Preslia, Praha, 58 : 231—246, 1986

Subalpine turf communities with *Deschampsia cespitosa* along the tracks and paths in the Krkonoše (= Giant Mountains) National Park

Subalpinská drnová společenstva s *Deschampsia cespitosa* podél cest a stezek v Krkonošském národním parku

Jana Husáková

Husáková J. (1986): Subalpine turf communities with *Deschampsia cespitosa* along the tracks and paths in the Krkonoše (= Giant Mountains) National Park. — Preslia, Praha, 58 : 231—246.

Along tracks and paths above the alpine timberline in the Krkonoše Mountains three fringe communities were recorded: (1) community *Nardus stricta-Deschampsia cespitosa*, (2) community *Poa supina-Deschampsia cespitosa* (mostly western part), (3) community *Ranunculus acris-Deschampsia cespitosa* (mostly eastern part). The cenoses under study are characterized from the synmorphological, synecological and syndynamic viewpoints.

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INTRODUCTION

The edges of frequently used paths and tracks above the alpine timberline are accompanied by fringe communities with a high cover degree of *Deschampsia cespitosa*, which is simultaneously the dominant of the stand. The representation of other species is highly variable. Thus, *D.c.* belongs to the dominant species of the turf phytocenoses distributed along mountain communications.

The analyses were made using the standard methods of the Zürich-Montpellier school. In the classification of the stands, however, the deductive method of classification of plant communities was also used (cf. Kopecký 1977, 1978b, Kopecký et Hejný 1971, 1978).

The plant nomenclature follows mostly Rothmaler (1976).

BRIEF DESCRIPTIONS OF NATURAL CONDITIONS IN THE TERRITORY UNDER STUDY

The area under study as shown in fig. 1 is delimited by the state frontier in the north and by a heavy line in the south. It represents the main range of distribution of fringe stands with *D.c.* as the dominant species. For the most part, it is above the alpine timberline, which lies at about 1200—1300 a.s.l. in the Krkonoše Mountains (Jeník 1961).

From the viewpoint of the vegetation under investigation, the geological and pedological conditions show little variation. The predominant granites, mica-schists and phyllites give rise to podzolized soils, brown podzolized soils and undeveloped soils. All soils are sandy loams in texture. Furthermore, raised bogs occur in the region (Chaloupský 1968, Boháč 1969, Boháč et Nálevka 1971).

Climatically, the territory belongs to the cold region and, with in its framework, to the cold and frigid areas. The annual mean temperatures lie within the limits of 4° to 2 °C or less. The

period with the mean daily temperature of ≧10 °C, which delimits the vegetation period according to the climatologists, is short: 100 to 80 days or less. The annual precipitation lies within the limits of 1400—1600 mm or more (cf. VESECKÝ et al. 1958).

The area in question is in permanent of influence local anemo-orographic systems (JENÍK 1961).

The climax communities occuring at these altitudes belong to the alliance *Pinion mughi* PAWŁOWSKI 1928 and, to a small extent at the highest altitudes, to the alliances *Nardo-Caricion rigidae* NORDHAGEN 1937 and *Juncion trifidi* PAWŁOWSKI 1928. At the top plateau communities of the alliance *Oxycocco-Empetrion hermaphroditi* NORDHAGEN 1937 occur. Of the other phytocenoses of this area, only the communities of the alliance *Calamagrostion villosae* PAWŁOWSKI 1928 are to be mentioned. However, the dwarf-pine stands have been replaced to a large extent by communities of the alliance *Nardo-Caricion rigidae* NORDHAGEN 1937.

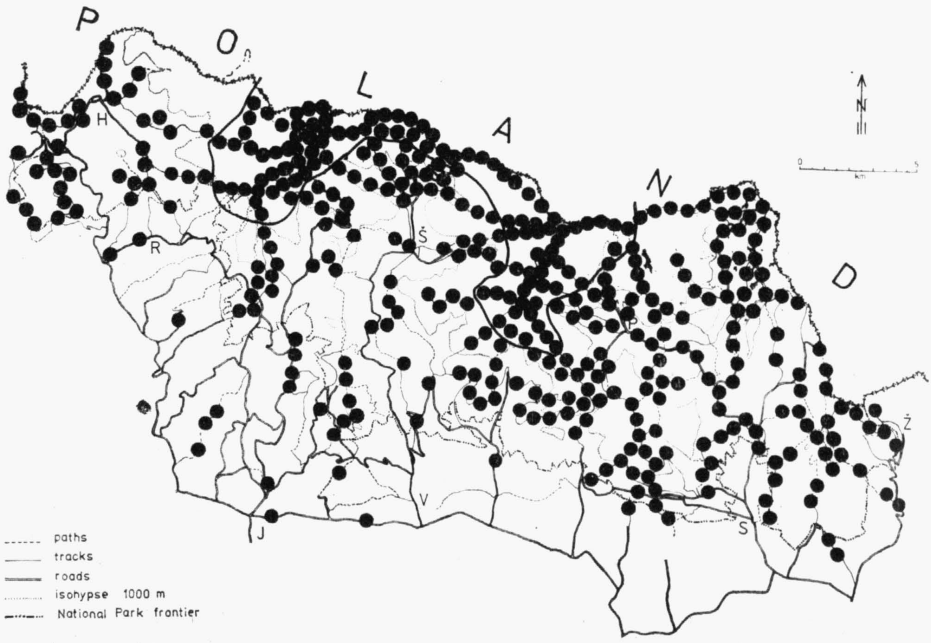

Fig. 1. — Distribution of *Deschampsia cespitosa* along studied communications in Krkonoše Mountains. Main distribution of communities with *Deschampsia cespitosa* is marked with heavy line. Town and villages: H — Harrachov, R — Rokytnice n. Jiz., J — Jilemnice, V — Vrchlabí, Š — Špindlerův Mlýn, P — Pec p. Sněžkou, S — Svoboda n. Úpou, Ž — Žacléř. Chalets: la — Labská bouda, lu — Luční bouda.

