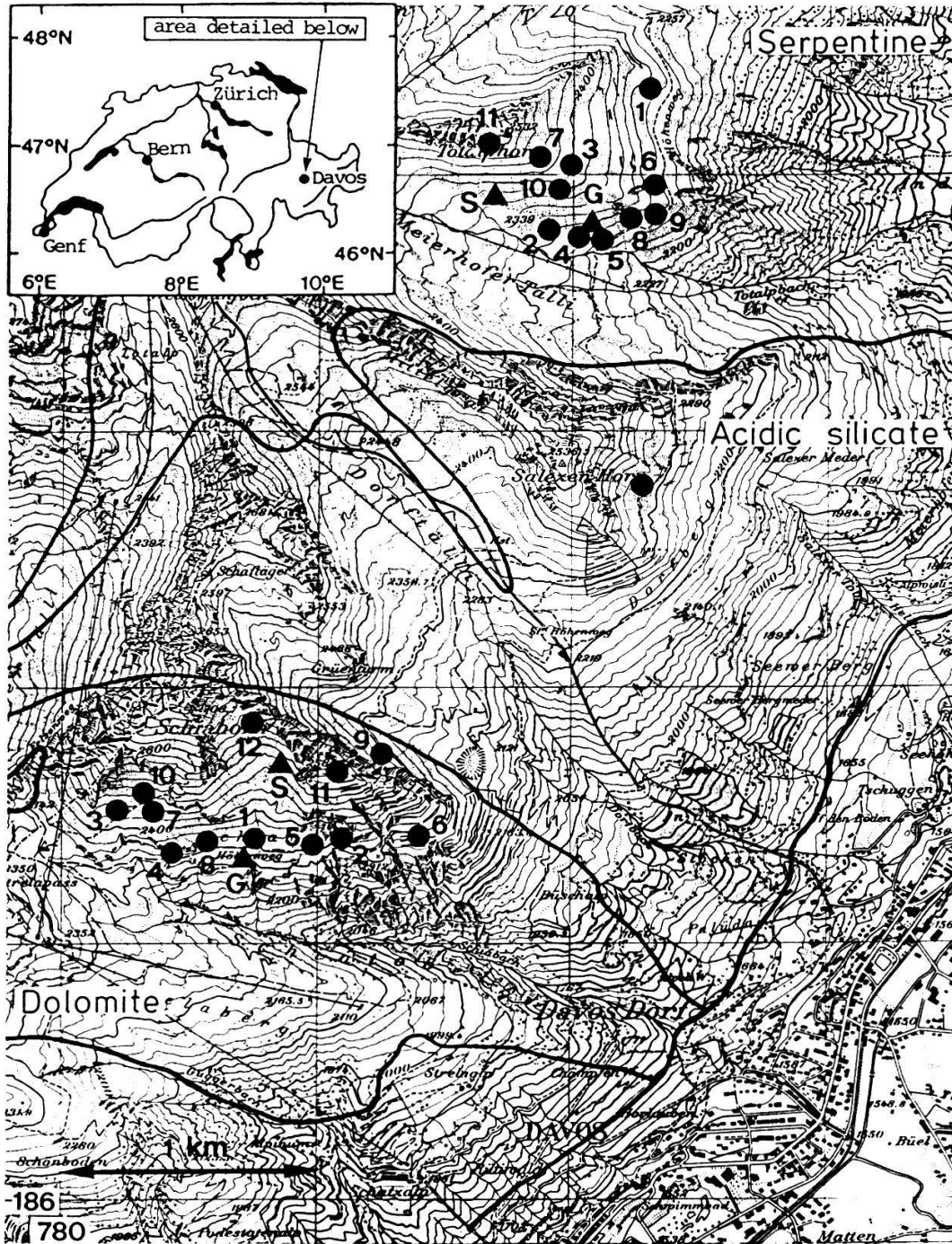


Fig. 1. Location of the study areas and the boundaries of the geological substrata; inset the relationship to other places in Switzerland. (Reproduced by permission of the Swiss Federal Office of Topography, 30 Oct. 1984).

Abb. 1. Lage des Untersuchungsgebietes und Grenzen des geologischen Substrates.

