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**Alpine Vegetation of the Teberda Reserve,  
the Northwestern Caucasus**

*Die Alpine Vegetation des Teberda Reservates,  
Nordwest-Kaukasus*

V.G. ONIPCHENKO

English edition by K. Thompson



## CONTENTS

1. Introduction	4
2. Site description and methods	6
2.1. Geography	6
2.2. Climate	8
2.3. Geology and soils (Makarov M.I., Volkov A.V., Onipchenko V.G.)	10
2.4. Flora and vegetation zones	14
2.5. Animals	15
2.6. History of human influence	16
2.7. Methods	17
3. Screes and pebbles - <i>Thlaspietea rotundifolii</i>	18
4. Rocks - <i>Asplenieta trichomanis</i> (Onipchenko V.G., Gorbachevskaya O.A.)	36
5. Fens - <i>Scheuchzerio-Caricetea fuscae</i>	49
6. Cold water springs - <i>Montio-Cardaminetea</i>	59
7. Kobresia grasslands - <i>Carici rupestris-Kobresietea bellardii</i>	62
8. Alpine heaths – <i>Juncetea trifidi</i>	67
9. Alpine grasslands - <i>Calluno-Ulicetea</i>	79
10. Snowbeds - <i>Salicetea herbaceae</i>	95
11. Subalpine meadows - <i>Mulgedio-Aconitetea</i>	108
12. Elfin - <i>Loiseleurio-Vaccinietea</i>	121
13. Elfin birch woodland - <i>Vaccinio-Piceetea</i>	136
14. Anthropogenic changes of the vegetation (Egorov A.V., Onipchenko V.G.)	142
15. Multivariate analysis of the syntaxa	145
Acknowledgements	150
References	151
Vascular plant species index	162

## 1. Introduction

High elevations are home to unique assemblages of plants and animals. Although the overall economic importance of alpine and subalpine ecosystems has probably never been particularly great, high mountains remain an integral and important part of the biosphere. Admittedly, this is one of the most fragile and poorly studied ecosystems in the world (BLISS 1985, WALTER & BRECKLE 1986, ARCHIBOLD 1995). Alpine tundras and subalpine meadows, grasslands and scrub communities are used as important grazing areas worldwide. The great aesthetic quality and solitude of alpine ridges attracts multitudes of tourists to the high-mountain wilderness areas (LUKSCHANDERL 1983).

The Teberda State Biosphere Nature Reserve (Teberdinskii Zapovednik) is one of the largest in the Caucasus, covering 85'000 ha. It has played an extremely important role in keeping biological diversity of thousands of species. The flora of the reserve is well-studied (VOROB'EVA & KONONOV 1991). The vegetation, on the other hand, has not yet been well documented (KOROTKOV 1994). This hampers conservation work in the region, since the preserve remains essentially the only "baseline" pristine area undamaged by grazing and other human activities in Karachaevo-Cherkessian Republic.

The main aim of our study was to describe the vegetation of the reserve in terms of its syntaxonomy. Our interests were focused mainly on the alpine (non-forest) vegetation, but some transitional to forest communities have also been included.

The present volume describes, for the first time in English, all principal types of alpine and subalpine plant communities of the Teberda Reserve. The monograph is intended as a handy reference for plant ecologists, park rangers, and amateur naturalists interested in studying plant ecology in the Northern Caucasus – a land of unsurpassed beauty and remarkable biological diversity.

Among different approaches to studying terrestrial ecosystem diversity, floristic classification (syntaxonomy) is the most widespread in Europe. We used this method of community classification to characterize communities since it has long ago become a common language for plant ecologists in many countries of the world. Position of a community within the syntaxonomic system may serve as its "address" when more detailed investigations take place. Syntaxonomic "reviews" are very important in national parks and nature

reserves, and in poorly studied vegetation areas as a first step in detailed vegetation surveys.

The syntaxonomic (floristic) classification was at first developed by Braun-Blanquet and colleagues early in this century (BRAUN-BLANQUET 1921). It very much resembles the conventional biological classification of living organisms. The highest level of classification is represented by classes, subdivided into orders. The latter are further subdivided into alliances (unions) and then into particular associations. Once classifications are published, scientists and land use managers can both use them as a common reference point.

The plant releves for this volume were collected over 16 years (1980-1995). Due to similar ecological conditions and vegetation structure of the Alps and the Caucasus, we chose to adjust the well-developed European system of higher syntaxa to our conditions. Regional specificity was reflected mostly at the level of alliance or association. Such an approach seems to allow comparison of vegetation structure between large regions.

