Preslia, Praha, 62 : 307—322

Alpine vegetation of the Králický Sněžník Mts. (The Sudeten Mts.)

Alpinská vegetace Králického Sněžníku

František Krahulec

Dedicated to Professor Zdeněk Černohorský on his 80th birthday

Krahulec F. (1990): Alpine vegetation of the Králický Sněžník Mts. (The Sudeten Mts.). — Preslia, Praha, 62 : 307—322.

Keywords: Alpine vegetation, synecology, Králický Sněžník Mts., Czechoslovakia

The paper gives a brief survey of plant communities occurring above the timberline on the periphery of the K. Sněžník Mts. (part of the E. Sudeten Mts.). Their relationships to wind exposition and snow conditions are given. K. Sněžník Mt. has a well developed top phenomenon but badly developed corie with rare avalanches which is the main reason for the absence of some communities. The syntaxonomic relationships of individual communities are briefly discussed.

Botanical Institute, Czechoslovak Academy of Sciences, 252 43 Průhonice, Czechoslovakia

The Králický Sněžník Mts. [1]) constitute a small mountain range reaching an altitude of 1424 m. It is a part of the Sudeten Mts. system. Only the highest peak of the same name reaches an altitude above the timberline. Krummholz (*Pinus mugo*) does not occur there nor in the Hrubý Jeseník Mts. as a native species. It was planted at the beginning of this century (Hošek 1964). The timberline is formed by spruce (*Picea abies*) at the altitude of 1340—1370 m. The flora of the Sněžník Mts. was studied in detail mainly by German botanists at the end of the last century (cf. Fiek 1881, Schube 1904). There is no detailed study about alpine vegetation. The vegetation phenomena were dealt with by Jeník (1961) without any concrete relevés. This paper is based on my thesis written at the conclusion of my studies at the Charles University (Krahulec 1975).

STUDY AREA

The Králický Sněžník Mts. are a part of the Sudeten Mts. situated in its eastern part, directly on the borderline between Czechoslovakia and Poland. The alpine vegetation is developed on the top above the timberline and on the avalanche path on the southern slope. This area has a pre-cambrian gneiss (of the Giera tow type) as a bedrock. There are large stone fields on the slopes. Climate characteristics were published by Fabiszewski (1968) recorded at a station situated on the NW slope near the mountain chalet at the altitude

[1]) Śnieżnik Klodzki in Polish, Glatzer Schneeberg, Spieglitzer Schneeberg in German

of 1217 m (period 1881—1939). The most important characteristics are the following: average temperature 2.4° C; annual precipitation 1182 mm; prevailing wind from the SW direction (25.5 %); only July and August are without frosts; total average number of days with frost: 181. The temperature characteristics from the top area (1370 m) are more extreme: 1.7 °C (period 1901—1950, VESECKÝ 1961).

The alpine vegetation is strongly influenced by winds directed towards the summit by valleys from all directions. The wind strongly influences the irregular distribution of the snow cover on the summit area. There are wind-swept places on the wind-ward slopes and snow fields on the lee-ward slopes. Snow drifted on the lee-ward slopes lead to the formation of avalanches. A known avalanche path is on the southern slope and begins at the source of the Morava river. However, the exact frequency of avalanches is unknown; it can be estimated as one in a decade.

METHODS

Vegetation was recorded by the relevé method; relevés were taken to cover the main vegetation types. To evaluate the cover the 7-degree Braun-Blanquet scale was used. The relevés were grouped according to their floristic composition and were compared with similar communities described from other parts of the Sudeten Mts., mainly with papers by ŠMARDA (1950), JENÍK (1961), BUREŠOVÁ (1976), and JENÍK, BUREŠ et BUREŠOVÁ (1980). K. Sněžník Mt. has rather a small area of alpine vegetation and all communities could be identified with those described from the other parts of the Sudeten Mts. Figure 1 gives the schematic map with the location of particular relevés.

Samples of the soil from the rhizosphere (5—10 cm) were taken to characterize particular communities. Soil reaction was measured with a glass electrode (5 or 2.5 g of soil was stirred with 12.5 ml distiled water or 0.1 N KCl); exchangeable ions were determined by AAS (5 g of soil washed with 200 ml 1 N KCl) (Ca, Mg) or by complexometric titration from the same solution (Al, H). Saturation is expressed as share of Ca + Mg in the total (Ca + Mg + Al + H).

VEGETATION[2])

Principal factors influencing the pattern of alpine vegetation are the formation of the relief together with soil conditions, exposition to the wind, and the depth and duration of the snow cover. Particular vegetation types which were distinguished have the following position with regards to the above mentioned gradients:

1. *Cetrario-Festucetum supinae* occupies the most extreme sites with respect to the exposition to wind and it has a shallow and short snow cover, and shallow soil;
2. *Festuco supinae-Vaccinietum myrtilli* is not so extreme with regard to the wind exposition, the thickness of snow cover and depth of soil profile;
3. *Sileno vulgaris-Calamagrostietum villosae* is a community on the slopes with moderate snow conditions and protection against the wind;
4. *Bistorto-Deschampsietum alpicolae* occupies the depressions with long duration of snow cover and good hydropedologic conditions during the vegetation season;
5. *Adenostyli-Athyrietum* and *Daphno-Dryopteridetum* are fern-rich communities occurring in the lower part of the avalanche path and having thick snow cover and good saturation by water during the vegetation season;

[2]) Plant names are according to NEUHÄUSLOVÁ et KOLBEK (1982)

