8. Alpine heaths – ***Juncetea trifidi***

Prodromus
Juncetea trifidi HADAC 1946
Caricetalia curvulae BRAUN-BLANQUET in BRAUN-BLANQUET & JENNY 1926
Anemonion speciosae MINAEVA ex ONIPCHENKO all.nov.
Campanulo ciliatae-Chamaesciadietum acaulis MINAEVA & ONIPCHENKO ass. nov.
Pediculari comosae-Eritrichietum caucasici MINAEVA & ONIPCHENKO ass. nov.
P.c.-E.c. typicum subass.nov.
P.c.-E.c. oxytropidetosum kubanensis MINAEVA & ONIPCHENKO subass. nov.
P.c.-E.c. bromopsietosum variegatae subass.nov.

Anemonion speciosae

The alliance comprises alpine lichen heaths (alpine tundra) and fellfields on windward crests and slopes on acid soils (ONIPCHENKO *et al.* 1987). Diagnostic species of *Juncetea trifidi, Caricetalia curvulae* are represented by *Helictotrichon versicolor, Luzula spicata, Minuartia recurva, Trifolium polyphyllum* (geographical vicarious species of *Trifolium alpinum), Euphrasia ossica (*geographical vicarious species of *Euphrasia minima)* (OBERDORFER 1978; GRABHERR 1993b). Due to the severe ecological regime (deep winter freezing, frequent summer drought, thin soil profile, great day-to-night temperature fluctuations), the communities have low production rates, high species richness and significant cover of lichens. Floristically and ecologically they are remarkably similar to the communities of *Carici rupestris-Kobresietea bellardii*. The low frequency of *Kobresia spp., Polygonum viviparum, Lloydia serotina* and *Draba scabra*, as well as a preference for warmer slopes (south and east aspect), distinguish *Anemonion* communities from the communities of the previous class (Table 8.1.). Their nomenclature type (typus) is *Pediculari comosae-Eritrichietum caucasici*.

Table 8.1.
Diagnostic table of *Juncetea trifidi*

	1	2	3	4
D.sp. *Campanulo ciliatae-Chamaesciadietum acaulis*				
Anthyllis vulneraria	V	-	I	III
Dactylina madreporiformis	V	-	I	-
Chamaesciadium acaule	V	I	II	IV
Primula algida	V	I	II	IV
Pulsatilla albana	V	I	-	III
Aetheopappus caucasicus	V	III	-	III
Campanula ciliata	IV	I	I	-
Gentiana aquatica	IV	-	I	II
Thymus nummularius	III	-	-	-
Jurinella moschus	III	-	-	II
Campanula saxifraga	II	-	-	-
D.sp. *Pediculari comosae-Eritrichietum caucasici*				
Gentiana pyrenaica	I	V	IV	III
Carum caucasicum	II	V	IV	II
Vaccinium vitis-idaea	II	V	IV	IV
Rhytidium rugosum	-	V	II	IV
D.sp. *P.c.-E.c. oxytropidetosum kubanensis*				
Oxytropis kubanensis	II	V	-	IV
Fritillaria lutea	-	IV	-	III
Plantago atrata	II	IV	-	IV
D.sp. *P.c.-E.c. typicum*				
Pedicularis caucasica	II	-	IV	-
Polytrichum juniperinum	II	-	IV	II
D.sp. *P.c.-E.c. bromopsietosum varigatae*				
Scabiosa caucasica	I	III	-	V
Bromopsis variegata (dom.)	V	V	-	V
Muscari racemosum	-	-	-	IV
Myosotis alpestris	III	I	I	IV
Silene saxatilis	II	I	-	III
Carex humilis	-	-	-	III
Polygala alpicola	I	-	-	III
Seseli alpinum	I	-	-	III
D.sp. *Anemonion speciosae*				
Arenaria lychnidea	V	V	V	IV
Carex sempervirens	V	IV	V	I
Carex umbrosa	IV	V	V	III
Eritrichium caucasicum	V	V	V	II
Minuartia circassica	IV	V	V	V
Anemone speciosa	V	V	V	IV
Pedicularis comosa	V	V	V	V
Thamnolia vermicularis	V	V	V	I
Cetraria nivalis	V	V	II	I
Cetraria cucullata	V	III	III	-

Table 8.1. (continued)