REMARKS ON THE DISTRIBUTION AND CENOLOGICAL AMPLITUDE OF *DESCHAMPSIA CESPITOSA* IN HIGHER ALTITUDES

In the Krkonoše Mountains *D.c.* occurs at altitudes up to 1595 m (ŠOUREK 1969). It occurs frequently in various types of habitats as the dominant species of the community.

D.c. is also a highly variable species, according to CHRTEK et JIRÁSEK (1965). Simultaneously, it is a species with a fairly wide ecological tolerance that enables it to grow even under remarkably different conditions. It occurs, therefore, in different habitats under various climatic conditions.

On the territory of Czechoslovakia, three subspecies of *D.c.* are recognized. However, most plants occurring in our country belong to *D.c.* subsp. *cespitosa*. From the highest altitudes of Czechoslovakia, CHRTEK et JIRÁSEK (l.c.) have described a new subspecies, viz. *D.c.* subps. *alpicola*, based upon the type specimen from Jeseníky Mountains; they also reported this subspecies from the Krkonoše Mountains. On the basis of the above-mentioned publication, some botanists working in the Krkonoše Mountains report this taxon together with the community description. However, according to Dr. J. CHRTEK's recent personal communication, *D.c.* subsp. *alpicola* is not typical of the Krkonoše Mountains and further studies of the local population are desirable. For this reason, in the present paper only the name *D.c.* is used.

The distributin of *D.c.* along the communications over the entire range of the Krkonoše Mountains is illustrated in fig. 1. Most localities are above 1000 m. The region delimiting the main distribution of communities with *Deschampsia cespitosa* as the dominant species is marked with a heavy line.

On the whole, three alliances have also been described based upon the high dominance of *D.c.* However, each of them belongs to a different order: *Deschampsion caespitosae* HORVATIĆ 1935 belongs to *Deschampsietalia caespitosae* HORVATIĆ 1956 or to *Molinietalia* W. KOCH 1926; *Deschampsion caespitosae* BORZA 1934 to *Adenostyletalia* G. BR.-BL. 1931; and *Poo chaixii-Deschampsion caespitosae* JENÍK, BUREŠ et BUREŠOVÁ 1980 to *Calamagrostietalia villosae* PAWŁOWSKI 1928 em. KLIKA in KLIKA et HADAČ 1944.

In the Krkonoše Mountains, the communities with *D.c.* have been reported by ZLATNÍK (1928) as *Deschampsietum caespitosae polygonosum bistortae* and later by BUREŠOVÁ (1976) as *Polygono-Deschampsietum alpicolae* (ZLATNÍK 1928) BUREŠOVÁ 1976 (*Poo chaixii-Deschampsion caespitosae* Jeník, Bureš et Burešová 1980). It occurs above the alpine timberline on sites with a long-lasting snow cover.

The next type of communities dominated by *D.c.* are nowadays represented by stands which arose from formerly intensively cultivated meadows. The majority of these stands occupy, from the viewpoint of syntaxonomy, a transitional position between the alliances *Nardion* BR.-BL. 1926 and *Triseto-Polygonion bistortae* MARSHALL 1947.

In the neighbourhood of the adjacent to mountain chalets there are stands with *D.c.* as the dominant species (see also ŠPATENKOVÁ-SKALSKÁ 1980). KROPÁČOVÁ et SÝKOROVÁ-HRUBCOVÁ (1972) reported meadows and pastures with *D.c.* — subassociation *Festuco* (*commut.*) — *Nardetum strictae deschampsietosum* KROP. 1968 — from the mountain crest of Český hřeben.

D.c. also forms a high degree of cover present in the territory under investigation in some spring-marsh communities of the alliance *Cardamino-Montion* BR.-BL. 1926, occupying small areas (cf. HADAČ et VÁŇA 1968, 1971).

BASIC CHARACTERISTIC OF EDGE HABITATS WITH *DESCHAMPSIA CESPITOSA*

In contradiction to roads, which represent certain construction work in the landscape and which are mostly differentiated into the roadway, verge and ditches, the structure of tracks and paths is much simpler. ZAPLETAL (1969)

attaches both types of communications to pat-routes which the earth surface reshapes only insignifficantly from the geomorphological viewpoint. However, in the conditions of the Krkonoše National Park, they represent a landscape element which must not be disregarded.

The paths arose mostly by trampling across the terrain and on their surfaces there is vegetation (living and dead) or bare soil. The track beds were mostly paved with stones. Where it was necessary, as an antierosion measure, ditches were excavated. Into these, the drainage runners led, crossing obliquely the track crown. Continuous transitions often exist between the paths and tracks.

The recent maintenance of old tracks consists mainly in repairs of their surface using crushed limestone and in widening of the track beds.

Under the influence of recreation and of traffic and track maitenance connected with it, the vegetation cover and the soil are mechanically damaged and the habitats along the tracks are eutrophicated to a certain degree. The most distinct enrichment with nutrients arises on much-frequented track sides, the surface of which are maintained with crushed limestone. This anthropic impact influences both the physical and chemical properties of the soils. The soils become more alkaline, which, in these oligotrophic conditions, results in a higher nutrient status of the habitats. The unfavorable influence of this limestone gravel on natural vegetation and soil in the area under investigation has been studied by Soják, Rejmánek et Kovář (1976), Adámková (1978) and Málková (1978).