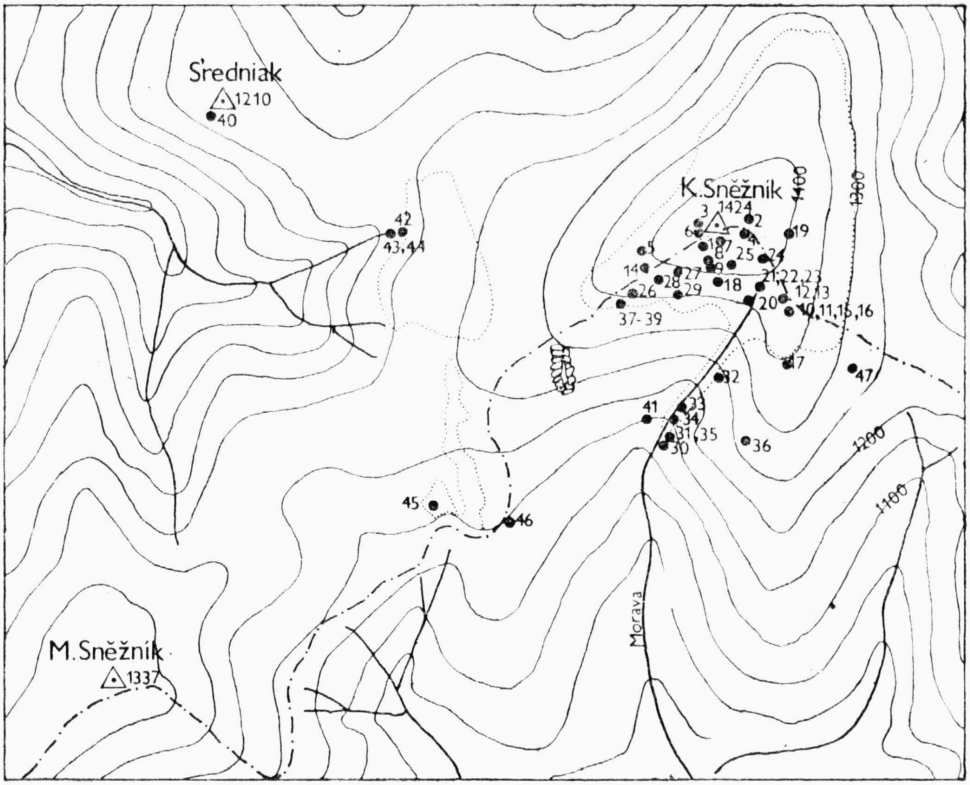

Fig. 1. — Map of the area studied. Points indicate localities of individual relevés.

6. The community with *Philonotis fontana* is a rare type occurring along a rare spring.

A brief description of particular vegetation types, their composition, and habitat conditions is given below.

1. *Cetrario-Festucetum supinae* JENÍK 1961

The communities of the most wind exposed habitats are formed by chionophobous species. *Festuca airoides*, *Calluna vulgaris*, *Huperzia selago*, *Hieracium alpinum*, and *Cetraria islandica* may be named as most typical representatives of these wind-swept communities (for details of floristic composition see Table 1). This vegetation type is confined to the most extreme habitats: on the top and W and NW slopes, i.e. places with the strongest exposition towards prevailing winds eroding the fine soil particles and transporting the snow cover away and increasing the evapotranspiration of plants. Soil is shallow and coarse; the snow cover is also shallow, with a duration not longer than 4—5 months. The snow changes into firn ice covering the soil surface in winter, during the frequent periods of snow-melting. On the slopes, a pronounced influence of solifluction on the soil surface is found. For this

Table 1. — *Cetrario-Festucetum supinae* JENÍK 1961

No. of relevé	1	2	3	4	5	6	7	8	9
altitude (m)	1422	1420	1420	1423	1390	1422	1422	1415	1410
orientation	SSW	NNW	NW	—	W	NNW	S	S	S
inclination (°)	5	5	15	0	10	10	10	5	5
area (m²)	12	16	10	16	16	15	12	88	8
cover of herb layer (%)	95	60	45	100	60	60	60	100	95
cover of moss layer (%)	0	20	20	0	50	50	50	5	10
date	3. 8. 1974	3. 8. 1974	5. 7. 1973	24. 8. 1974	1. 8. 1974	3. 8. 1974	3. 8. 1974	26. 8. 1974	26. 8. 1974
number of species	10	12	12	8	11	10	12	8	9
E_1									
Festuca airoides	5	3	3	4	1	2	1	2	3
Calluna vulgaris	2	1	—	2	2	1	2	1	1
Hieracium alpinum	1	2	—	—	+	1	1	.	.
Deschampsia flexuosa	+	+	.	+	1	+	2	3	3
Homogyne alpina	+	1	.	1	.	.	—	+	1
Solidago virgaurea	+	+	—	.	+	.	1	.	.
Huperzia selago	.	—	+	.	.	.	.	.	.
Carex bigelowii	.	.	.	1	.	.	.	.	.
Polygonum bistorta	—	+	+	+	—	+	+	2	1
Ligusticum mutellina	—	.	.	.	.	.	.	.	.
Calamagrostis villosa	1	.	.	+	.	.	—	1	+
Luzula luzuloides	.	.	.	.	+	.	.	1	.
Hypochoeris uniflora	.	.	.	.	.	.	—	.	.
Vaccinium vitis-idaea	—	+	.	.	1	1	1	.	1
Vaccinium myrtillus	.	2	.	.	2	2	2	.	2
Picea abies	.	.	.	.	—	.	.	.	.
E_0									
Cetraria islandica	.	.	2	.	3	3	3	1	2
Dicranum fuscescens	.	2	2	.	.	.	.	.	.
Bryum caespiticium	.	.	1	.	.	.	.	.	.
Dicranum scoparium	.	.	.	.	.	1	.	.	.
Polytrichum juniperinum	.	1	1	.	.	1	.	.	.
Lophozia alpestris	.	.	1	.	.	.	.	.	.
Pohlia nutans	.	.	1	.	.	.	.	.	.