	1	2	3	4
D.sp. *Caricetalia curvulae, Juncetea trifidi*				
Trifolium polyphyllum	III	V	II	III
Euphrasia ossica	IV	V	IV	III
Luzula spicata	III	V	V	II
Helictotrichon versicolor	V	V	V	V
Minuartia recurva	III	III	II	V
Other frequent species				
Alchemilla caucasica	IV	V	III	V
Antennaria dioica	IV	V	III	II
Anthemis marshalliana	V	V	II	V
Aster alpinus	V	IV	I	IV
Campanula collina	V	IV	I	IV
Campanula tridentata	IV	V	V	IV
Cetraria islandica	V	V	V	IV
Cetraria laevigata	IV	IV	I	-
Cladonia gracilis	III	V	III	-
Cladonia mitis	III	V	IV	I
Cladonia pyxidata	V	III	V	IV
Erigeron alpinus	V	V	III	II
Festuca ovina	V	V	V	V
Gentiana biebersteinii	V	II	II	V
Gentiana verna	III	II	II	IV
Polygonum bistorta	V	V	I	IV
Ranunculus oreophilus	IV	I	I	IV
Veronica gentianoides	V	V	IV	V

Syntaxa:
1 - *Campanulo ciliatae-Chamaesciadietum acaulis*, 2 - *Pediculari comosae - Eritrichietum caucasici oxytropidetosum kubanensis*, 3 - *P.c.-E.c. typicum*, 4 - *P.c.-E.c. bromopsietosum variegatae*

8.1. *Campanulo ciliatae-Chamaesciadietum acaulis*

Synonym: *Pediculari chroorrhynchae - Eritrichietum caucasici chamaesciadietosum acaule* MINAEVA 1987

Floristic features

The association includes communities on stabilized dry alpine talus (screes, fellfields). *Anthyllis vulneraria*, *Dactylina madreporiformis*, *Chamaesciadium acaule*, *Pulsatilla albana*, *Aetheopappus caucasicus*, *Campanula ciliata* (Table 8.2.), represent the diagnostic set. Due to substrate peculiarities, some common species of *Gypsophilion tenuifoliae* are rather frequent.

The floristic richness of this community type is high. We registered 80 vascular plant species, 12 bryophytes and 14 macrolichens in 9 releves of the

association. Mean values per releve were 38, 1 and 8 species respectively. A more precise estimate of the species richness shows values of 4.5, 22.1 and 46.0 vascular plant species for 0.01, 1 and 100 square m respectively (ONIPCHENKO & SEMENOVA 1995). In comparison with the next association, the role of lichens is not great. Their cover ranges between 2% and 20% (with the mean of 10%).
Vascular plant cover is larger (15-50%, mean 32%). Typus, or nomenclature type, is releve No. 10/84.

Ecological features

These open communities on dry stabilized screes are typical of snowfree areas of the alpine zone (2700-2950 m a.s.l., mean 2820 m). They prefer steep (15-30°, mean 27°) slopes of "warm" aspect (south, east, southeast). There are many stones covering 3-70% (mean 40%). The high floristic richness is due to sparse plant cover and low competition between the plants. The soil seed bank of the communities is substantial (about 2800 germinable seed per square m) (SEMENOVA & ONIPCHENKO 1994). *Luzula spicata, Primula algida, Euphrasia ossica* are the main components of the bank, each containing more than 200 seeds /square m. According to their floristic composition and structure, we may consider the communities as seral, being gradually succeeded by the communities belonging to the next association.

8.2. *Pediculari comosae-Eritrichietum caucasici*

Synonym: *Pediculari chroorrhynchae-Eritrichietum caucasici* MINAEVA 1987 (*Pedicularis chroorrhyncha* Vved.=*P.comosa* L.)

Floristic features

This association combines closed winter-snowfree communities of the alpine and upper subalpine zones. The diagnostic species set is represented by several common alpine species (*Gentiana pyrenaica, Carum caucasicum, Vaccinium vitis-idaea, Rhytidium rugosum*). The main floristic features of the association consist of a low frequency (or absence) of *Campanulo ciliatae-Chamaesciadietum acaulis* - species and a good representation of *Anemonion speciosae* and *Juncetea trifidi* - species (Table 8.3.). The other characteristic property of the communities is an abundance of fruticose

lichens. Lichens cover from less than 1% to 55% (average 28%), while the same values for vascular plants and bryophytes are 15-80% (47%) and less than 1 - 25% (4%) respectively.