## 2. Site description and methods

### 2.1. Geography

Teberda State Reserve is located on the northern macroslope of the western Caucasus in the Karachaevo-Cherkessian Republic of Russia. The total Reserve area is about 850 square km. The main section of the Reserve occupies the upper reaches of the Teberda river valley between 41° 35' and 41° 55' E, 43° 13' and 43° 28' N (Fig. 1).

There is a considerable elevation range within the Reserve between the lowest (bottom of the valley, 1259 m a.s.l.) and the highest (Mt. Dombai-Ulgen, 4046 m a.s.l.) points. About 83% of the Reserve territory lies above 2000 m a.s.l.

The hydrological network is well developed. Overall, there are 130 glacial lakes and 30 rivers. All rivers belong to the Teberda river watershed. Lakes and rivers cover about 0.3% of the reserve area (POLIVANOVA 1990).

Three main geological factors have shaped the relief, namely glacial processes (ancient and modern), water erosion, slope processes, including avalanches, rock falls and creep processes. There are 85 existing glaciers, occupying about 10% of the reserve area.

The late Pleistocene glaciers covered most of the mountains from their summits to about 2400 m. The valley glacier extended down to 1300 m (elevation of the town of Teberda) and even lower (SHCHERBAKOVA 1973). The U-shaped ("trog") form of many valleys indicates their former glaciation. TUSHINSKIY (1957) described four phases of the local glaciation during the Holocene. Since 1850 the glaciers have been steadily retreating. Outcrops (rocks and screes) are well represented in all vertical zones, but their role is most important in the alpine and subnival zones. They cover about 26% of the area of the Reserve.

Permafrost relief forms are restricted to several high stone ridges above 3400 m. The distribution of permafrost is, therefore, very limited and permafrost has negligible influence on the vegetation.