Table 2. — *Festuco supinae-Vaccinietum myrtilli* ŠMARDA 1950

No. of relevé	10	11	12	13	14	15	16	17	18	19
altitude (m)	1375	1375	1380	1380	1390	1375	1375	1355	1400	1400
orientation	SE	SE	ES	SE	W	SE	SE	SW	S	NE
inclination (°)	5	5	10	5	10	5	5	15	10	15
area (m^2)	16	16	16	16	20	16	16	16	20	10
cover of herb layer (%)	100	100	100	100	60	100	100	90	100	60
cover of moss layer (%)	5	10	25	1	80	25	30	50	0	75
date	10. 8. 1974	10. 8. 1974	10. 8. 1974	10. 8. 1974	24. 8. 1974	10. 8. 1974	10. 8. 1974	4. 8. 1974	5. 7. 1973	6. 7. 1975
number of species	9	8	12	11	7	10	12	12	8	10
Vaccinium vitis-idaea	5	5	3	2	2	2	2	1	1	2
Vaccinium myrtillus	.	.	3	3	3	5	4	5	5	3
Calluna vulgaris	—	1	2	2	2	.	1	1	.	1
Festuca supina	1	1	1	2	.	1	1	+	—	.
Deschampsia flexuosa	1	.	.	1	1	.	.	2	1	1
Homogyne alpina	.	.	.	2	.	—	1	.	+	.
Sorbus aucuparia	.	.	+	.	.	.	.	—	.	.
Picea abies	.	.	.	.	1	.	.	.	.	.
Melampyrum pratense	.	.	.	.	.	.	.	1	.	.
Empetrum hermaphroditum	.	.	.	.	.	.	.	.	.	2
Polygonum bistorta	1	+	—	+	.	+	+	+	2	.
Calamagrostis villosa	1	+	+	1	+	.	+	.	+	—
Ligusticum mutellina	—	.	.	—	.	.	.	.	.	.
Trientalis europaea	.	.	.	2	.	.	.	.	.	.
Luzula luzuloides	.	.	.	.	.	—	.	.	—	.
Solidago virgaurea	.	.	.	.	.	—	—	—	.	.
Carex canescens	—	.	.	.	.	.	.	.	.	.
Cetraria islandica	1	1	2	.	5	.	2	3	.	4
Dicranum scoparium	.	.	1	.	.	1	1	1	.	.
Pleurozium schreberi	.	1	1	1	.	1	.	.	.	.
Polytrichum formosum	.	.	1	.	.	.	.	.	.	2
Barbilophozia barbata	.	.	2	.	.	.	.	.	.	.
Ptilidium ciliare	.	.	.	.	.	1	1	.	.	.
Cladonia gracilis var. *elongata*	.	.	.	.	.	.	2	.	.	.
Racomitrium heterostichum	.	.	.	.	.	.	.	1	.	.
Dicranum fuscescens	.	1	.	.	.	.	.	.	.	1
Polytrichum juniperinum	.	.	.	.	.	.	.	.	.	1

Table 3. — *Sileno vulgaris-Calamagrostietum villosae* JENÍK et al. 1980

No. of relevé	20	21	22	23	24	25
altitude (m)	1360	1375	1375	1375	1415	1415
orientation	S	S	S	S	SE	S
inclination (°)	30	10	5	10	5	1
area (m^2)	25	16	16	16	5	16
cover of herb layer (%)	75	100	80	100	100	100
date	5. 7. 1973	3. 8. 1974	5. 7. 1973	3. 8. 1974	8. 7. 1973	24. 8. 1974
number of species	22	7	8	12	8	10
Calamagrostis villosa	2	5	3	1	1	2
Luzula luzuloides	+	.	+	1	2	1
Ligusticum mutellina	+	.	.	+	.	.
Polygonatum verticillatum	—	+	1	1	.	.
Anthoxanthum alpinum	+	.	.	.	.	.
Trientalis europaea	—	1	.	1	.	.
*Viola *sudetica*	+	.	.	—	.	.
Silene vulgaris	.	+	+	—	.	.
Potentilla aurea	.	.	—	+	.	+
Polygonum bistorta	+	2	2	4	4	4
Veratrum lobelianum	2	.	—	—	—	+
Deschampsia cespitosa	—	.	.	.	.	.
Rumex alpestris	+	.	.	.	.	+
Ranunculus platanifolius	+	.	.	.	.	.
Phyteuma spicatum	—	.	.	.	.	.
Doronicum austriacum	—	.	.	.	.	.
Geranium sylvaticum	—	.	.	.	.	.
Cicerbita alpina	—	.	.	.	.	.
Paris quadrifolia	—	.	.	.	.	.
Athyrium distentifolium	—	.	.	.	.	.
Myosotis nemorosa	—	.	.	.	.	.
Poa chaixii	+	.	.	.	.	.
Chamaerion angustifolium	—	.	.	.	.	.
Deschampsia flexuosa	.	+	.	2	.	2
Vaccinium myrtillus	.	+	.	—	.	.
Homogyne alpina	.	.	.	.	2	1
Potentilla erecta	.	.	.	.	1	.
Festuca airoides	.	.	.	.	1	—
Vaccinium vitis-idaea	.	.	.	.	+	.
Solidago virgaurea	.	.	.	.	.	—
Senecio nemorensis	2	.	+	.	.	.

reason the community has an open canopy; on the top plateau where the conditions are not so extreme the vegetation canopy is more closed with a higher share of *Deschampsia flexuosa* (relevés 7—9).

2. *Festuco supinae-Vaccinietum myrtilli* ŠMARDA 1950

The composition of this community of dwarf shrubs is given in Table 2. *Vaccinium myrtillus*, *V. vitis-idaea*, *Calluna vulgaris*, and rarely *Empetrum hermaphroditum* are the most important dwarf shrubs here. The penetration of *Picea abies* and *Sorbus aucuparia* seedlings is very typical of this vegetation type. It is confined to less extreme habitats as are those of *Cetrario-Festucetum*. This community occurs often on the margin of stone fields, as one

Table 4. — *Bistorto-Deschampsietum alpicolae* (Zlatník 1926) Burešová 1976

No. of relevé	26	27	28	29
altitude (m)	1350	1380	1375	1380
orientation	S	SW	SW	SW
inclination (°)	10	5	10	10
area (m²)	20	12	12	16
cover of herb layer (%)	90	100	100	100
date	3. 7. 1973	24. 8. 1974	24. 8. 1974	24. 8. 1974
number of species	17	7	10	8
Deschampsia cespitosa	5	3	3	3
Rumex alpestris	+	1	+	+
Polygonum bistorta	1	3	3	4
Veratrum lobelianum	+	+	1	1
Senecio nemorensis	1	.	—	.
Luzula luzuloides	+	+	1	1
*Viola *sudetica*	+	.	.	.
Ligusticum mutellina	—	.	.	.
Trientalis europaea	+	.	.	.
Calamagrostis villosa	+	1	2	.
Silene vulgaris	.	.	—	+
Epilobium palustre	—	.	.	.
Crepis paludosa	—	.	.	.
Chaerophyllum hirsutum	—	.	.	.
Aconitum napellus	+	.	.	.
Senecio rivularis	+	.	.	.
Senecio fuchsii	+	.	.	.
Poa chaixii	+	.	2	.
Homogyne alpina	.	+	.	—
Doronicum austriacum	.	.	+	.
Deschampsia flexuosa	.	.	.	1

of the first stages of succession. These dwarf shrub communities are most typical of the convex places with shallow soil on the periphery of the top area. The community has usually a closed canopy, which is often differentiated into two layers: the upper with *Vaccinium* species, *Luzula luzuloides*, *Polygonum bistorta*, and *Calamagrostis villosa*, and the lower layer with *Homogyne alpina*, *Trientalis europaea*, *Calluna vulgaris*, and *Deschampsia flexuosa*. The moss layer is regularly developed. The dominating *Vaccinium* species is determined by the extremity of the habitat: the more extreme the habitat the higher is share of *V. vitis-idaea*. *Empetrum hermaphroditum* as the prevailing species occurs on a small outcrop on the eastern slope.