We registered 102 vascular plant species, 27 bryophytes and 20 lichens in 28 releves of the association. Mean numbers per releve were 31, 3, and 6 species respectively. Vascular plant species richness was estimated as 6.2, 25.0, and 39.8 species per 0.01, 1 and 100 square-m plots respectively (ONIPCHENKO & SEMENOVA 1995).

Three subassociations can be further distinguished according to their floristic composition and ecological properties:

P.c.-E.c. typicum (typus, or nomenclature type, No. 75/93) *Pedicularis caucasica* and *Polytrichum juniperinum* are the diagnostic species of the association. The diagnostic species of the other subassociations are practically absent. Floristic richness is relatively low (25 vascular plant species per releve). The communities are more typical of the ridges of various aspects.

P.c.-E.c. oxytropidetosum kubanensis (Typus, or nomenclature type, No. 18/81) comprises floristically rich alpine lichen heaths with high frequency of *Oxytropis kubanensis, Fritillaria lutea, Plantago atrata.* They occupy mainly southern and eastern slopes.

P.c.-E.c. bromopsietosum variegatae (Typus, or nomenclature type, No. 103/95) pools low alpine and high subalpine variants of the association. The lichen cover here is the lowest (mean 7%), while the vascular plant cover is the highest (mean 65%) among the communities of the association. Some species of subalpine grasslands (*Scabiosa caucasica, Myosotis alpestris, Polygala alpicola, Seseli alpinum*) as well as steppe species (*Carex humilis, Muscari racemosa*) form the diagnostic set of the subassociation. The communities are well known in Russian publications as species-rich *Bromus variegatus* - grasslands (SHIFFERS 1953, VOROB`EVA 1977b, TANFIL'EV *et al.*, 1979).

Ecological features

The communities occupy windward crests and slopes within the altitude range of 2350-3000 m (mean 2710 m). They prefer moderate (2°-30°, mean 15°) slopes of southern and eastern aspects. As a rule, stone cover is not great (0-30%, mean 5%). The communities of the association have been the subjects of our long-term ecological investigation (RABOTNOV 1987, ONIPCHENKO 1994).

Table 8.2.

Campanulo ciliatae-Chamaesciadietum acaulis

Releve No.	5	4	28	32	10	6	42	13	55
Year	89	83	83	83	84	84	89	84	83
Altitude (* 10)	285	280	280	285	280	295	290	270	280
Steepness	30	30	15	30	30	15	30	25	35
Exposition	se	s	e	se	sse	se	se	s	e
Vascular plant cover	35	50	25	20	25	15	40	50	35
Bryophyte cover	0.5	1	0	0.5	0.5	0.5	10	3	0.5
Lichen cover	5	10	15	5	2	20	10	15	15
Stone cover	60	20	40	70	60	60	20	5	3
Lichen species number	7	8	10	7	6	8	7	12	7
Bryophytes species number	2	0	0	0	0	1	2	2	6
Vascular plants species number	54	38	29	38	37	34	37	34	40
D.sp. *Campanulo ciliatae-Chamaesciadietum acaulis*									
Anthyllis vulneraria	1	2	1	1	1	1	1	1	1
Dactylina madreporiformis	+	+	1	+	+	+	+	+	
Chamaesciadium acaule	+	+	1	+	1	+	1	1	+
Primula algida	+		+	+	+	+	+	+	+
Pulsatilla albana	+	1	+		+	+	+	1	+
Aetheopappus caucasicus	1	1	+	+	1	+	1	1	
Campanula ciliata	+	+	+	1	1	1			+
Gentiana aquatica	+	+	+		+	+	+	+	
Thymus nummularius	+	+		+	1				+
Jurinella moschus		+		+	1		1	+	
Campanula saxifraga	+			+	1				
D.sp. *Anemonion speciosae*									
Arenaria lychnidea	+	1	1	1	1	1	1	1	+
Carex sempervirens	1		1	1	1	1	2	1	1
Carex umbrosa	+	+			1		+	1	1
Eritrichium caucasicum	+	+	+	+	+	+	+		+
Minuartia circassica		1	1	1	1	1	+		1
Anemone speciosa	1	1	+	+	+	1		1	+
Pedicularis comosa	1	1	+	+	+	+	+	+	+
Thamnolia vermicularis	+	1	1	+		1	1	1	1
Cetraria nivalis	+	+	1	+	+	1	+	1	
Cetraria cucullata	+	+	1	+	+	1		1	+
D.sp. *Caricetalia curvulae, Juncetea trifidi*									
Trifolium polyphyllum	+		1			1		1	1
Euphrasia ossica	+	+		+	+		1	+	+
Luzula spicata	+			1		+	+		+
Helictotrichon versicolor	1	+	1	+	+	+	+		+
Minuartia recurva	+				+		+		+
Other species									
Alchemilla caucasica		1	1		1		1	1	2
Antennaria dioica	1	+	1	+		+			2
Anthemis marshalliana	1	+	1	+	+	+	1	+	+
Aster alpinus	1	1	1	+	1	+	+	+	+
Astragalus levieri	+	+						+	
Bromopsis variegata (dom.)	1	2	1	+	1		1	2	1
Campanula collina	1	+	+	+	+		1	1	1