The habitats of stand with *D.c.* along the tracks and paths in contrast to the surrounding grassland stands, are also influenced by the slower melting of the snow cover there, especially on sites where it has been compacted by supply vehicles or by skiing.

STRUCTURE OF THE COMMUNITIES

The fringe communities with *D.c.* as dominant species usually occur in continuous and conspicuous stands, mainly in a 20 to 100 cm wide belt along the tracks or paths.

The total cover of *D.c.* is represented by the fifth degree (2/3 of cases) and by the fourth degree of the five-degree scale. (1/3 of cases). The following accompanying species occur most frequently, but with a low degree of cover: *Taraxacum officinale*, *Cerastium holosteoides*, *Poa supina* and *P. annua* (see Tab. 1)[1]. The following species are also present with a relatively high constancy and with a mostly higher, but fluctuating degree of cover: *Nardus stricta*, *Deschampsia flexuosa*, *Agrostis tenuis*, *Calamagrostis villosa*, *Anthoxanthum odoratum*, *Homogyne alpina*, *Polygonum bistorta*. *D.c.*, as dominant, is characterized by the ability to form large tufts which strongly suppress the other species. In the stands examined, a two-layer structure is distinguishable. The upper layer ($E_{1\beta}$) with a very low cover degree consists of species taller than 30 cm (*Ranunculus acris*, *Polygonum bistorta*, *Calamagrostis villosa*). *D.c.* reaches into this layer by its flowering and fruiting shoots which grow up to 75 cm high. The ground layer ($E_{1\alpha}$) consists, first of all, of the *D.c.* tufts and of other representatives of the family *Poaceae*. As a result, reduced vitality is obvious in many species.

[1]) Species in Tab. 1 are lined up in the groups of diagnostic taxa.

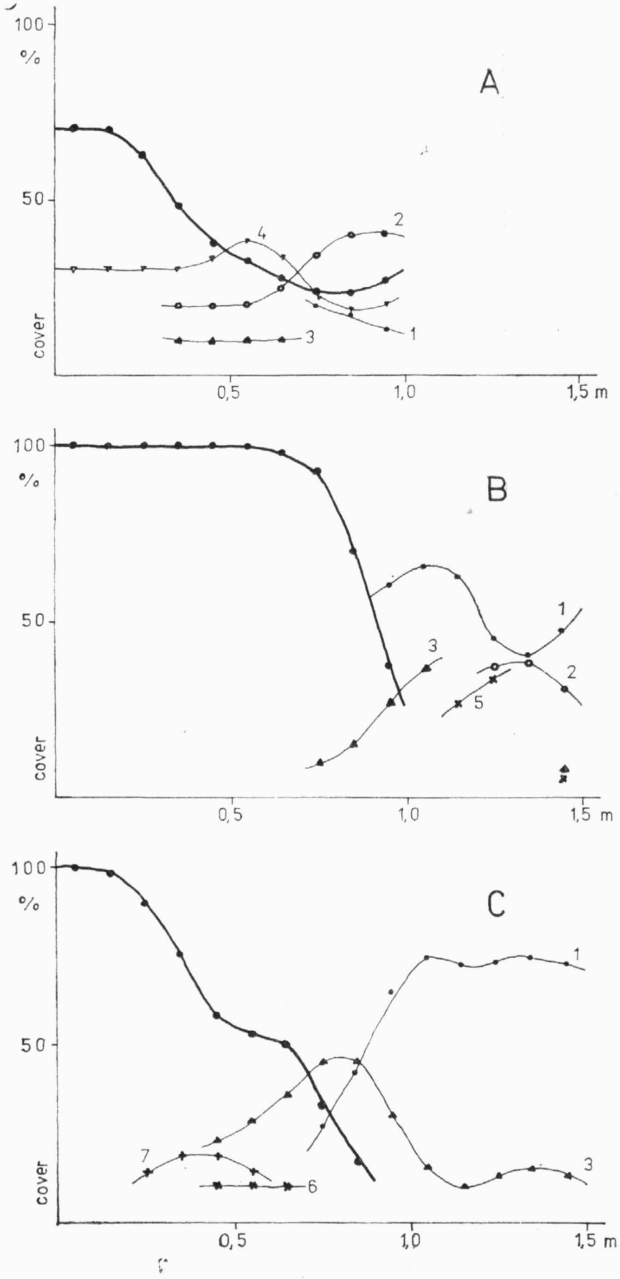

Fig. 2. — Transects through stands with *Deschampsia cespitosa* perpendicular to the track. A — north slope of Kotel Mountain, 1370 m, B, C — ost of Mumlava springs, 1350 m. Heavy line — *D.c.*, 1 — *Nardus stricta*, 2 — *Deschampsia flexuosa*, 3 — *Anthoxanthum odoratum*, 4 — *Galium harcynicum*, 5 — *Carex bigelowii*, 6 — *Agrostis rupestris*, 7 — *Taraxacum officinale*.