Another community type was found on the outcrops of the serpentine on the top of Středniak (German name Mittelberg — 1212 m), cca 1 km N of the top of K. Sněžník. This community contains some plants absent in the summit area: *Campanula rotundifolia*, *Hieracium pilosella*. The following relevé (no. 40) was taken at that place:

Orient. W, incl. 5°, 5 m²; cover of herb layer 80 %, cover of moss layer 15 %: *Festuca airoides* 3, *Vaccinium vitis-idaea* 1, *Antennaria dioica* 2, *Campanula rotundifolia* 1, *Hieracium pilosella* +, *Botrychium lunaria* r, *Euphrasia* sp. div. +; *Cladonia* sp. div. 2, *Polytrichum juniperinum* 1.

Table 5. — *Daphno-Dryopteridetum* (30, 31) and *Adenostyli-Athyrietum* (32–35)

No. of relevé	30	31	32	33	34	35	36
altitude (m)	1125	1140	1250	1170	1150	1125	1280
orientation	S	SW	S	S	S	S	SSW
inclination (°)	20	35	25	20	15	5	15
area (m²)	25	16	16	25	20	16	10
cover of herb layer (%)	100	100	90	100	100	100	100
cover of moss layer (%)	1	0	5	0	0	0	5
date	7. 8. 1974	7. 8. 1974	15. 7. 1971	5. 7. 1973	5. 7. 1973	7. 8. 1974	1. 8. 1974
number of species	22	19	17	18	11	7	10
Daphne mezereum	+	+	.	.	.	.	.
Rosa pendulina	1	1	.	.	.	.	.
Athyrium filix-femina	2	1	.	.	.	.	.
Pulmonaria obscura	1	1	.	.	.	.	.
Actaea spicata	1	+	.	.	.	.	.
Geranium robertianum	—	+	.	.	.	.	.
Myosotis sylvatica	1	1	.	.	.	.	.
Petasites albus	2	2	.	.	.	.	.
Aconitum napellus	+	+	.	.	.	.	.
Oxalis acetosella	1	+	.	.	.	.	+
Prenanthes purpurea	—	.	.	.	.	.	.
Phegopteris connectilis	+	.	.	.	.	.	.
Polystichum aculeatum	—	—	.	.	.	.	.
Milium effusum	.	+	.	.	.	.	.
Geranium sylvaticum	.	—	.	—	.	.	.
Urtica dioica	.	—	.	.	.	.	.
Impatiens noli-tangere	.	1	.	.	.	.	.
Dryopteris filix-mas	2	5	3	1	+	+	.
Rubus idaeus	1	1	3	1	1	.	.
Athyrium distentifolium	2	.	1	5	5	5	5
Melandrium rubrum	1	.	.	—	+	.	1
Stellaria nemorum	.	2	.	.	.	1	1
Calamagrostis arundinacea	3	.	3	—	.	+	.
Senecio nemorensis	.	.	1	1	+	.	.
Paris quadrifolia	.	.	1	1	.	.	.
Phyteuma spicatum	.	.	1	+	+	.	.
Doronicum austriacum	.	.	—	—	.	+	.
Rumex alpestris	.	.	1	2	2	3	2
Lilium martagon	.	.	1	—	—	.	.
Cicerbita alpina	.	.	1	—	.	.	.
Ranunculus platanifolius	.	.	1	.	—	+	.
Poa chaixii	.	.	.	—	.	.	.
Calamagrostis villosa	+	.	.	.	.	.	+
Polygonatum verticillatum	.	.	.	.	—	.	.
Sorbus aucuparia juv.	—	.	.	.	.	.	.
Trientalis europaea	.	.	.	.	.	.	—
Homogyne alpina	.	.	.	.	.	.	—
Vaccinium myrtillus	.	.	.	.	.	.	—
Deschampsia flexuosa	.	.	.	—	.	.	.
Viola biflora	—	.	.	.	.	.	.
Chrysosplenium alternifolium	.	.	.	+	.	.	.
Picea abies juv.	.	—	.	.	.	.	.
Anthriscus nitida	.	.	.	—	.	.	.
Galeobdolon montanum	.	.	1	.	.	.	.
Chamaerion angustifolium	.	.	+	.	.	.	.
Mnium affine	1	.	.	.	.	.	.

Dicranum scoparium	.	.	1	.	.	.	.
Plagiothecium cavifolium	.	.	—	.	.	.	.
Plagiothecium denticulatum	.	.	—	.	.	.	.
Polytrichum formosum	.	.	.	.	.	.	1

3. *Sileno vulgaris-Calamagrostietum villosae* JENÍK, BUREŠ et BUREŠOVÁ 1980

Stands of *Calamagrostis villosa* occupy large areas on the southern and eastern slopes (Table 3). They have rather a thick snow cover with melting time in April and sometimes in the first half of May. The soil is usually covered by *Calamagrostis* litter which enables the slow movement of snow down-slope during the winter. This mowement prevents the establishment of spruce near its timberline. The soil is deep by comparison with previous communities. The *Calamagrostietum* has a lower number of species compared with similar stands on the periphery of cories in the Krkonoše and Hrubý Jeseník Mts. Rel. No. 20 is taken from the stand below the source of the Morava river; it has enriched soil and is also enriched by some species characteristic of fern communities growing on the avalanche path. Rel. 23—25 represent the variant with dominating *Polygonum bistorta* — it indicates snow fields (with regular snow cover till the middle of May). This stand is the most chionophilous community in the area together with the next community type.

JENÍK (1961) described the occurrence of the ass. *Crepido-Calamagrostietum villosae* from the K. Sněžník; however, this community type does not occur here. The stands of *Calamagrostis villosa* occurring at the top of K. Sněžník belong to an association poor in species described later from the H. Jeseník Mts. (*Sileno-Calamagrostietum*).