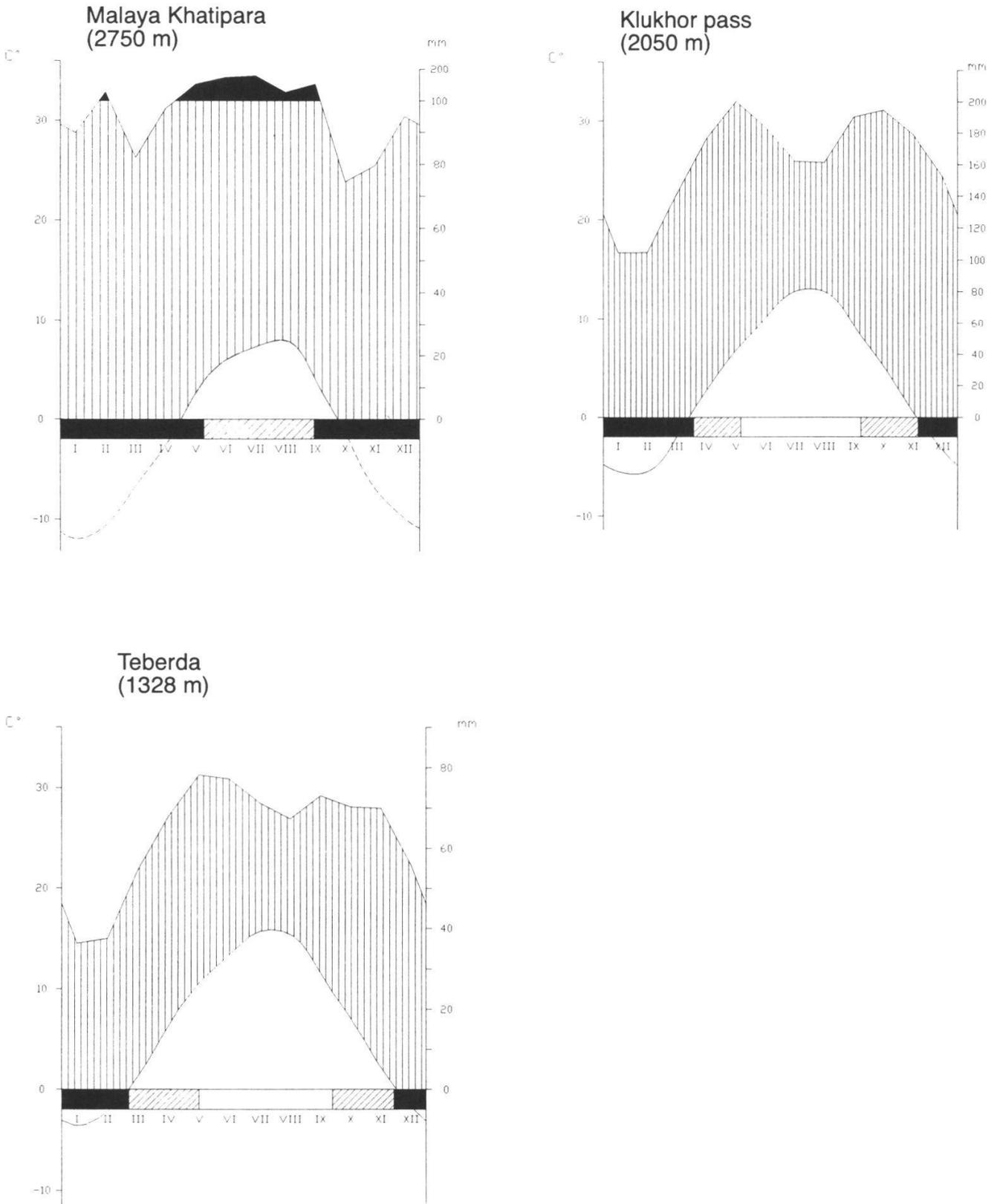


## 2.2. Climate

There are two permanent state meteorological stations in the Reserve, Teberda and Klukhor Pass (Fig. 1). Climatic diagrams of the stations are presented in Fig. 2.2-2.3. The climate of different parts of the Reserve varies considerably due to two main factors: elevation and distance from the Main Caucasian Range (south boundary of the Reserve). Overall, mean temperature decreases by 0.5-0.6 °C with 100 m increase in altitude. Precipitation increases with altitude up to about 2200-2500 m. Moist air masses are brought mainly by south winds from the Black Sea. Thus, precipitation sharply decreases from the Main Caucasian Range northward. South winds are predominant in the area, with the south slopes being windward and north slopes leeward with heavy snow accumulation (snow beds) determining the pattern of vegetation cover.

A typical climatic diagram for alpine zone in the northern part of the Reserve (Malaya Khatipara, temporary meteorological station) is represented in Fig. 2.1. The climate of the alpine zone can be considered as the mountain climate of the temporal zone (type X (VI), according WALTER *et al.* 1975). Mean annual temperature is about -1,2 °C and mean annual precipitation - 1400 mm. These features resemble those of some areas in the Swiss Alps, for example Weissfluhjoch (2667 m a.s.l.) near Davos (ZINGG 1961). Air humidity averages about 79% during the summer months. Average duration of time with 100% air humidity is about 4 hours per day. Insolation at the soil level is about one half of the potential because of the clouds (see GRISHINA *et al.* 1986). The warmest month is August with mean temperature + 8.3 °C, but frost can occur throughout the summer.

**Fig. 2.** Climatic diagrams of three meteorological stations in Teberda Reserve



### 2.3. Geology and soils

Siliceous rocks are prominent in the Teberda reserve. Local outcrops of limestone are known from two km outside the northern reserve boundary. The main bedrock type is grey granite. Different kinds of schists (biotit, chlorite, etc.), as well as gneisses, are well represented on several mountain ranges.

Alpine soils of the reserve were studied by several authors (ANTIPOV-KARATAEV *et al.* 1936, SEREBRYAKOV 1957, SHAL'NEV *et al.* 1977, VLADYCHENSKIY & GRISHINA 1987, GRISHINA *et al.* 1993, MAKAROV *et al.* 1997, ONIPCHENKO *et al.* 1998). The authors followed the Soviet system of soil taxonomy. Since this system is not now commonly used in the West, below we describe the soil categories according to the International FAO system. As a whole, a shallow profile and great stone content characterize mountain soils. For example, in the lower horizons at a depth of 40-50 cm the percentage of stones may reach 80%.

The main type of forest soil of the Reserve is Cambisol, in particular Humic Cambisol. This soil profile has O, A, B, and C, horizons. The organic horizon (O) is 5-10 cm thick and is divided into OL, OF and OH sublayers. Such differentiation is clearly defined in dark coniferous forests on northern slopes, but it does not occur in pine forests on southern slopes. The texture of the mineral horizons is coarse sandy loam. The B horizon is only slightly enriched by clay. The upper border of the C horizon lies at a depth of 50-70 cm. Soils on northern slopes are usually darker due to a high humus content (up to 11% C). Soils on southern slopes contain less humus and are also characterized by a thinner profile.