Table 8.2. (continued)

Releve No.	5	4	28	32	10	6	42	13	55
Year	89	83	83	83	84	84	89	84	83
Campanula tridentata			1	+	+	1	1	+	1
Carum caucasicum	+			+		+			
Cetraria islandica	1	1	1	1	+	1	+	1	1
Cetraria laevigata	+	+	2	+	+	1			1
Cladonia gracilis		+	1				+	1	+
Cladonia mitis			+			1		1	1
Cladonia pyxidata	1	+	+	+	1	1	1	1	+
Erigeron alpinus	+	+	+	+	+	+	+	1	
Festuca ovina	1	1	1	1	+	1	1	1	1
Gentiana biebersteinii	+	+	+	+	+	+	+	+	+
Gentiana septemfida		+			+	+	+	1	
Gentiana verna	+					+	+	+	+
Lloydia serotina	+			+	+				
Myosotis alpestris	+	+			+			+	
Oxytropis kubanensis	1		1			1		1	
Plantago atrata		1						1	+
Polygonum bistorta	1	1	+	+	+	+	+	+	
Polytrichum juniperinum	+					+			+
Potentilla gelida	1			+		+		+	
Potentilla nivea		+	+					+	
Primula ruprechtii	+	+							+
Ranunculus oreophilus	+	1		+	+		+	+	
Vaccinium vitis-idaea	2			1		1			1
Veronica gentianoides	1	1	+	+	+	+	1	1	+

Sporadic species (number of releve in parenthesis, abundance are showen after ":", unless it is not "+", Braun-Blanquet scale)

Alopecurus glacialis (42/89), Anthemis cretica (5/89), Asperula alpina (5/89, 10/84), Bryoerythrophyllum recurvirostrum (42/89), Bryum sp. (42/89), Carum meifolium (4/83:1), Centaurea cheiranthifolia (4/83, 42/89), Cladonia foliacea (13/84:1), Cladonia furcata (28/83), Cornicularia muricata (13/84:1), Deschampsia flexuosa (5/89), Draba hispida (42/89), Draba siliquosa (5/89), Empetrum nigrum (5/89), Eurhynchium pulchellum (55/83), Festuca varia (5/89), Galium verum (5/89), Gentiana pyrenaica (5/89), Gnaphalium supinum (5/89, 6/84), Hieracium umbellatum (55/83), Hymenostomum microstomum (13/84), Juniperus communis (5/89, 55/83), Kobresia schoenoides (32/83:1), Minuartia aizoides (5/89:1), Mnium ambiguum (55/83), Parmelia vagans (42/89, 13/84:1), Pedicularis caucasica (32/83, 6/84), Physconia muscigena (13/84), Poa badensis (4/83), Pohlia cruda (55/83), Polygala alpicola (42/89:1, 55/83), Polytrichum piliferum (5/89, 55/83), Potentilla crantzii (55/83), Sanionia uncinata (55/83), Saxifraga flagellaris (32/83, 6/84), Saxifraga juniperifolia (32/83), Saxifraga moschata (55/83), Scabiosa caucasica (55/83), Scorzonera cana (5/89), Sedum tenellum (5/89), Seseli alpinum (55/83), Silene saxatilis (10/84, 42/89:1), Taraxacum confusum (42/89), Tortella tortuosa (13/84:1), Valeriana alpestris (5/89, 32/83), Viola altaica (4/83, 55/83).

Date (day.month), size (sq.m) and location of the releves.