4. *Bistorto-Deschampsietum alpicolae* (ZLATNÍK 1926) BUREŠOVÁ 1976

This community type (Table 4) indicates depressions with a high snow cover and with a good hydropedologic regime during the vegetation season. The rare occurrence is also on the periphery of a small spring on the SW slope.

5. *Adenostyli-Athyrietum* (ZLATNÍK 1928) JENÍK 1961
Daphno mezerei-Dryopteridetum filicis-maris SÝKORA et ŠTURSA 1973

The lower half of the avalanche path consists of coarse scree. The Morava river (here as a small brook) flows inside it, rarely rising to the surface. The scree is overgrown by rich stands of ferns and of some broad leaved herbs (see Table 5) habitats of which are characterized by a high snow cover (more than 1 m) during the whole winter which lasts to mid of May. The decisive factor determining these communities are snow avalanches restricting the establishment of spruce forest at this altitude. The avalanche path has its end in the altitude of 1100 m! The good hydropedologic conditions and the enrichment by fine particles eroded in upper parts by snow avalanches cause thehigh productivity of these communities (the ferns reach a height of 1.5 m!). The high snow cover protects the soil against frosts, the temperature is above zero during the winter and almost all biomass produced in the previous year is decomposed in the spring.

The more distributed type is that dominated by *Athyrium distentifolium*, It is stratified into two layers: the upper contains *Athyrium distentifolium*, *A. filix-femina* (rarely), *Dryopteris filix-mas*, *Rubus idaeus*, *Senecio nemorensis*, *Cicerbita alpina*, *Doronicum austriacum*, *Lilium martagon*, and *Ranunculus platanifolius*. The lower layer contains *Rumex alpestris*, *Stellaria nemorum*, *Paris quadrifolia*, and *Melandrium rubrum*. Some shrubs occur also in this community: *Daphne mezereum*, *Ribes petraea*, *Lonicera nigra*, and *Rosa pendulina*. The growth of plants starts here very late, after 10 June, due to long-lasting snow cover and low insolation (the avalanche path is narrow with tall spruce trees on the edges). On the other hand, snow protects namely ferns against late frosts.

The communities of this unit have close relations to spruce forests (as *Athyrio alpestris-Picetum*). Rel. No. 36 in Table 5 represents a stand from the gap in such a spruce forest. Note the absence of some plants typical of avalanche paths in this gap!

The second community dominated by *Dryopteris filix-mas* occurs here in one small stand under the rocks at the end of the avalanche path. The snow cover is deep here but compared with *Adenostyli-Athyrietum* it is of shorter duration due to higher insolation. It differs from the *Adenostyli-Athyrietum* by the presence of spring herbs — as *Pulmonaria obscura*, *Lathraea squamaria*, etc. It is probably a relic of some forests (*Aceri-Fagetum*). This idea, already suggested by Sýkora et Šturs a (1973), is supported by the composition of forest floor species found under the isolated tree of *Acer pseudoplatanus* in adjacent spruce forest. It can be illustrated by the following relevé:

Rel No 41: orient. SE, incl. 10°, 1150 m a.s.l., 16 m². 5. 8. 1974; cover of herb layer 100 %: *Dryopteris filix-mas* 3, *Athyrium distentifolium* 3, *Calamagrostis arundinacea* 1, *Stellaria nemorum* 1, *Rumex alpestris* 1, *Senecio fuchsii* +, *Oxalis acetosella* 1, *Urtica dioica* +, *Galeobdolon montanum* +, *Lilium martagon* r. *Gagea lutea*, *Corydalis intermedia* and *Myosotis sylvatica* were also found during the spring.

Daphno-Dryopteridetum should be distinguished from the *Dryopteris* dominated stands of *Adenostyli-Athyrietum*. Sýkora et Šturs a (1973) gave one relevé (No. 32, Table 5 of this paper) taken in the K. Sněžník and classified it as *Daphno-Dryopteridetum*. It is clearly *Adenostyli-Athyrietum*.

6. Spring community with *Philonotis fontana*

Springs are very rare in the alpine periphery of the K. Sněžník Mt. The strongest one, of the Morava river, is canalized and has no special vegetation; and there is only one other spring on the SW slope with special vegetation (Table 6). This poor community is difficult to classify — it is similar to the relevé published by Zlatník (1926) from the Krkonoše Mts. An absence of alpine species is characteristic of this community. Hadač (1983) does not mention any similar community.

7. Rare vegetation types

Some rare community types were found in the area of the top of the K. Sněžník Mt. They usually represent communities known from the localities in other parts of the Sudeten Mts: from cories in the Krkonoše and Hrubý Jeseník Mts. Here, they are usually present as individual stands, but their

Table 6. — Community with *Philonotis fontana*

No. of relevé:	37	38	39
altitude (m)	1345	1345	1360
orientation	S	S	S
inclination (°)	5	5	5
area (m²)	2	1	2
cover of herb layer (%)	60	40	60
cover of moss layer (%)	50	80	70
date	17. 8. 1974	17. 8. 1974	17. 8. 1974
number of species	5	5	7
Stellaria alsine	3	+	2
Myosotis nemorosa	2	+	2
Epilobium palustre	1	2	2
Chrysosplenium alternifolium	1	2	2
Senecio rivularis	.	.	1
Deschampsia cespitosa	.	.	+
Philonotis fontana	3	5	4

presence indicates similarity of K. Sněžník to other, richer localities of the Sudeten Mts. The following communities were found:

The community of scrubs dominated by *Salix silesiaca* and its hybrids was observed in a ravine under the chalet on the NW slope (in Poland). It is a vicarious type to the species richer community as described from the Velká kotlina corie (Hrubý Jeseník) — *Salici silesiaceae-Betuletum carpaticae* REJMÁNEK, SÝKORA et ŠTURSA 1971.

Rel. No. 42: orient. NW, incl. 25°, 1180 m a.s.l., 30 m², 6. 6. 1975; cover of shrub layer 80 %, cover of herb layer 80 %, cover of moss layer 5 %: *Salix silesiaca* (et *S.* × *subcaprea* and *S.* × *subaurita*) 5, *Sorbus aucuparia* +; *Athyrium distentifolium* 2, *Cicerbita alpina* +, *Rumex alpestris* 1, *Doronicum austriacum* 2, *Melandrium rubrum* r, *Stellaria nemorum* 2, *Calamagrostis arundinacea* 1, *Veratrum lobelianum* +, *Petasites albus* 2, *Solidago virgaurea* r, *Milium effusum* +, *Calamagrostis villosa* 1, *Prenanthes purpurea* r, *Polygonum bistorta* r, *Crepis paludosa* 1, *Epilobium alpestre* r, *Geum rivale* 1, *Aconitum napellus* 1, *Senecio rivularis* r, *Alchemilla* sp. +, *Chaerophyllum hirsutum* 2, *Myosotis nemorosa* +; *Mnium affine* 1, *Atrichum undulatum* 1, *Pellia* sp. +.