- ▲ = experimental plots G = on grassland, S = on scree.
- = natural subpopulations used in the demographic studies.

2.2. CHARACTERISTICS OF THE LOCAL SECTORS STUDIED

Biscutellia levigata occurs in various niches; the local sectors selected for the present study are accordingly situated upon various substrata and also support various types of vegetation (Table 2). The development

Table 1. Characteristics of the local sectors.

Tab. 1. Charakterisierung der Untersuchungsflächen.

- = not covered by stones, (+) = scarcely covered, + = moderately covered, ++ = scree slope

DOL = dolomite, SER = serpentine, SIL = acidic silicate

Plot code	Altitude a.s.l. (m)	Exposition	Slope %	Vegetation cover %	Surface rock cover	Remarks
DOL 1	2350	S	35	95	(+)	grassland
DOL 2	2340	S	75	70	(+)	grassland
DOL 3	2430	S	40	80	(+)	grassland
DOL 4	2330	S	35	70	+	intermediate
DOL 5	2340	S	50	60	+	intermediate
DOL 6	2300	S	50	50	(+)	intermediate
DOL 7	2440	S	50	60	+	intermediate
DOL 8	2360	S	60	40	++	scree slope
DOL 9	2320	E	60	30	++	scree slope
DOL 10	2460	S	50	20	++	scree slope
DOL 11	2560	S	55	20	+	highest site
DOL 12	2540	S	60	70	(+)	highest site
SER 1	2290	S	30	60	-	dense vegetation
SER 2	2300	S	35	60	(+)	dense vegetation
SER 3	2400	ESF	25	70	-	dense vegetation
SER 4	2280	S	45	25	(+)	intermediate
SER 5	2270	S	50	35	(+)	intermediate
SER 6	2280	E	30	20	(+)	intermediate
SER 7	2430	SSE	30	30	+	intermediate
SER 8	2280	SW	50	20	++	sparse veg.
SER 9	2280	SE	40	15	(+)	sparse veg.
SER 10	2380	S	50	10	+	sparse veg.
SER 11	2510	S	70	5	++	highest site
SIL	2320	E-S	30-60	70	-	grassland

of grazing. It should be noted that even the limited surfaces are frequently heterogeneous and comprise numerous microniches.

2.2.1. Dolomite

Grassland (DOL 1, DOL 2, DOL 3, Figs 3,4)

The sectors studied represented rather dense alpine meadow grassland with a plant height of 15-30 cm; the vegetation corresponded to the Seslerio - Caricetum sempervirentis association or to transitions between Seslerio - Caricetum and Caricetum firmae (Table 2). The sector DOL 2 was a well-developed terraced grassland ("Treppenrasen", Fig. 4). The soils were rendzinas with a varying amount of organic matter. The sectors DOL 1 and DOL 3 were frequently grazed by cattle, sheep, and wild animals.