5/89 - 09.08, 100, M.Khatipara; 4/83 - 20.08, 15, M.Khatipara (G.Levitskaya); 28/83 - 31.08, 15, M.Khatipara (A.Baykalova); 32/83 - 31.08,16, M.Khatipara (A.Baykalova); 10/84 - 01.09, 25, M.Khatipara; 6/84 - 25.08, 25, M.Khatipara; 42/89 - 30.08, 25, Bol.Khatipara; 13/84 - 01.09, 25, M.Khatipara; 55/83 - 10.09, 25, Mukhu

A short account on the research results is presented below.

The average composition of the aboveground **biomass** in this community is the following: vascular plants - 113, lichen - 440, mosses - 3, litter and dead plant parts - 230 g/square m d.w. Belowground biomass and dead matter were estimated as 480 and 400 g/sq. m d.w. respectively. Total annual net-production is low (about 150 g/sq.m d.w) (ONIPCHENKO 1985).

The communities have homogeneous fine **spatial structure** (ONIPCHENKO & POKARZHEVSKAYA 1994). This structure is very peculiar: small lichen patches alternate with graminoid bunches or isolated shoots of vascular plants. The following hypothesis was put forward to explain such structure (ONIPCHENKO 1985, 1994, GRABHERR 1989): in poor shallow soils, the roots of vascular plants occupy a larger area than their aboveground shoots. Thus, vacant space above ground becomes available for the fruticose lichens, since they compete very little for nutrients with the vascular plants. Results of a special series of long-term experiments confirmed this hypothesis.

The high **floristic richness** may probably be attributed to a long period of stable existence of the communities, which was demonstrated both by spore and pollen, and phytolith soil analyses (PAVLOVA & ONIPCHENKO 1992, BLINNIKOV 1994). It is interesting to note that floristic richness of soil and epiphytic algae was also very high in this community (SHTINA *et al.* 1995).

Long term experiments of reciprocal sod transplantations between pairs of different alpine communities showed that most species of the alpine heath could successfully grow under more favourable conditions, but that they are excluded from the grasslands due to competition. On the other hand, dominants of *Nardetalia* - grasslands cannot survive the abiotic stress of the harsh alpine heaths' environment (SENNOV & ONIPCHENKO 1994).

Soil **seed bank** is relatively small (about 350 seed/ sq.m). Species producing many seeds (*Euphrasia ossica, Primula algida, Gentiana pyrenaica, Veronica gentianoides*) are well represented in the bank (SEMENOVA & ONIPCHENKO 1994). Due to the generally very severe environment, the recovery process after disturbance of alpine heaths is very slow. For example, revegetation after mild digging by wild boar on a single occasion (*Sus scrofa* L.) took at least 15 years (ONIPCHENKO & GOLIKOV 1996). The communities serve as winter pastures for wild ungulates. Lichen cover degradation takes place in overgrazed areas. Some special protection (restricted grazing of livestock) is absolutely necessary for the preservation of these fragile and species-rich communities, which have such exceptional aesthetic value.

Table 8.3.