Tab. 1. — Communities with *Deschampsia cespitosa*

Community	*Nardus stricta-Deschampsia cespitosa* a					*Poa supina-Deschampsia cespitosa* b			c				*Ranunculus acris Deschampsia cespitosa* d							
Relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	C
Plot area (m²)	4	7	4	4	8	7	5	7	6	7	4	7	7	4	6	4	6	7	8	
Cover (%)	70	100	75	90	95	95	75	100	95	100	70	95	90	80	95	75	90	100	95	
Number of species	8	6	8	7	11	17	11	11	15	13	16	14	27	15	18	16	13	21	15	
Deschampsia cespitosa	5	5	5	5	4	4	5	5	5	5	5	5	5	4	4	4	4	4	4	V
Nardus stricta	1	1	+	1	.	.	.	1	.	.	.	.	+	.	+	.	.	+	.	III
Deschampsia flexuosa	1	1	+	+	.	.	.	+	.	.	.	.	1	.	.	.	.	+	.	II
Anthoxanthum odoratum	1	1	1	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	II
Calamagrostis villosa	+	.	+	2	1	1	.	+	.	.	.	1	+	1	.	.	.	+	.	III
Agrostis tenuis	.	1	.	.	.	+	+	.	1	1	.	1	1	.	+	.	+	1	.	III
Homogyne alpina	.	.	+	+	.	.	.	.	.	+	+	+	+	1	.	.	.	+	.	III
Polygonum bistorta	+	r	.	.	.	.	.	.	1	1	.	.	+	.	+	.	+	.	+	III
Hieracium alpinum	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	+	.	.	II
Potentilla aurea	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	1	.	+	+	II
Solidago minuta*	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	.	+	.	.	II
Potentilla erecta	1	.	.	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	II
Agrostis rupestris	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	I
Hypochoeris uniflora	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.	.	.	I
Luzula sudetica	.	.	.	.	.	.	.	.	.	.	r	.	.	.	+	.	.	.	.	I
Poa supina	.	.	.	.	+	1	+	+	+	1	1	1	+	.	+	+	+	.	.	IV
Epilobium angustifolium	.	.	.	.	+	+	.	.	.	.	1	+	+	+	.	+	.	.	.	II
Alchemilla vulgaris	.	.	.	.	r	.	.	1	.	.	.	.	+	.	1	.	.	+	1	II
Plantago major	.	.	.	.	.	+	+	.	.	.	r	.	.	.	.	r	.	1	.	II
Ranunculus repens	.	.	.	.	.	.	+	2	.	.	.	.	r	.	.	.	.	2	.	II
Epilobium montanum	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	r	.	I
Cirsium arvense	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Senecio fuchsii	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	I
Veronica sepyllifolia	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Epilobium adenocaulon	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	I
Heracleum sphondylium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Rumex acetosella	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I

Sagina procumbens	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Stellaria media	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium repens	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Urtica dioica	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Tussilago farfara	.	.	.	.	3	.	+	.	.	1	.	+	.	.	.	.	.	.	.	II
Taraxacum officinale	.	.	.	.	+	+	+	1	+	+	+	+	1	r	+	1	+	1	+	V
Cerastium holosteoides	.	.	.	.	+	+	+	+	+	+	+	.	1	+	1	+	1	+	+	IV
Ranunculus acris	.	.	.	.	.	.	.	.	.	.	r	.	+	2	1	2	2	1	1	III
Phleum alpinum	.	.	+	.	.	.	.	.	.	.	+	.	+	+	1	+	1	.	+	III
Poa pratensis	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	+	+	+	1	III
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	1	+	+	1	.	+	.	+	II
Rumex alpestris	.	.	.	.	+	.	.	.	.	.	.	.	.	+	1	+	.	1	.	II
Alopecurus pratensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	I
Leontodon hispidus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	I
Silene dioica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	I
Veronica chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	I
Achillea millefolium	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Carum carvi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Dactylis glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	I
Geranium sylvaticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Lathyrus pratensis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Leontodon autumnalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Poa trivialis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Silene vulgaris	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	+	+	.	.	II
Trientalis europaea	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Myosotis nemorosa	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	r	.	I
Sagina saginoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	I
Senecio nemorensis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	I
Stelaria uliginosa	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	I

Species in one relevé only:

4: *Festuca supina* +; 6: *Bellis perennis* r, *Veronica beccabunga* +; 9: *Hieracium* sp. jv. r; 11: *Vaccinium myrtillus* +; 13: *Campanula rotundifolia* +, *Luzula luzuloides* +; 14: *Juncus filiformis* +, *Sorbus aucuparia* jv. r; 15: *Campanula bohemica* +; 18: *Galium* sp. jv. 1.

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a) Derivate community *Deschampsia cespitosa*-[*Nardetalia*] (1—4)
d) Derivative community *Deschampsia cespitosa*-[*Convolvulo-Chenopodiea*] (5—7)
c) Derivate community *Deschampsia cespitosa*-[*Nardetalia*/*Convolvulo-Chenopodiea*] (8—12)
d) Derivate community *Deschampsia cespitosa*-[*Triseto-Polygonion bistortae*] (13—19)

The variability of the species composition across a belt along paths and tracks is very small. It is mostly distinguishable in the belts that are more than 50 cm wide, situated along the heavily frequented communications (see also fig. 2). The inner part of the belt is somewhat richer in the species characteristic of trampled communities whereas the outer part is richer in species of the contact communities (mainly the matgrass and dwarf-pine stands). Only exceptionally on the inner side of the belt, a narrow (5—10 cm) strip was observed, consisting of fragments of trampled communities of the order *Plantaginetalia majoris* Tx. (1947) 1950. Of course, the situation is different in places where the vacationers gather in greater numbers. For examples of the structure of fringe stands with *D.c.* and contact grass communities see also transects in fig. 2.