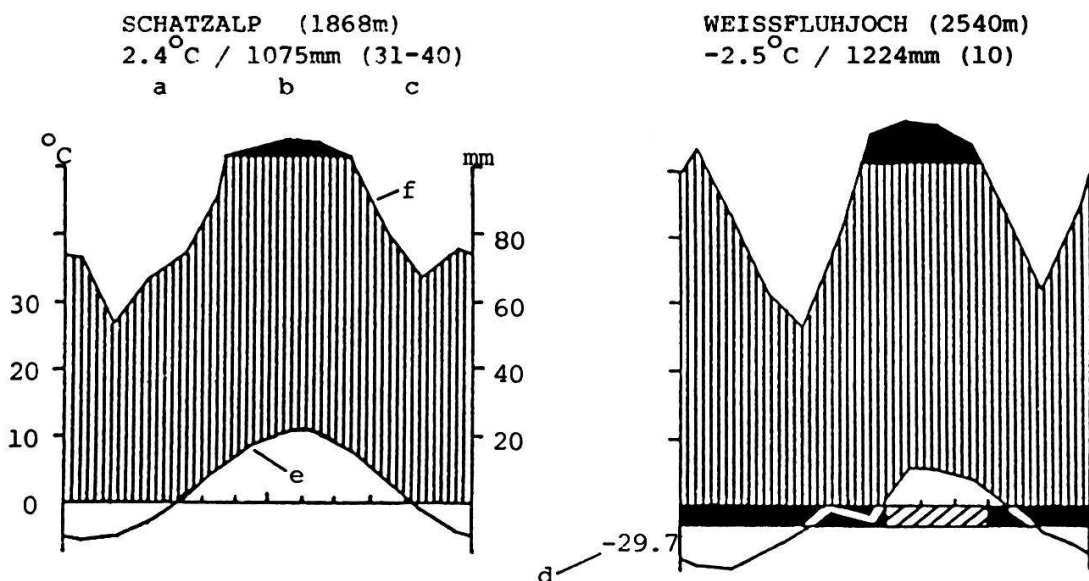


Fig. 2. Climatic diagram of Schatzalp (from WALTER and LIETH 1960-1967) and of Weissfluhjoch (from GIGON 1971).

Abb. 2. Klimadiagramm der Schatzalp und des Weissfluhjochs.

- | | |
|------------------------------|--------------------------------|
| a: mean annual temperature | d: lowest temperature recorded |
| b: mean annual precipitation | e: curve of mean monthly temp. |
| c: duration of observations | f: curve of mean monthly prec. |
| (left temp., right prec.) | |

Ordinate: one division = 10°C or 20 mm rain, black 200 mm rain

Abcissa: months (January - December)

Table 2. Phytosociological relevés taken in the local sectors studied. Frequency according to BRAUN-BLANQUET (1964).
Tab. 2. Vegetationstabelle der Untersuchungsflächen.

Taxon	DOL	SER	SIL
	111 123456789012	11 12345678901	
<i>Biscutella levigata</i>	++1+++1+211+	+11+1+1++++	+
<i>Campanula scheuchzeri</i>	+++++++ ++	+++++++ ++	+
<i>Minuartia verna</i>	+1+++ + 11+	+ +++ +++++	
<i>Silene willdenowii</i>	+ ++1++11	+ +1++++1+	
<i>Thymus polytrichus</i>	+++++ + +	++ ++++++	
<i>Festuca pumila</i>	1111 +1+ 11	11 11+++	
<i>Viola calcarata</i>	+ +++++ 11 +	++ +++++ ++	
<i>Anthyllis alpestris</i>	+1111 1+ 11	11 1 + +	
<i>Carex sempervirens</i>	3231212	112 1 +	1
<i>Gentiana campestris</i>	+++++ ++	+ + ++	
<i>Dryas octopetala</i>	++12 +31 1	+2 +	
<i>Carduus defloratus</i>	++ +11	+ + ++1+	
<i>Daphne striata</i>	++ ++ +	++ +	
<i>Euphrasia minima</i>	+1 ++	++ +	1
<i>Homogyne alpina</i>	+ 1 ++	+ ++	+
<i>Erica carnea</i>	1 ++	++ +1 +	
<i>Polygala chamaebuxus</i>	++ +	+ 1 + ++	
<i>Selaginella selaginoides</i>	++ +	+++ ++	
<i>Silene acaulis</i>	+ 1	++ ++ +	
<i>Bellidiastrum michelii</i>	+ + +	+ ++	
<i>Thesium alpinum</i>	+ +++	+ +	
<i>Leontodon hyoseroides</i>	+ 1 +	+++ +	
<i>Ligusticum mutellinoides</i>	+ 1	1 1	+
<i>Campanula cochleariifolia</i>	+ ++	+ ++	
<i>Carex ornithopoda</i>	+ +	1 1	
<i>Antennaria dioeca</i>	+ +	+ +	
<i>Gentiana nivalis</i>	+ +	+ +	
<i>Sesleria coerulea</i>	213+1+2++11+		
<i>Galium anisophyllum</i>	++++++1+ +1		
<i>Helianthemum alpestre</i>	112++ 1+ 2		
<i>Carex firma</i>	+1222 + + 2		
<i>Androsace chamaejasme</i>	++1++ 1+ 1		
<i>Scabiosa lucida</i>	+11++11+		
<i>Draba aizoides</i>	+1 ++ + 1+		
<i>Hieracium villosum</i>	+ ++1 + +		
<i>Myosotis alpestris</i>	+ + ++ +1		
<i>Ranunculus montanus</i>	+ + + ++ +		
<i>Polygonum viviparum</i>	+++ ++ +		
<i>Salix serpyllifolia</i>	+ 22 +11		
<i>Leontodon hispidus</i>	+ +++ +		
<i>Chrysanthemum adustum</i>	+ ++1		
<i>Poa alpina</i>	+ 111+		
<i>Hutchinsia alpina</i>	+ 11++		
<i>Gentiana clusii</i>	+++		