In the vicinity of the chalet I observed also a spring community with *Cardamine opizii* (this species was described from the area of the K. Sněžník Mt.). Its classification is very uncertain, a higher vegetation unit can only be stated (*Cardamino-Montion*).

Rel. No. 43: 150 m SSW from the chalet, incl. 10°, 1170 m a.s.l., 10 m², 6. 7. 1975 cover 100 %; Rel No. 44: the same place 50 m below of rel. 43, incl. 10°, 1160 m a.s.l., 10 m², cover 100 %: *Cardamine opizii* 6:5, *Chaerophyllum hirsutum* 1:1, *Geum rivale* +; 1, *Stellaria nemorum* +; +, *Aconitum napellus* .; 1.

The graminous community dominated by *Calamagrostis arundinacea* was found on a secondary meadow on the lee-ward side of the saddle between K. Sněžník and Malý Sněžník. It is classified as *Bupleuro-Calamagrostietum arundinaceae* JENÍK 1961, because it it similar to known stands from other parts of the Sudeten Mts.

Rel. No. 45: orient. SE, incl. 15°, 1160 m a.s.l., 20 m², 5. 8. 1974; cover of herb layer 100 %, *Calamagrostis arundinacea* 4, *Poa chaixii* 2, *Deschampsia flexuosa* 1, *D. cespitosa* +, *Festuca rubra*

+, *Viola *sudetica* 1, *Hieracium aurantiacum* +, *Lilium martagon* r, *Carlina acaulis* 1, *Rumex alpestris* 1, *Polygonum bistorta* 1, *Mercurialis perennis* 1, *Leucanthemum vulgare* +, *Potentilla aurea* 1, *Melampyrum sylvaticum* 1, *Hypericum maculatum* 1, *Ajuga reptans* +, *Silene vulgaris* 1, *Vaccinium myrtillus* 1, *Carex pallescens* +, *Cardaminopsis halleri* r, *Asarum europaeum* +, *Solidago virgaurea* +.

Nardus-rich communities are confined to the edges of paths. They are rich in species and *Campanula barbata* has optimum conditions in these communities with slight disturbance. This species occurs only in the K. Sněžník Mts. and Hrubý Jeseník Mts. in Czechoslovakia. The following relevés classified into the *Nardion* alliance illustrate this community type:

Rel. No. 46: orient. SE, incl. 15°, 1140 m a.s.l., 3.5 m², 3. 8. 1974; cover of herb layer 100 %, cover of moss layer 50 %: *Nardus stricta* 4, *Festuca airoides* 1, *Potentilla aurea* 1, *Deschampsia flexuosa* 1, *Polygonum bistorta* r, *Campanula barbata* 1, *Ligusticum mutellina* +, *Anthoxanthum alpinum* +, *Luzula luzuloides* +, *Melampyrum sylvaticum* 1, *Hieracium lachenalii* +, *Calamagrostis arundinacea* 3, *Rumex alpestris* +, *Silene vulgaris* r, *Vaccinium myrtillus* r, *Solidago virgaurea* +, *Omalotheca norvegica* +, *Hieracium alpinum* +; *Polytrichum formosum* 3, *P. juniperinum* 2.

Rel. No. 47: orient. S, incl. 10°, 1280 m a.s.l., 10 m², July 1973; cover of herb layer 100 %, cover of moss layer 5 %: *Campanula barbata* 1, *Omalotheca sylvatica* +, *Thesium alpinum* +, *Luzula multiflora* +, *Rhinanthus alpinus* +, *Agrostis tenuis* 1, *Festuca rubra* 2, *Crepis conyzifolia* 2, *Viola *sudetica* 1, *Ligusticum mutellina* 2, *Poa chaixii* 2, *Ajuga reptans* +, *Carex pallescens* +, *Lysimachia nemorum* r, *Nardus stricta* 1, *Potentilla aurea* 2, *Ranunculus platanifolius* +, *Carex ovalis* r, *Hypericum maculatum* +, *Veronica officinalis* 1, *Hieracium lachenalii* r, *Carex pilulifera* r, *Potentilla erecta* 1, *Polygonum bistorta* +, *Prunella vulgaris* r; *Polytrichum* sp. 2.

These communities can be classified as *Thesio alpini-Nardetum* JENÍK, BUREŠ et BUREŠOVÁ 1980.

DISCUSSION

The communities described above represent the whole set forming a coenocline of chionophobous-chionophilous communities. There is a strong correlation between the communities described and the relief and exposition towards prevailing winds. In this respect, K. Sněžník has the same general pattern of plant communities as are those described in the Krkonoše and the Hrubý Jeseník Mts. (JENÍK 1961, BUREŠOVÁ 1976). Similar pattern can be found in the properties of soils of particular communities (Table 7). I know that these data on soil properties have low statistical value. However, if they are compared with those published by BUREŠOVÁ (1976) the same trends in soil properties can be found: pH, content of humic substances (or carbon), content of nitrogen. It is sometimes difficult to say what is the cause and what the consequence: if the soil influences the community composition or if it is influenced by it (e.g. low pH in the communities of *Vaccinium myrtillus*). The correlation between soil properties and composition of plant communities is so close that one set can predict the other.