A more detailed insight into the communities along the tracks and paths with *D.c.* as dominant species reveals that the other species participating in these fringe communities can be divided into three following communities:

Community *Nardus stricta-Deschampsia cespitosa*

This community, which is poorest from the floristic viewpoint, is characterized primarily by the presence of *Nardus stricta*, *Deschampsia flexuosa*, *Anthoxanthum odoratum* and *Calamagrostis villosa*. The floristic structure is presented in Tab. 1, relevés 1—4. Most species of this type belong to units of the class *Nardo-Calunetea* Preising 1949. By the deductive classification method of the plant communities (Kopecký 1977, 1978b, Kopecký et Hejný 1971, 1978), this community can be evaluated as derivate community *Deschampsia cespitosa*-[*Nardetalia*].

Localization of relevés

1. Along the path not far off Výrovka chalet, 1340 m; July 19, 1977.
2. Above Kotelné jámy cirque along the path, 1400 m; August 8, 1976.
3. Along the track not far off Růžohorky chalets, 1370 m; July 22, 1977.
4. Above Jelenka chalet along the path, 1350 m; August 14, 1978.

Community *Poa supina-Deschampsia cespitosa*

This community is characterized first of all by the presence of synanthropic species (species of the units of the division *Convolvulo-Chenopodiea* Krippelová 1978), especially *Poa supina*, *Epilobium angustifolium*, *Alchemilla vulgaris*, *Plantago major*, differential species *Tussilago farfara* and with a high constancy *Taraxacum officinale* and *Cerastium holosteoides* — see Tab. 1, relevés 5—12. Further most relevés are characterized by the presence of species from surrounding mat-grass stands. From the viewpoint of the deductive classification method of plant communities (Kopecký l.c, Kopecký et Hejný l.c.), this community can be evaluated as two following communities: derivate community *Deschampsia cespitosa*-[*Convolvulo-Chenopodiea*] — see Tab. 1, relevés 5—7 and derivate community *Deschampsia cespitosa*-[*Nardetalia*/*Convolvulo-Chenopodiea*] — see Tab. 1, relevés 8—12. Differences betwen both derivate communities is before all probably in development (younger or older stands) and/or in closely neighbourhood of mat-grass stands. This community is distributed mostly in the western part of Krkonoše Mountains.

Localization of relevés

5. Along the track on west margin of nature reserve "Pančavská louka", 1340 m; September 7, 1980.

6. Not far off "Bouda na Pláni" chalet along the track, 1190 m; June 24, 1977.
7. Along the track west of Obří bouda chalet, 1420 m; July 24, 1977.
8. Along the track on NW margin of nature reserve "Pančavská louka", 1350 m; September 7, 1980.
9. Near SW margin of nature reserve "Pančavská louka" along the track, 1350 m; September 7, 1980.
10. Dtto, 1340 m; September 7, 1980.
11. Along the track not far off "Bufet na Rozcestí" chalet, 1340 m; July 23, 1977.
12. Along the track near north margin of nature reserve "Pančavská louka", 1340 m; September 7, 1980.

Community *Ranunculus acris-Deschampsia cespitosa*

The community richest in species is characterized primarily by the presence of the following meadow species: *Ranunculus acris*, *Phleum alpinum*, *Festuca rubra*, *Poa pratensis*, *Polygonum bistorta*, *Alopecurus pratensis*. Also present are species of grassland communities of the subalpine belt; synanthropic species, which indicate disturbed sites; and high constancy species, *Taraxacum officinale* and *Cerastium holosteoides*. For floristic composition see Tab. 1, relevés 13—19. By the deductive classification method of plant communities (KOPECKÝ l.c., KOPECKÝ et HEJNÝ l.c.) this community can be evaluated as derivate community *Deschampsia cespitosa-[Triseto-Polygonion bistortae]*.

This community is distributed mostly in the eastern part of Krkonoše Mountains (see p. 17).

Localization of relevés

13. Along the track above Výrovka chalet, 1500 m; July 1977.
14. On NW slope Liščí hora mountain along the track, 1350 m; July 23, 1977.
15. Along the track ost of Luční bouda chalet, 1420 m, July 24, 1977.
16. Not far off Luční bouda chalet along the track, 1420 m; July 24, 1977.
17. Along the track on Luční hora mountain, 1520 m; July 25, 1977.
18. Along forest track between Martinovka chalet and Fučíkovy boudy chalets, 1260 m; September 7, 1980.
19. Along the track on Luční hora mountain, 1520 m; July 25, 1977.

ECOLOGICAL REMARKS

D. c. is to be regarded as a species with a progressive trend of spreading in nutrient-rich conditions owing to its resistance to mechanical damage. Therefore, it thrives under intesive pasturing of sheep or cows, or in cattle paths between pastures. In the vicinity of sheep pens in the Carpathians, the *D.c.* stands link up with the outer edges of *Rumex alpinus* or other nitrophilous plant stands. The outer edges of the *D.c.* stands merge with the pastures already mentioned also by SMARDA (1963).

The habitats colonized by *D.c.* stands differ not only in their position on the mountain relief (tracks and paths along contour lines, along slopes and on plains), but in trophic conditions,[2] traffic intensity, mechanical damage, stage of development of their vegetation, and in their contact communities.

The complex of anthropogenic impacts and of their partial components (traffic, track and path maintenance, hiking) in connection with their intensity, strongly limits the dominant species of the neighbouring grassland stands (primarily *Nardus stricta* and *Deschampsia flexuosa* — see next section).

[2] The trophic conditions are evaluated on the basis of species richness, of representation of species indicating more eutrophic conditions, and by the presence of crushed limestone in the vicinity.