Table 2. (continued)

Taxon	DOL										SER										SIL
	111					11					11					11					
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
<i>Sedum atratum</i>	+																				
<i>Polygala alpestris</i>																					
<i>Valeriana montana</i>																					
<i>Aster alpinus</i>																					
<i>Saxifraga caesia</i>																					
<i>Soldanella alpina</i>																					
<i>Pedicularis verticillata</i>																					
<i>Bartsia alpina</i>																					
<i>Erigeron uniflorus</i>																					
<i>Taraxacum alpinum</i>																					
<i>Saxifraga moschata</i>																					
<i>Ranunculus alpestris</i>																					
<i>Arenaria ciliata</i>																					
<i>Arabis alpina</i>																					
<i>Achillea atrata</i>																					
<i>Juncus trifidus</i>																					1
<i>Luzula lutea</i>																					
<i>Solidago alpestris</i>																					
<i>Deschampsia flexuosa</i>																					1
<i>Lotus alpinus</i>																					
<i>Senecio doronicum</i>																					
<i>Cerastium latifolium</i>																					
<i>Gentiana kochiana</i>																					+
<i>Anthoxanthum alpinum</i>																					
<i>Festuca violacea</i>																					
<i>Vaccinium gaultherioides</i>																					2
<i>Leontodon helveticus</i>																					+
<i>Salix breviserrata</i>																					
<i>Loiseleuria procumbens</i>																					2
<i>Vaccinium myrtillus</i>																					+
<i>Salix herbacea</i>																					
<i>Soldanella pusilla</i>																					
<i>Asplenium viride</i>																					
<i>Vaccinium vitis-idaea</i>																					+
<i>Antennaria carpatica</i>																					2
<i>Arnica montana</i>																					1
<i>Primula hirsuta</i>																					1
<i>Helictotrichon versicolor</i>																					+
<i>Nardus stricta</i>																					+
<i>Phyteuma hemisphaericum</i>																					+
<i>Pulsatilla sulphurea</i>																					+
<i>Pulsatilla vernalis</i>																					+
<i>Senecio carniolicus</i>																					+

Table 2. (continued)

Species found only in one relevée (except for acidic silicate):

DOL 1:	<i>Ligusticum mutellina</i> (+)
DOL 2:	<i>Arctostaphylos uva-ursi</i> (+), <i>Globularia cordifolia</i> (1), <i>G. nudicaulis</i> (+), <i>Leontopodium alpinum</i> (+), <i>Nigritella nigra</i> (+), <i>Primula auricula</i> (+)
DOL 4:	<i>Carlina simplex</i> (+)
DOL 6:	<i>Botrychium lunaria</i> (+), <i>Helianthemum grandiflorum</i> (+)
DOL 7:	<i>Salix reticulata</i> (+), <i>Veronica aphylla</i> (+), <i>V. fruticans</i> (+)
DOL 9:	<i>Doronicum grandiflorum</i> (+), <i>Draba tomentosa</i> (+), <i>Hieracium bifidum</i> (+)
DOL 11:	<i>Elyna myosuroides</i> (2)
DOL 12:	<i>Draba carinthiaca</i> (+), <i>Gentiana verna</i> (+), <i>Saxifraga oppositifolia</i> (+), <i>Sedum alpestre</i> (+)
SER 2:	<i>Campanula barbata</i> (+), <i>Cardamine resedifolia</i> (+)
SER 3:	<i>Geum montanum</i> (1), <i>Potentilla aurea</i> (+)
SER 5:	<i>Calamagrostis villosa</i> (1), <i>Carex ericetorum</i> (+)
SER 7:	<i>Minuartia sedoides</i> (+)
SER 8:	<i>Lycopodium selago</i> (+)
SER 9:	<i>Larix decidua</i> (+)

DOL = dolomite, SER = serpentine, SIL = acidic silicate



Fig. 3. The local sector DOL 1, dolomite grassland.
Abb. 3. Die Fläche DOL 1, Dolomitrasen.