When we compare the communities described above from the area of K. Sněžník with communities known from some similar complexes of localities in other parts of the Sudeten Mts. (JENÍK 1961, BUREŠOVÁ 1976, JENÍK, BUREŠ et BUREŠOVÁ 1980 etc.) the following conclusions can be stressed:

1. The communities on the top area are almost identical with those known from the Krkonoše and Jeseník Mts. (High Sudeten);

Table 7. — Some soil characteristics of alpine plant communities

	pH-H_2O	pH-KCl	C %	N %	C : N	Al mval	H mval	Ca mval	Mg mval	saturation %
Cetrario-Festucetum callunetosum	3.7	2.9	12.1	0.59	20.5	3.9	4.5	1.6	0.3	18.4
Cetrario-Festucetum typicum	3.8	3.2	24.5	1.56	15.7	6.2	6.1	3.9	1.3	29.7
Sileno-Calamagrostietum	4.2	3.7	27.4	1.78	15.5	22.5	5.2	1.1	0.5	5.5
Sileno-Calamagrostietum[1])	4.1	3.8	5.5	0.4	13.8	6.5	2.1	0.5	0.1	6.5
Festuco-Vaccinietum	3.5	2.8	34.3	1.38	24.9	9.4	15.0	9.6	1.7	31.7
Polygono-Deschampsietum	4.8	4.4	23.0	1.83	12.6	1.0	2.0	17.3	3.0	87.1
Adenostyli-Athyrietum	3.3	2.9	30.8	1.76	17.5	6.9	14.5	13.4	2.2	42.2
Daphno-Dryopteridetum	4.7	4.1	7.9	0.55	14.4	2.4	1.8	9.5	1.6	72.5

[1]) enriched *Calamagrostietum* under the spring of the Morava river

2. The set of communities occurring on the avalanche path is poor in comparison with the other parts of the High Sudeten Mts.;
3. There are no spring communities with alpine species in the alpine area of the K. Sněžník Mts.

I shall try to explain these phenomena on the basis of the theory of anemo-orographic systems proposed by JENÍK (1961). There are several valleys, from south, west and north, directing winds towards the top. So, the top phenomenon (Gipfelphaenomen) is well developed here. The top plateau is relatively small compared with plateaus in the Krkonoše Mts. and with the main mountain range of the Jeseník Mts. For this reason communities of wind-swept places are well developed here together with some communities situated in the lee-ward parts of the top periphery. The avalanches are rare here as well as the other phenomena dependent on them. The first such phenomenon is the removal of weathered material from the upper parts of the avalanche path. Due to this water from springs flows through the waste (weathered material) and does not form a special habitat for plant communities. The corie of the Morava river is not fully developed here, because there is not prevailing wind from one direction as in other parts of the High Sudeten Mts. (i.e. the Krkonoše and H. Jeseník Mts.). Snow drifts in different parts of winter and in different winters are situated on different slopes. The only known avalanche path is the one leading down from the source of the Morava river. I infer from the composition of plant communities that the avalanches can rarely occur on the eastern slope (in Poland). Their frequency is probably lower than on the southern slope. There are no special communities on this path, but it is treeless and there are some special growth forms of spruce, what I consider as a good indication of avalanches.

The space for the differentiation of alpine communities is limited here. The communities on the K. Sněžník Mts. are differentiated at the altitude of cca 80 m (timberline 1340 m — top 1424 m). On the other hand, some localities in the Krkonoše Mts. have available altitude 200—300 m above the timberline. Some of the communities cannot be classified into several units (e.g. *Cetrario-Festucetum supinae*). The communities do not form clear belts, they are compressed into one belt. The species set of alpine species is depauperate here and this is the other reason for small differentiation of alpine communities.

The syntaxonomic relationships cannot be solved on poor and depauperate communities of the Sněžník. I accept the system proposed by MORAVEC et al. (1983a, b). I have only one objection concerning *Calluno-Ulicetalia*. This community type does not contain primary communities in Central Europe. The alpine dwarf shrub communities, as primary communities, forming a special vegetation belt, are similar in this respect to other alpine dwarf shrub communities of European mountains. JENÍK, BUREŠ et BUREŠOVÁ (1980) suggested a new alliance *Melampyro-Vaccinion* with *Festuco-Vaccinietum* as a type. They included it in *Vaccinio-Piceetea*. I prefer to classify these alpine dwarf shrub communities as *Loiseleurio-Vaccinietea* and *Rhodoreto-Vaccinietalia*. There is low indication in species composition to accept this solution; however, the ecological role played by this community in the E. Sudeten lead me to accept it. I think that the *Festuco-Vaccinietum* represents a community of *Loiseleurio-Vaccinietea* as a marginal community of this class, both with respect to the species composition and to the distri-

bution area. This is a reason why it has no species characteristic for low syntaxonomic units.

THE PHYTOSOCIOLOGICAL CLASSIFICATION OF COMMUNITIES

(Fytocenologická klasifikace společenstev)

Juncetea trifidi Hadač in Klika et Hadač 1944
Caricetalia curvulae Br.-Bl. in Br.-Bl. et Jenny 1926
Juncion trifidi Pawłovski 1928
Cetrario-Festucetum supinae Jeník 1961
Loiseleurio-Vaccinietea Eggler 1952 em. Schubert 1960
Rhodoreto-Vaccinietalia Br.-Bl. in Br.-Bl. et Jenny 1926
Melampyro-Vaccinion Jeník, Bureš et Burešová 1980
Festuco supinae-Vaccinietum myrtilli Šmarda 1950
Mulgedio-Aconitetea Hadač et Klika in Klika et Hadač 1944
Adenostyletalia G. Br.-Bl. 1931
Dryopteridi-Athyrion (Sýkora et Štursa 1973) Jeník, Bureš et Burešová 1980
Adenostyli-Athyrietum alpestris (Zlatník 1928) Jeník 1961
Daphno mezerei-Dryopteridetum Sýkora et Štursa 1973
Calamagrostietalia villosae Pawłovski in Pawłowski, Sokołowski et Wallisch 1928
Calamagrostion villosae Pawłowski 1928
Sileno vulgaris-Calamagrostietum villosae Jeník, Bureš et Burešová 1980
Calamagrostion arundinaceae (Luquet 1926) Jeník 1961
Bupleuro-Calamagrostietum arundinaceae (Zlatník 1928) Jeník 1961
Poo chaixii-Deschampsion cespitosae Jeník, Bureš et Burešová 1980
Bistorto-Deschampsietum alpicolae (Zlatník 1926) Burešová 1976
Salicion silesiacae Rejmánek, Sýkora et Štursa 1971
Salici silesiacae-Betuletum carpaticae Rejmánek, Sýkora et Štursa 1971
Nardo-Callunetea Preising 1949
Nardetalia Preising 1949
Nardion Luquet 1926, Br.-Bl. 1926
Thesio alpini-Nardetum Jeník, Bureš et Burešová 1980
Montio-Cardaminetea Br.-Bl. et Tüxen ex Klika et Hadač 1944
Montio-Cardaminetalia Pawłowski in Pawłowski, Sokołowski et Wallisch 1928
Cardamino-Montion Br.-Bl. 1926 em. Hadač 1983
community with *Philonotis fontana*
community with *Cardamine opizii*

Acknowledgement

Prof. Jan Jeník suggested me to work on the Králický Sněžník; Dr. Marcel Rejmánek was my supervisor and gave me valuable suggestions as well as Dr. Jiřina Slavíková. All those people I am indebted for their care.