This provides *D.c.* with an easier existence and promotes spreading, because it demands rather eutrophic conditions and is resistant to mechanical damage. The anthropogenic soils influenced in the above-mentioned way (see also p. 6) are not a suitable substrate for many other species of the neighbouring stands. These species either do not occur there at all or are represented only insignificantly and often with a reduced vitality. It must be emphasized that the microhabitat conditions are of great importance. It often happens that the surface of some track has been repaired with crushed limestone only in some sections; this is manifested immediately by the floristic composition of the neighbouring fringe stand. In other cases, the soil surface is more disturbed in places. Further, many sites are climatically more favourable (the microrelief or the vicinity of dwarf-pines, spruce groups or spruce forests). However, the contact community affects the species composition of the community as well.

With respect to the environmental conditions, two main types of habitats with *D.c.* as the dominant species are distinguished:

(1) The sites colonized by stands of the community *Nardus stricta-Deschampsia cespitosa* are the least influenced, i.e., with a low nutrient content in the soil, little mechanical disturbance, and situations with a low intensity of traffic and hiking. Often this community occurs near dwarf-pine stands and on wet microhabitats near raised bogs.

(2) Eutrophic and /or climatically favourable sites that are more mechanically disturbed, host the communities *Poa supina-Deschampsia cespitosa* and community *Ranunculus acer-Deschampsia cespitosa*. The second community, richest is species, is often found in the vicinity of formerly intensively cultivated meadows in the eastern part of Krkonoše Mountains (see p. 10, 17).

The fringe communities with *D.c.* as dominant species occur mainly on sunny sites and less on partly shaded sites (e.g. stands of dwarf-pine, spruce forests). In shaded habitats, the representation and cover degree of *D.c.* decreases substantially. The species *Stellaria nemorum*, *Ranunculus repens*, *Rumex alpestris*, etc. then become dominant at the timberline and, above all, below in (HUSÁKOVÁ 1981).

A certain similarity between the predominantly subalpine cenoses with dominant *D.c.* along tracks and paths and in the meadow communities with dominant *D.c.* in the riparian zone of streams, also reflects a similarity in the ecological conditions.

In the riparian zones of streams that have not been channalized, spring floods occur, which bring about silt accumulation and detritus deposition (this means enrichment with mineral nutrients of both inorganic and organic origin), retardation of the onset of the vegetation period and a certain mechanical damage to both the plants and the soil surface. In the summer, on the contrary, the ground water level drops and the mostly sandy-loamy soils dry out.

The hydrological and trophic soil régime of the habitats along the tracks and paths shows certain analogous features. The compacted snow (see p. 6) usually persists till the end of April, in some years even longer. For this reason, the soils are richly supplied with water prior to the onset of the vegetation period. In contrast to the meadows with *D.c.* as the dominant species, the soils in the riparian zones along the streams at the lower altitudes do not

become dry because of higher precipitation. A certain enrichment with nutrients of the habitats along the tracks and paths is caused by traffic, maintainance of the tracks and rambling. The most significant enrichment with nutrients takes place along the tracks and paths whose sufrace was repaired with crushed limestone (see p. 6).

In addition, the habitats along the mountain tracks and paths in the subalpine zone, with *D.c.* as dominant species are analogous not only to the meadows occupying large areas of the riparian zones along the streams in the foothills and lowlands, but first of all, to the communities of springs in the Krkonoše Mountains themselves. The similarity consists above all in the soil-hydrological conditions and in the necessity to resist mechanical damage in these habitats. Closely related are also the periodically inundated cenoses with *D.c.* along the streams in the Jizerské hory Mountains, as reported by Studnička (1978).

DEVELOPMENT OF FRINGES

The above mentioned communities are to be regarded as stands of spontaneous origin. They arose either by the overgrowing on bare soil surface of tracks or their margins or by destruction of surrounding grass communities (the matgrass stands; lesser stands of *Polygono-Deschampsietum alpicolae*, abandoned meadows with *D.c.* as dominant species, stands of *Cetrario-Festucetum supinae* Jeník 1961, and raised bog communities). Sometimes both developing origins are diffused and often is difficult to determine the presupposed origin of the fringe community (see p. 18).

Related to the present stands with *D.c.* occurring along the tracks and paths were those stands that already formerly occupied small areas on some convenient sites along tracks. These sites were first of all, wide ditches or places disturbed mechanically; mainly by the erosive and acumulative effects of the water. The tufts of *D.c.* also predominated or occured together with *Nardus stricta* and *Deschampsia flexuosa* along the more intensely trampled tracks and paths. *D.c.* grew here also in its trampled form, often together with *Poa supina* on the surface. A certain analogy of the conditions along the tracks and paths is provided by the occurrence of *D.c.* in the old military trenches on the northern slope of the mountain Studničná hora (see also Štursová 1974, Málková 1978).

Origin of fringe communities by destruction of stands of the association *Polygono (bistortae)-Deschampsietum alpicolae* (Zlatník 1928) Burešová 1976 or formerly cultivated meadows and stands with *Nardus stricta* seems to be gradual. In case of mat-grass[3] stands, the most frequent contact community, this process is as follows:

The gradual replacement of the dominant species (*Nardus stricta* → *D.c.*) along the track and path edges is conditioned, first of all, by hiking and by the cessation of cultivation of grasslands above the alpine timberline; secondly; by periodical trampling and by the compacting of soil by vehicle wheels, blanketing of both vegetation and soil with gravel and earth, and increase of pH and mineral nutrient levels in the soil.

[3] *Nardus stricta* is particularly sensitive to mechanical damage and at the present time generative reproduction is practically absent in high altitudes (Štursová 1974).