Pediculari comosae-Eritrichietum caucasici

Releve No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	8	11	16	17	18	19	39	34	51	36	77	34	54	12	68	75	18	16	59	45	70	70	87	8	51	47	86	03
Year	81	81	81	81	81	81	81	81	83	83	93	83	83	84	95	93	91	94	94	91	93	94	95	84	93	93	93	95
Altitude (* 10)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2
	75	70	65	65	65	65	75	80	80	65	80	85	90	70	65	90	00	80	86	80	60	75	75	45	35	50	55	55
Steepness	5	10	10	10	10	10	20	20	15	10	15	8	7	20	20	30	10	10	10	10	2	20	25	20	20	20	30	30
Exposition	sw	s	s	se	se	se	e	e	e	e	e	s	ne	ne	sw	sw	ne	se	w	s	nw	se	se	e	s	se	s	e
Vascular plant cover	40	40	60	60	40	50	30	40	30	40	45	30	25	30	50	40	30	50	40	30	60	50	70	80	70	60	70	60
Bryophyte cover	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	5	1	1	1	1	10	10	3	20	20	25	2	10
Lichen cover	50	40	15	30	40	35	55	45	40	40	35	50	35	50	30	40	25	5	30	40	20	20	5	1	3	0	0	5
Stone cover	1	0	1	1	10	1	10	15	0	1	1	5	1	1	10	10	30	5	5	5	+	+	2	0	+	5	5	1
Lichen species	9	8	8	7	7	6	7	9	6	9	5	8	7	6	7	11	5	1	6	5	4	4	3	1	3	3	1	7
Bryophytes species	1	1	1	1	1	1	0	1	1	1	8	1	2	2	6	4	2	5	2	1	5	4	4	2	1	2	6	8
Vascular plants	33	38	38	31	37	32	35	36	31	29	29	24	22	30	21	21	24	32	25	17	32	38	38	35	38	32	40	43
D.sp. *Pediculari comosae-Eritrichietum caucasici*																												
Gentiana pyrenaica	1	+	+	+	+	+	+	+	+	+	1	+	+	+	+	1		+	1		+	1	+					+
Carum caucasicum	1	1	+	1	1	1	1	1	1	1	1	+	+	1		1	+	+	1		1	+						
Vaccinium vitis-idaea	1	+	+	+	+	1	+	1	+	1	1			1	+	1	2		+	2	1	2	1	2				1
Rhytidium rugosum	+	+	1	+	1	+		1	+	+			+		+			+				1		2	2	2	+	2
D.sp. *P.c.-E.c. oxytropidetosum kubanensis*																												
Oxytropis kubanensis	1	1	2	1	1	1	1	1	+	1												1	2	1		2	2	+
Fritillaria lutea	+	+	+	+	+	+	+	+														+	+		+		+	
Plantago atrata			1	1	1	1	+	1	1	1												1		1	1	1	1	2
D.sp. *P.c.-E.c. typicum*																												
Pedicularis caucasica											+	+	+	+	+	+	+											
Polytrichum juniperinum											+	+		+	+	+	+	+		+				+		+		
D.sp. *P.c.-E.c. bromopsietosum varigatae*																												
Scabiosa caucasica	+	+	+	+			+	1													+	+	1	1	1	2	1	+
Bromopsis variegata (dom.)		+	1	1	1	1	+	1	+	1											3	2	2	2	2	2	2	3
Muscari racemosum																							+	+		+	+	+
Myosotis alpestris		+						+									+						+	+	+	+	+	+
Silene saxatilis			+																			+			+	+		+

Table 8.3. (continued)

Releve No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
	8	11	16	17	18	19	39	34	51	36	77	34	54	12	68	75	18	16	59	45	70	70	87	8	51	47	86	03
Year	81	81	81	81	81	81	81	81	83	83	93	83	83	84	95	93	91	94	94	91	93	94	95	84	93	93	93	95
Carex humilis																									2	1	2	2
Polygala alpicola																								+	+	+		+
Seseli alpinum																					+	1		1				+
D.sp. *Anemonion speciosae*																												
Arenaria lychnidea	+	1	+	+	+	+	1	1		1	+	1		1	+	1	+	+	+	1	+	+	+	+	+			+
Carex sempervirens	1	1	+	1	+	1	1		+		1	1	1	1	1	1	1	+	1				1					
Carex umbrosa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	+	2		2	+	r	1			1	+	1		
Eritrichium caucasicum	+		+	+	1	+	+	+	+	+	+	+	1	+	1	+	+	+	+				+			+		
Minuartia circassica	+	+	1	1	1	+	+	1	+	1	+	1	+	1	+		+	+	+	+	+	1	+	1	+	+	+	1
Anemone speciosa	2	2	2	2	2	1	1	1	1	1	1	1	1	1	2	1	+	+	+	+	1	1	+	1				+
Pedicularis comosa	+	+	+	1	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
Thamnolia vermicularis	1	2	1	1	1	2	1	1	1	1	1	1	2	2	1	1	1		1	1								+
Cetraria nivalis	1	1	1	+	1	+	+	1	3	1		1			+	2	2											+
Cetraria cucullata	+	+	+		+			+		1		1	+	2		1	+											
D.sp. *Caricetalia curvulae, Juncetea trifidi*																												
Trifolium polyphyllum	1	2	1		1	1	1	1	1	2	1		1	+					+			1				1	1	1
Euphrasia ossica	+		+	+	+	+	+	+	+	+	+		+	+	+	+	+	+		r	+		+		+			+
Luzula spicata	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+				+			
Helictotrichon versicolor	1	+	+	1	1	1	+	+	+	1	1	1	+	1	+	1	+	+	1	+	2	1	+	1	+	2	1	1
Minuartia recurva		+	+	+	+	+		+			+							+		r	+	+	+		+	+	+	+
Other species																												
Abietinella abietina																					1	1					+	
Aetheopappus caucasicus		+	+	+	+		+																1			+	1	+
Agrostis vinealis					+						+							+	+		1							
Alchemilla caucasica	1	1	+	+	+	+	1	1	2	1		+	+		+			+	+		1	+	+	+	1	+	1	2
Antennaria dioica	1	2	1	1	1	1	1	1	1	1	1			1	+			1	+	1		+	+					+
Anthemis cretica	+	+									+			+					+	r								
Anthemis marshalliana		1	1	+	+	+	+	+	+	+	+						+	+	+		+	1	+	1	+	+	+	+
Anthoxanthum odoratum		+																	+	1			+					
Anthyllis vulneraria												+							+						1	1	+	2