SOUHRN

V předložené práci je popsána alpinská vegetace skupiny Králického Sněžníku, samostatné horské skupiny Východních Sudet. Jednotlivými tabulkami jsou dokumentována častější společenstva, vzácnější společenstva jsou doložena snímky v textu. Pro jednotlivá společenstva je uvedena jejich stručná charakteristika, jsou popsány jejich podmínky prostředí. Za nejvýznačnější faktor určující rozdělení alpinských společenstev v oblasti vrcholu K. Sněžníku považuji vztah ke sněhové pokrývce a expozici vůči převládajícím větrům. Soupis všech společenstev včetně jejich fytocenologického zařazení je uveden v samostatné kapitole v závěru. Při řazení do vyšších syntaxonomických jednotek se přidržuji systému posledních přehledů společenstev s výjimkou zařazení asociace *Festuco supinae-Vaccinietum myrtilli*. Protože se jedná o primární společenstvo, neřadím tuto jednotku do řádu *Calluno-Ulicetalia*, což je jednotka v našich poměrech obsahující většinou sekundární společenstva jednotlivých lesních stupňů. *Festuco-Vaccinietum* zaujímá v systému gradientů stejný prostor, jako alpinská společenstva drobných keříků v jiných evropských pohořích, a proto považuji toto společenstvo za hraniční jednotku zařaditelnou do třídy *Vaccinio-Loiseleurietea*.

Alpinská vegetace K. Sněžníku je srovnatelná s vegetací Krkonoš a Hrubého Jeseníku pouze pokud se týká společenstev vyfoukávaných či mírně chionofilních poloh. Má daleko chudší soubor společenstev vázaných na závětrné polohy a zcela chybějí prameniště s alpinskými druhy. Toto lze vysvětlit v rámci teorie anemo-orografických (A-O) systémů. Na K. Sněžníku není vyvinut A-O systém tak dokonale, jako v Krkonoších či Hrubém Jeseníku. Vítr je k hlavnímu vrcholu usměrňován z několika různých směrů, takže sníh se pak nehromadí na jednom místě a nevytvářejí se pravidelné laviny, které by udržovaly nejen bezlesý charakter závětrného prostoru, ale zároveň též přemísťovaly i zvětralinový plášť. Bezlesý charakter je udržován ojediněle padajícími lavinami (odhad jejich frekvence je 1× za deset let). Tato frekvence však nestačí odstraňovat zvětraliny z horní části svahu; nejsou zde žádné obnažené skály ani prameniště, protože voda je skryta ve zvětralinovém plášti, či se do něho po několika metrech ponořuje (případ silného pramene Moravy).

REFERENCES

Burešová Z. (1976): Alpínská vegetace Krkonoš: struktura a ekologie porostů na Luční (1547 m) a Studniční hoře (1555 m). [Alpine vegetation of the Krkonoše mountains: structure and environmental relationships of plant communities on the Mt. Luční (1547 m) and Mt. Studniční (1556 m)]. — Opera Corcontica, Praha, 13 : 67—94.

Fabiszewski J. (1968): Porosty Śnieżnika Kłodzkiego i Gór Bialskich. — Monogr. Botan., Warszawa, 26 : 1—116.

Fiek E. (1881): Flora von Schlesien, preussischen und österreichischen Antheils, ... — Breslau.

Hadač E. (1983): A survey of plant communities of springs and mountain brooks in Czechoslovakia. — Folia Geobot. Phytotax., Praha, 18 : 339—361.

Hošek E. (1964): O zalesňování Králického Sněžníku. — Čas. Slez. Muz.-Dendrol., Opava, 1964 : 365—373.

Jeník J. (1961): Alpínská vegetace Krkonoš, Králického Sněžníku a Hrubého Jeseníku. — Praha.

Jeník J., Bureš L. et Burešová Z. (1980): Syntaxonomic study of vegetation in Velká kotlina cirque, the Sudeten mountains. — Folia Geobot. Phytotax., Praha, 15 : 1—28.

Krahulec F. (1975): Vegetace kulminační části Králického Sněžníku. — Ms. [Dipl. Práce; depon. in: Knih. Kat. bot. přírod. fak. UK Praha].

Moravec J. et al. (1983a): Přehled vyšších vegetačních jednotek České socialistické republiky. — Preslia, Praha, 55 : 97—122.

Moravec J. et al. (1983b): Rostlinná společenstva České socialistické republiky a jejich ohrožení. — Severočes. Přír., Litoměřice, Příl. 1983/1 : 1—120 + I—XVIII.

Neuhäuslová Z. et Kolbek J. [red.] (1982): Seznam vyšších rostlin, mechorostů a lišejníků střední Evropy v bance geobotanických dat BÚ ČSAV. — Průhonice.

Rejmánek M., Sýkora T. et Štursa J. (1971): Fytocenologické poznámky k vegetaci Hrubého Jeseníku. — Campanula, Ostrava, 2 : 31—39.

Schube T. (1904): Flora von Schlesien, preussischen und österreichischen Anteils. — Breslau.

Schubert R. (1960): Die zwergstrauchreichen azidiphilen Pflanzengesellschaften Mitteldeutschlands. — Pflanzensoziologie, Jena, 11 : 1—235.

Sýkora T. et Štursa J. (1973): Vysokostébelné nivy s dominancí kapradin v sudetských karech — Daphno (mezereo)-Dryopteridetum ass. nova. — Preslia, Praha, 45 : 338—354.

Šmarda J. (1950): Květena Hrubého Jeseníku. Část sociologická. — Čas. Mor. Mus., Brno, 1950 : 78—156.

Vesecký A. [red.]: (1961): Podnebí Československé socialistické republiky. Tabulky. — Praha.

Zlatník A. (1926): Les associations de la végétation des Krkonoše et le pH. — Věstn. Král. Čes. Společ. Nauk, Tř. 2, Praha, 1926/10 : 1—67.

Received 16 November 1989