This replacement of the dominant species is very noticeable, for example, along the little frequented paths passing through the *Nardus stricta* stands. In these paths, only a slightly decreased vitality of *Nardus stricta* can be observed; furthermore, the paths become visible by the tufts kicked off from the paths. If the trampling intensity increases, the parts of tufts growing in the middle part of the paths die off and the soil surface becomes bare. At places like these, *D.c.* can gradually establish itself. Along the wider and more frequented paths, a certain boundary can develop in the course of time, which is different from the surrounding *Nardus stricta* stands; first of all by the lower presence of forbs and higher presence of grasses. Under the influence of a higher nutrient content (provided that trampling is excluded) the plants of such a fringe become somewhat more vital than in the surrounding stands. The relevé 1 (Tab. 2) may serve as an example of such a stand. Sometimes the stands with *Deschampsia flexuosa* as the dominant species of such a fringe are present — relevé 2 (Tab. 2). From the phytocenological viewpoint both relevés belong to the alliance *Nardion* Br.-Bl. 1926. Along the more frequented paths or less frequented tracks the representation of *D.c.* becomes higher. As examples, the relevés 3 and 4 (Tab. 2) are presented (both relevés belong again to the alliance *Nardion* Br.-Bl. 1926).

Localization of relevés (Tab. 2)

1. Along the path on SO slope of Lysá hora Mountain, 1280 m; August 10, 1976.
2., 4. Along the path between chalet Luční bouda and brook Stříbrná bystřina, 1420 m; July 21, 1977.
3. Along the track not far off Růžohorky chalets, 1370 m; July 22, 1977.

Under the influence of either continuous or temporary disturbance of the soil bare places arise in the fringe stands, where the propagules originate from the vicinity or distant sites. Great and not only mechanical disturbances of the soil surfaces occurred especially about the year 1970 (see p. 234).

The sources of propagules of *D.c.* are, first of all, the surrounding stands, especially those described by Burešová (1976) as *Polygono* (*bistortae*)—*Deschampsietum alpicolae* and, formerly, intensely cultivated meadows in the vicinity of the mountain chalets.

The sources of the most species of ± natural grassland communities of subalpine belt are before all the surrounding *Nardus stricta* stands.

Of the species belonging to the division *Convolvulo-Chenopodiea* Krippelová 1978, *Poa supina* is the most significant; it formerly grew on the track surfaces, especally of the stone-paved tracks (probably closely related to the association *Poo supinae-Alchemilletum hybridae* Aichinger 1933). Fragments still occur only exceptionally at several places in old, not maintained, but frequented tracks (see also Hejný et Kopecký et al. 1979). The trampled form of *D.c.*is present in these fragments with a higher cover degree. These stands with *Poa supina* (*Polygonion avicularis* Br.-Bl. 1931) are retreating, owing to the present changes in the use of the Krkonoše Mountains.

Other species of the division *Convolvulo-Chenopodiea* Krippelová 1978 are spreading along roads, tracks and paths from ruderal habitats close to chalets in close vicinity, from lover altitudes of the Krkonoše Mountains and from their foothills as a consequence of traffic and hiking (see also Kopecký 1971, Kopecký 1978 a, Husáková et Guzikowa 1979). For the vertical spreading of this species from the lower altitudes the following kinds of

Tab. 2. — Fringe stands with *Nardus stricta* and *Deschampsia flexuosa* as dominant species

Relevé	1	2	3	4
Plot area (m^2)	5	5	4	6
Cover (%)	90	95	75	90
Number of species	9	5	5	5
Nardus stricta	5	1	4	2
Deschampsia flexuosa	1	4	.	3
Deschampsia cespitosa	+	1	3	2
Anthoxanthum odoratum	+	1	1	1
Agrostis tenuis	r	2	+	1
Calamagrostis villosa	+	.	+	.
Calluna vulgaris	+	.	.	.
Galium harcynicum	2	.	.	.
Luzula luzuloides	1	.	.	.
Vaccinium myrtillus	+	.	.	.

propagule transport are most important: anemoagestochory, agestochory, rypochory and epiantropochory (terms used after LHOTSKÁ 1968 and LEVINA 1944). About 20 years ago, the zoochory connected with horse-carts could still be considered. Nowadays, zoochory can be important only locally, in the first place, possibly, through the mediation of small rodents.

The propagules of meadow species are probably of dual origin. The first source was more or less local (especially in the eastern part of Krkonoše Mountains),[4] because in the past the percentage of intensively cultivated meadows was much higher in this region. After the management of these areas had ceased, the meadow species disappeared gradually. A part of these species found refuges in the stands on eutrophic and mechanical disturbed soils, which started to expand along tracks and paths. Formerly, under the influence of meadow cultivation, very little difference existed between the stands along the communications and the surrounding stands. The main development of the fringe stands is connected with termination of cultivation of the surrounding areas and with the progressive increase in the numbers of visitors to the mountains (see also HUSÁKOVÁ 1982). The other source of propagules of these meadow species is found at the lower altitudes of the Krkonoše Mountains in the same way as synanthropic species (see above).

Often both above-mentioned developments of stands with *D.c.* diffused; first of all along tracks, whose surface was partly repaired with crushed limestone. Here, fringes of *D.c.* formerly often occured (see above). On disturbed places many species become extinct, including those which had even been dominant before (*Nardus stricta*, *Deschampsia flexuosa*). The empty areas were than colonized by *D.c.*, partly by vegetative spreading from the remaining tufts, partly generatively by newly arising tufts. Other species colonizing these areas belong predominantly to synanthropic and meadow species.

[4] The plateau of east Krkonoše Mts. was longer and more intensively cultivated than the plateau of west Krkonoše Mts. (for details see LOKVENC 1978). Especially permanent settlement of Luční bouda chalet and intensive pasturing around it caused considerable occurrence of meadow species from lower altitudes. Therefore, there remains here to the present time a seed bank of meadow species.