Fig. 4. The local sector DOL 2, well-developed terraced grassland "Treppenrasen" on dolomite.
Abb. 4. Die Fläche DOL 2, gut entwickelter Treppenrasen auf Dolomit.



Fig. 5. The local sector DOL 4, intermediate sector on dolomite.
Abb. 5. Die Fläche DOL 4, intermediäre Fläche auf Dolomit.

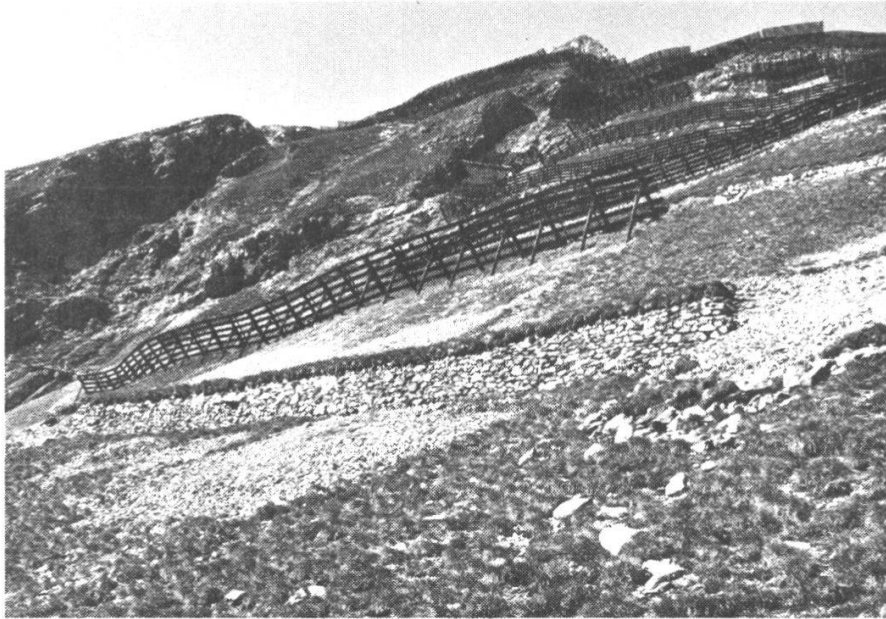


Fig. 6. The local sector DOL 6, intermediate sector on dolomite; anti avalanche defense works.

Abb. 6. Die Fläche DOL 6, intermediäre Fläche auf Dolomit mit Lawinerverbauungen.



Fig. 7. The local sector DOL 8, dolomite scree slope.

Abb. 7. Die Fläche DOL 8, Dolomitschutthalde.

Intermediate sectors (DOL 4, DOL 5, DOL 6, DOL 7, Figs 5,6)

The open vegetation of the sectors corresponded rather to the same association as the grassland sectors (Table 2). Rock debris and fine earth material, brought down the slope by rockfall and snowmelt-runoff, occasionally covered the vegetation in all sectors. The soil was a slightly developed rendzina with only a small amount of fine soil. All sectors were grazed by wild animals, sectors DOL 4 and DOL 7 also by cattle.

Scree slopes (DOL 8, DOL 9, DOL 10, Fig. 7)

The open vegetation corresponded to transitions between Seslerion coeruleae and Thlaspietum rotundifolii (Table 2). The sectors were influenced by strong rockfall; with a possible damage to roots and stems of plants by the resulting debris. The undeveloped soil was liable to summer and autumn droughts. The sectors were seldom grazed.

Highest sectors (DOL 11, DOL 12, Fig. 8)

The vegetation of these two sectors corresponded to the same association as the scree slopes (Table 2). On account of the high altitude, the climatic conditions here were more extreme. The soil was a slightly developed rendzina; both sectors were very strongly grazed by ibex.

Most of the sectors described above were not directly influenced by man. The two sectors DOL 6 and DOL 11 are situated within barriers built to prevent avalanches and some mechanical damage of the turf could be observed.