Humic Cambisols of the Teberda Reserve are acidic to slightly acidic (pH 5.5-6.5). An A-horizon with pH about 5.5 is considered as umbric, otherwise (pH > 6.0) it is mollic. The sum of exchangeable base cations is about 300-400 mmol/kg. Ca is the main exchangeable base cation.

The main subalpine and alpine grassland soils are Leptosols, most frequently Umbric Leptosols. Their soil profile consists of A, B, and C horizons. The A-horizon can be divided into two sublayers. The upper 10-cm sublayer is strongly penetrated by the roots of grasses, which constitute 4-11% of horizon volume. The lower sublayer above 20 cm does not form the firm turf. The texture of Leptosols is coarse sandy loam, clay is not differentiated throughout the profile. The upper border of the C horizon lies at a depth of about 50 cm. Morphological features of Umbric Leptosols in the alpine zone are similar to those of the subalpine zone. The only difference is that the alpine soils are shallower.

Properties of A horizons (0-10 cm) of subalpine and alpine Umbric Leptosols which are formed under different plant communities are shown in Table 2.1. The humus content of an acidic unsaturated Umbric Leptosol might be up to 20%. Soils also accumulate high amounts of total N and P. The humus contains a large proportion of slightly humified plant debris. This is primarily due to low microbial activity within the accumulated raw humus. The subalpine and alpine soils are poor in available nitrogen and phosphorus, but they are enriched by potassium due to potassium-rich parent rock material.

Umbric Leptosols of subalpine grasslands have pH 4.7-5.6 and total exchangeable base cations are about 150-170 mmol/kg. Soils of subalpine tall herbaceous communities, which are formed at the gently sloping positions disturbed by landslips and temporary streams, differ from soils of subalpine meadows. They accumulate less organic C and N and are characterized by relatively low concentrations of available  $N(NH_4)$ , while accumulation of total and available P is more expressed.

Alpine Leptosols are more acidic (pH 4.3-5.2), have lower base saturation (14-52%) and lower sum of exchangeable base cations (30-150 mmol/kg). We studied the change in the alpine soil properties along a catena at Mt. Malaya Khatipara (GRISHINA *et al.* 1993). It has been shown that the stone content decreases, while percentage of fine grained soil fraction, actual and hydrolytic soil acidity, content of exchangeable ammonium and storage of organic matter increases from the upper parts of slopes down to the snow bed depressions.

The study of alpine Leptosols under various plant communities, which occupy different positions along alpine toposequences throughout the Teberda reserve, confirmed some of our earlier findings. Alpine heath soils of ridges and prominent top part of slopes have the highest value of exchangeable base cations and relatively low concentrations of available N and P (Table 2.1.). The C:P ratio in these soils is large that testifies about impoverishment of organic matter by P.

The Leptosols of alpine meadows in typical slope positions are characterized by some decreasing of exchangeable base cations and increasing of available N and P relative to other alpine communities. Low concentrations of organic C may be caused by more active organic matter mineralization in the most favourable conditions of the alpine zone. Soils of slope depressions (ass. *Hedysaro caucasicae* - *Geranietum gymnocauli*) are more acidic and unsaturated with base cations.

**Table 2.1.**

Some properties of A horizons of investigated soils.

First column for all properties – mean value, second column – standard deviation, BS – rate of base saturation