Table 8.3. (continued)

Releve No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	8	11	16	17	18	19	39	34	51	36	77	34	54	12	68	75	18	16	59	45	70	70	87	8	51	47	86	03
Year	81	81	81	81	81	81	81	81	83	83	93	83	83	84	95	93	91	94	94	91	93	94	95	84	93	93	93	95
Aster alpinus	+	+	+	+	+		+	+		1								+					+	1	1	1	1	+
Bryum caespiticium															+	+		+			1		+				+	
Campanula collina	1	1	1		+	+	+	+	+		+							+					1	+	+	1	+	1
Campanula tridentata	2	1	2	1	1	2	1	1	2	1	2	2	1	1	2	2	2	1	2	2	1	+	+	+		1		1
Centaurea cheiranthifolia																								1	+		+	
Ceratodon purpureus															+						+	+						
Cetraria islandica	3	3	1	3	3	3	4	3	2	2	2	2	2	2	2	2	2	+	2	3	2	2	1	1		+		1
Cetraria laevigata	1		1	+		+	1	1	1	1		1	+															
Chamaesciadium acaule							+					+			1			+					+		+	1	+	1
Cladonia furcata	+	+			+					+						+										+		
Cladonia gracilis	+	+	+	+	+	+	+	+	1	+		+	+	1	+	+			+									
Cladonia mitis	1	1	1	1	2	2	2	2	1	1	2	2	1	2	1	1			1	1								+
Cladonia pyxidata	1		+	+			1	+		+	1	+	+	1	1	+	+		+	+	1	+	+		+	+		+
Erigeron alpinus	+	+	+	+	+	+	+	+		+	+	+		+	+		+	+			+		+					+
Eurhynchium pulchellum											+							+					1					+
Festuca ovina	2	1	1	1	1	1	2	1	1	1	2	2	1	1	1	2	1	1	2	2	1	2	+	1	1		1	1
Gentiana aquatica																		+			r						r	
Gentiana biebersteinii	+							+	+	+		+		+				+			+		+	+	+	+	+	+
Gentiana septemfida	+	+	+		+			+				+		+		+			+	+							+	+
Gentiana verna					+				+	+		+		+		+		+			+	+			+	+		+
Gymnadenia conopsea		+																								+	+	
Hedysarum caucasicum																					+	+	+					
Hieracium umbellatum																						+	+	+				
Juniperus communis		+						+																				+
Luzula multiflora																		+					+					+
Peltigera rufescens		+						+			+				+	+							+					+
Poa badensis					+													+									r	
Polygonum bistorta	+	+	+	+	+	+	+	+		+		+				1						1	1		1		2	1
Polytrichum piliferum														+	+	1												
Potentilla crantzii			+	+	+	1																+		+	1		+	

Table 8.3. (continued)

Releve No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	8	11	16	17	18	19	39	34	51	36	77	34	54	12	68	75	18	16	59	45	70	70	87	8	51	47	86	03
Year	81	81	81	81	81	81	81	81	83	83	93	83	83	84	95	93	91	94	94	91	93	94	95	84	93	93	93	95
Potentilla gelida	1	+		+		+	+	+	+		+	+	+	+		+	+					+						
Primula algida									+		+			+	+			+				+		+	+		+	+
Primula ruprechtii		+				+		+	+		+																+	
Pulsatilla albana			+																				+		1	+	1	
Ranunculus oreophilus									1	+								+			+	1	+	+			+	+
Scorzonera cana	+						+			+				+							+	+		+				
Taraxacum confusum	+						+	+										+										
Taraxacum stevenii	+	+			+				1		+		1	+		+	+						+	1		+	+	
Tortella tortuosa											+																+	+
Veronica gentianoides	1	1	1	1	1	1	+	+	+	+	+	+		+	+	+	+	+	+		+	+	1		+	+	+	+
Viola altaica							+															+		+				