2.2.2. Serpentine

Sectors with dense vegetation (SER 1, SER 2, SER 3, Fig. 9)

The vegetation of these sectors corresponded to the alliance Galio anisophyllo - Minuartion vernaе, but could not be assigned to any known association (Table 2). The soil was an alpine brown earth, and the sectors were occasionally grazed by cattle.

Intermediate sectors (SER 4, SER 5, SER 6, SER 7, Fig. 10)

The vegetation belonged more or less to the same alliance as in the sectors previously described (Table 2), but the soil was less developed and

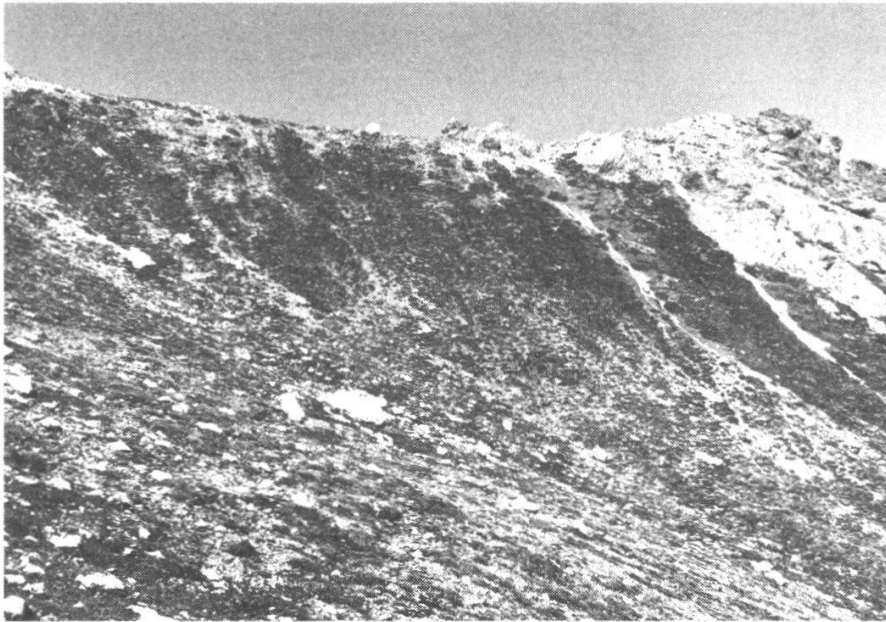


Fig. 8. The local sector DOL 12, highest sector on dolomite.
Abb. 8. Die Fläche DOL 12, höchste Fläche auf Dolomit.



Fig. 9. The local sector SER 1, dense vegetation on serpentine.
Abb. 9. Die Fläche SER 1, hohe Vegetationsbedeckung auf Serpentin.



Fig. 10. The local sector SER 5, intermediate sector on serpentine.
Abb. 10. Die Fläche SER 5, intermediäre Fläche auf Serpentin.



Fig. 11. The local sector SER 9, sparse vegetation on serpentine.
Abb. 11. Die Fläche SER 9, niedrige Vegetationsbedeckung auf Serpentin.



Fig. 12. The local sector SER 11, highest sector on serpentine; the metallic frame used for demographic census is seen.

Abb. 12. Die Fläche SER 11, höchste Fläche auf Serpentin, der Metallrahmen für die demographischen Untersuchungen ist zu sehen.



Fig. 13. The local sector SIL, grassland on acidic silicate.

Abb. 13. Die Fläche SIL, Silikatrasen.

covered by more rock debris. Grazing was seldom observed and only wild animals viz. Rupicapra rupicapra and Lagopus mutus, were seen.

Sectors with sparse vegetation (SER 8, SER 9, SER 10, Fig. 11)

The vegetation of these sectors represented a pioneer stage on a virgin soil (Table 2). It did not correspond to any known association.

Highest sector (SER 11, Fig. 12)

The vegetation here was very scarce; only four species, viz. Biscutella levigata, Cerastium latifolium, Minuartia verna, and Silene willdenowii, occurred in the conditions of scree slopes and crevices.

2.2.3. Acidic silicate (SIL, Fig. 13)

The relatively low growing vegetation of the only sector studied on this substratum did not correspond to any described association (Table 2). The soil was an alpine brown earth. The sector was grazed by cattle and/or sheep.