Community	n	Depth, cm		N	P	N(NH <sub>4</sub> ) <sub>av</sub>		P <sub>avall.</sub>	pH (H <sub>2</sub> O)	Hydrolytic acidity	K		Ca	Mg	BS						
						mg/kg	mmol/kg				mmol/kg	%									
<i>Hyalopoo ponticae-Pedicularietum nordmannianae</i>	15	10	3	0,75	0,15	0,03	43	13	13	4,3	0,2	233	68	8	4	25	17	6	2	14	7
<i>Caro caucasici-Caricetum nigrae</i>	13	16	9	0,99	0,12	0,04	34	25	40	5,4	0,4	96	65	7	6	92	89	17	17	52	21
<i>Ranunculetum brachylobi</i>	13	8	3	0,43	0,16	0,02	32	19	38	4,6	0,2	131	58	4	1	20	3	5	1	21	8
<i>Hedysaro caucasicae-Geranium gymnocauli</i>	15	10	4	0,70	0,11	0,02	46	10	8	5,0	0,3	181	39	7	2	46	20	9	5	26	10
<i>Pediculari comosae-Eritrichietum caucasici</i>	15	12	5	0,85	0,13	0,04	28	14	6	4,8	0,3	128	36	7	3	85	57	16	11	43	18
<i>Polygono viviparum-Salicetum kazbekensis</i>	14	11	4	0,95	0,19	0,03	31	16	10	4,9	0,2	178	40	5	1	87	62	17	8	38	7
<i>Violo altaicae-Festucetum variae</i>	13	18	8	0,84	0,19	0,04	35	11	28	4,7	0,3	119	51	7	3	70	35	14	8	44	16
<i>Rhytidio rugosi-Kobresietum capilliformis</i>	13	11	1	0,88	0,27	0,07	25	10	13	5,2	0,2	138	25	7	2	118	35	23	7	52	7
<i>Cephalario giganteae-Ligusticetum alani</i>	13	23	13	0,70	0,25	0,03	34	16	56	5,6	0,3	99	39	1	6	134	52	27	13	63	10
<i>Anthriscu sylvestris-Rumicetum alpini</i>	11	14	6	0,70	0,31	0,05	31	15	69	4,7	0,4	109	28	8	4	112	65	29	21	54	13
<i>Lerchenfeldio-Rhododendretum caucasici</i>	11	19	7	1,12	0,32	0,10	24	19	35	3,8	0,5	161	111	1	4	157	69	38	18	58	23
<i>Aconito nasuti-Juniperetum</i>	14	16	6	1,14	0,27	0,13	33	18	14	5	4,5	130	92	7	2	144	39	24	6	62	20
<i>Betonici macranthae-Calamagrostietum arundinaceae</i>	17	15	4	0,98	0,14	0,02	45	13	16	5,1	0,3	133	30	9	3	121	36	27	9	54	9
<i>Swertio Ibericae-Caricetum nigrae</i>	12	28	12	1,76	0,55	0,04	45	22	48	5,7	0,3	43	10	2	13	287	102	53	21	89	5

The most acidic and unsaturated soils are formed at the low end of the alpine hydrologic gradients (soils of alpine snowbeds). However soils of these two communities are differed from one to another. Development of *Ranunculetum brachylobi* in accumulative positions near the upper boundary of the alpine zone causes relatively low concentrations of soil C, N and P, while in soils of *Hyalopoo ponticae-Pedicularietum nordmannianae* accumulation of organic matter and associated elements is more expressed.

Among alpine soils the Leptosols of *Kobresia*-grasslands are characterized by the highest value of pH, exchangeable cations and base saturation, as these soils are formed in areas of distribution of easily-weathered porphyritic granite. It seems to us that the comparatively high ammonium content in the soils of alpine grassland is caused by disturbance regime (TILMAN 1988), while the same in the soils of snow bed communities is connected with the short vegetative season that prevents full uptake of ammonium by plants.

Histosols are another type of subalpine and alpine soil. Terric and Fibric Histosols are formed in swamp communities and Folic Histosols are the soil of *Rhododendron caucasicum* elfins. All Histosols are characterized by the high level of C and N accumulation and have high C:N and C:P ratios. Nevertheless the Histosols of dry and moist positions differ strongly in acidity and available nutrients concentrations. Histosols of subalpine and alpine swamps contrary to Leptosols have high value of pH, total exchangeable base cations and base saturation, while their hydrolytic acidity is the lowest. Moist Histosols contain also high concentrations of available N and P. Folic Histosols contrary to swamp soils have low pH and available N and P concentrations. Hydrolytic acidity of these soils is very high, which determines the low base saturation in spite of high amount of base cations.

There are no signs of podzolization in the alpine soils. Only a low rate of gleization can be observed in the soils of snow beds with water saturation during the rather short snow-melting period. Thus, alpine soils of the area differ considerably from podzolic and pseudoglei soils of the Alps (BOUMA *et al.* 1969; BOUMA & VAN DER PLAS 1971; GRACANIN 1972; POSCH 1977; NESTROY 1984; MULLER 1987), but they are similar to the Alpine Turf soils of the Rocky mountains (Colorado) (RETZER 1956, 1974; JOHNSON & CLINE 1965) and to the Alpine Humus Soils in Australia (COSTIN *et al.* 1952; COSTIN 1955).