Sporadic species (number of releve in parenthesis, abundance are showen after ":", unless it is not "+", Braun-Blanquet scale)

Aconitum nasutum (51/93:r), Ajuga orientalis (12/84), Androsace albana 18/91), Barbilophozia lycopodioides (159/94), Botrychium lunaria (70/94), Brachythecium sp. (70/93), Brachythecium velutinum (77/93, 16/94), Bryum capillare (77/93), Bryum imbricatum (77/93, 18/91), Bupleurum falcatum (51/93:r, 86/93), Calamagrostis arundinacea (8/84:2, 47/93), Campanula ciliata (51/83, 54/83), Campylium radicale (68/95), Campylopus fragilis (75/93), Carex atrata (70/93), Carex caryophyllea (70/94:1, 103/95), Carum meifolium (16/81), Cerastium purpurascens (19/81, 70/94), Cladonia coniocraea (70/94), Cladonia crispata (70/93), Cladonia ecmocyna (103/95), Cladonia foliacea (51/93:1), Cornicularia muricata (75/93, 45/91), Cruciata laevipes (8/84), Dactylina madreporiformis (75/93), Daphne glomerata (8/84), Deschampsia flexuosa (11/81, 87/95), Desmatodon latifolius (77/93, 70/94:1), Dicranum congestum (54/83:1), Distichium capillaceum (103/95), Draba hispida (51/93, 86/93), Draba scabra (54/83), Encalypta ciliata (87/95, 103/95), Galium verum (103/95), Gnaphalium supinum (159/94, 45/91:r), Heterocladium dimorphum (86/93), Hieracium macrolepis (70/93, 70/94), Hieracium prenanthoides (103/95), Hypnum cupressiforme (103/95), Isopterygiopsis pulchella (77/93), Jurinella moschus (47/93, 86/93:r), Kobresia schoenoides (54/83:1), Leskeella nervosa (159/94), Lloydia serotina (54/83, 18/91:r), Minuartia imbricata (18/91), Parmelia vagans (51/93), Pedicularis nordmanniana (16/94), Peltigera canina (70/93, 70/94), Physconia muscigena (86/93), Plagiochila porelloides (103/95), Polygonum alpinum (51/93), Polygonum viviparum (12/84), Potentilla nivea (16/81, 18/81), Pterigynandrum filiforme (103/95), Ranunculus caucasicus (51/93), Rhinanthus minor (70/93, 86/93), Saxifraga flagellaris (18/91), Sedum tenellum (18/91, 8/84), Sempervivum caucasicum (51/93), Senecio aurantiacus (70/94), Senecio karjaginii (16/81), Stereocaulon alpinum (159/94), Tortula ruralis (70/93, 86/93), Trifolium ambiguum (70/93:1, 51/93:2), Vicia cracca (8/84, 86/93), Weissia wimmeriana (87/95).

Date (day.month), size (sq.m) and location of the releves.

8/81 - 23.07, 100, M.Khatipara; 11/81 - 30.07, 25, M.Khatipara; 16/81 - 01.08, 16, M.Khatipara; 17/81 - 12.08, 16, M.Khatipara; 18/81 12.08, 25, M.Khatipara; 19/81 -12.08, 25, M.Khatipara; 39/81 -08.09, 100, M.Khatipara; 34/81 - 06.08, 25, M.Khatipara; 51/83 - 10.09, 25, Mukhu; 36/83 - 31.08, 16, M.Khatipara; 77/93 - 22.08, 9, M.Khatipara; 34/83 - 31.08, 25, M.Khatipara; 54/83 - 10.09, 25, Mukhu; 12/84 - 01.09, 16, M.Khatipara; 68/95 - 13.07, 16, Baduk; 75/93 - 22.08, 9, M.Khatipara; 18/91 - 04.08, 6, M.Khatipara; 16/94 - 08.07, 16, Azgek; 159/94 - 05.09, 16, Oriuchat; 45/91 - 19.08, 16, Ullu-Murudzhu; 70/93 - 17.08, 8, Baduk; 70/94 - 16.07, 15, Bol.Khatipara; 87/95 - 24.07, 16, Bol.Khatipara; 8/84 - 26.08, 25, M.Khatipara; 51/93 - 14.08, 16, M.Khatipara; 47/93 - 10.08, 16, M.Khatipara; 86/93 - 26.08, 25, M.Khatipara; 103/95 - 05.08, 25, M.Khatipara.