Further studies are needed of stands with *D.c.* as dominant species (along the tracks and paths, arisen by degradation of intensively managed meadows and occurring in connection with intensive mountain pasturing) as well as about *D.c.* This species could easily be used more frequently for erosion control in mountainous regions. It would thrive especially on bare places along the communications or around buildings under construction. A successful sowing of a small area (part of an unsued track) with an autochthonous grass mixture, in which *D.c.* predominated, has already been made in the Krkonoše Moutains not far from the chalet Luční bouda (MÁLKOVÁ 1978).

ACKNOWLEDGEMENTS

I thank Ing. K. KOPECKÝ, DrSc. for his helpful comments. I am also indebted to Dr. D. BLAŽKOVÁ, CSc., academician S. HEJNÝ, DrSc., Dr. F. KRAHULEC and Dr. R. NEUHÄUSL, DrSc. for their comments to the present paper. Dr. J. KVĚT, CSc., I thank for language correction of the manuscript.

SUMMARY

Along the strongly frequented tracks and paths, mainly above the alpine timberline, the stands with *Deschampsia cespitosa* as dominant species were recorded. The predominance of this species is connected with its resistance to trampling, to blanketing with gravel and earth and with its ability to grow in soils rich in nutrients, and rather moist to wet. Various combinations of these factors give rise to two different habitat types, on which grow the three following communities (in brackets is classification after deductive classification method of plant communities — KOPECKÝ 1977, 1978b, KOPECKÝ et HEJNÝ 1971, 1978): Community *Nardus stricta-Deschampsia cespitosa* (derivate community *Deschampsia cespitosa-[Nardetalia]*) is a species poor community that grows on little influenced sites. The others grow on eutrophic and/or climatically favourable sites. Community *Poa supina-Deschampsia cespitosa* (derivate community *Deschampsia cespitosa-[Nardetalia/Convolvulo-Chenopodiea]*; derivate community *Deschampsia cespitosa-[Convolvulo-Chenopodiea]*) is distributed chiefly in the western part of Krkonoše Mountains. Community *Ranunculus aeris-Deschampsia cespitosa* (derivate community *Deschampsia cespitosa-[Triseto-Polygonion bistortae]*) is distributed mainly in the eastern part of Krkonoše Mountains, because this part was intensively cultivated for a longer period. An important component in these rich species communities are species of the vegetational units belonging to the division *Convolvulo-Chenopodiea* KRIPPELOVÁ 1978, which accentuates the synanthropic character. Most species of the units belonging to the division *Convolvulo-Chenopodiea* KRIPPELOVÁ 1978 originated from lower altitudes, their propagules being spread by traffic, track and path maitenance and rambling.

Besides the habitat conditions strongly influenced or even conditioned by human activities, which are analyzed in detail in the closing parts of the paper, the microrelief and the contact communities also play an important part. The syngenetic viewpoint is very important as well. Stands arose either by the overgrowing or by destruction surrounding grass communities.

Above timberline, the examined stands along the tracks and paths are important for erosion control.

SOUHRN

Podél silně frekventovaných cest a stezek, především nad alpinskou hranicí lesa, byly zaznamenány porosty s dominantní *Deschampsia cespitosa*. Převaha tohoto druhu souvisí s jeho odolností k sešlapu, překrývání štěrkem a zeminou a se schopností růst na půdách bohatých na živiny a poněkud vlhkých až mokrých. Různé kombinace těchto faktorů dávají vznik dvěma odlišným stanovištím, na kterých rostou tři následující společenstva (v závorce je uvedena klasifikace podle deduktivního způsobu klasifikace rostlinných společenstev — KOPECKÝ 1977, 1978b, KOPECKÝ et HEJNÝ 1971, 1978): Společenstvo *Nardus stricta-Deschampsia cespitosa* (odvozené společenstvo *Deschampsia cespitosa-[Nardetalia]*) je druhově chudé společenstvo, které roste na málo ovlivněných stanovištích. Další dvě společenstva rostou na eutrofních a (nebo) klimaticky příznivějších stanovištích. Společenstvo *Poa supina-Deschampsia cespitosa* (odvozené společenstvo *Deschampsia cespitosa-[Nardetalia/Convolvulo-Chenopodiea]*; odvozené společenstvo *Deschampsia cespitosa-[Convolvulo-Chenopodiea]*) je rozšířeno hlavně v západních Krkonoších.

Společenstvo *Ranunculus acris-Deschampsia cespitosa* (odvozené společenstvo *Deschampsia cespitosa-[Triseto-Polygonion bistortae]*) je rozšířeno především ve východních Krkonoších, protože tato část byla intenzivněji a déle obhospodařována. Důležitou složkou těchto druhově bohatých společenstev jsou druhy oddělení *Convolvulo-Chenopodiea* Krippelová 1978 a podřazených jednotek, které zdůrazňují synantropní charakter. Většina druhů náležejících uvedenému oddělení a podřazeným jednotkám je původem z nižších poloh — diaspory těchto druhů se šíří s dopravou, úpravami komunikací a pěší turistikou.

Přestože jsou stanovištní podmínky silně ovlivněny nebo dokonce způsobeny lidskou činností, která je podrobně analyzována v závěrečných částech práce, důležitou roli mají rovněž mikrorelief a kontaktní společenstva. Velmi důležité je také syngenetické hledisko. Porosty s dominantní *Deschampsia cespitosa* vznikají jednak přerůstáním, jednak destrukcí sousedních travinných porostů.

Studované porosty podél cest a stezek nad alpinskou hranicí lesa jsou důležité z hlediska půdní eroze.

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Received 20 March, 1985