## 2.4. Flora and vegetation zones

As in any mountain flora, the flora of Teberda reserve is rather rich. VOROB'EVA & KONONOV (1991) list 1280 vascular plant species for the reserve. The flora of bryophytes contains 73 liverworts and 227 leafy mosses (IGNATOVA *et al.*, 1990). Recently we added to the lists 30 vascular plants species and 67 mosses (ONIPCHENKO & IGNATOVA 1996). Similar floristic richness is known for other mountain regions in Europe, for example, Davos (SCHIBLER 1937).

The main life form groups of vascular plants are herbaceous polycarpic perennials (75%), annuals (11%), trees and shrubs (8%) and monocarpic perennials (4%) (VOROB'EVA & KONONOV 1991). There are 23 threatened species listed in the "Red Data Book of Russia" in the reserve.

Four main vegetation zones are well represented in the reserve, namely forest, subalpine, alpine and subnival zones. The total number of plant species decreases from the forest through subalpine and alpine to the subnival zone: 900, 373, 206, and 122 species respectively (VOROB'EVA & KONONOV 1991).

Forests cover about 34% of reserve area. Five species of trees are the most common (occupied part of the total forest area is represented in parenthesis, %): Scots Pine (*Pinus sylvestris*) (34.7), Litwinov's birch (*Betula litwinowii*) (27.1), Caucasian Fir (*Abies nordmanniana* (12.6)), Caucasian spruce (*Picea orientalis* (8.4)), and Caucasian beech (*Fagus orientalis* (3.3)) (VOROB'EVA *et al.* 1986).

Pine forests are more typical of the northern part of the reserve. They occupy mainly southern and eastern dry slopes from the valley bottom up to the timberline. Climatic upper timberline of the area lies at 2500-2600 m, but the actual timberline lies at lower altitude (2200-2350 m). Dark coniferous forests are well developed in the moist southern part of the reserve near the Main Caucasian Range. They prefer valley bottoms on northern and western slopes. Birch forests replace conifers near the timberline (2000-2200 m) and across avalanche paths. Short birch forests (5-12 m) and *Rhododendron caucasicum*-elfin woods (subalpine shrub community) are typical of northern slopes near the timberline. Dwarf pine and alder elfin woods, common in the Alps, are notably absent in the vegetation of the Caucasus.

Traditionally the area above the timberline is considered as the alpine zone (*sensu lato*) in temperate mountains (ELLENBERG 1988, WALTER & BRECKLE 1986). Most Caucasian botanists, however, (GROSSGEIM 1948, SHIFFERS 1953,

KONONOV 1957, VOSKANYAN 1977 et al.) do not hold this point of view. Traditionally, they divided the area into three zones: subalpine, alpine (*sensu stricta*) and subnival. The subalpine zone lies near and above the actual timberline up to the climatic timberline. We can easily distinguish this zone from the alpine zone by the type of plant communities developing in snowed depressions. Communities of *Mulgedio-Aconitetea* are typical for such places in the subalpine zone. In the alpine zone (*sensu stricta*) communities belonging to another class - *Salicetea herbaceae* - occupy snowbed depressions. The more favourable temperature regime in the subalpine zone leads to intensive spring snowmelt, which prolongs the vegetative season in snowbeds as compared with the alpine zone.

The snow line in the region is located at about 3000 m. This elevation can be considered as a border dividing the alpine and subnival zones. Sparse plant communities on rocks and screes alternating with glaciers and snowfields are commonly found in the subnival zone. According to our observations, the upper limit of vascular plant distribution here is approximately 3750 m. Several species (*Saxifraga moschata*, *S. sibirica*, *Draba rigida*, *D. siliquosa*, *Minuartia imbricata*, *Primula meyeri*, *Senecio karjaginii*, *Potentilla gelida*, *Carum caucasicum*, *Hyalopoa pontica*) reach this elevation on the southern slope of Mt. Kyshkadzhar.

## 2.5. Animals

The fauna of the reserve is also rich, but only a few systematic groups have been investigated in detail. Birds and mammals play an important role in alpine ecosystems. There are 22 nesting bird species in the alpine zone (POLIVANOVA 1990). The grouse family [*Tetraogallus caucasicus* (Pallas), *Alectoris kakelik* (Falk), *Lyrurus mlokosiewiczii* Taczanowski] are prominent plant consumers and seed dispersers, especially of berry-producing plants (*Juniperus communis*, *Empetrum nigrum*, *Vaccinium spp.*, etc.).

Wild ungulates are represented in the alpine zone by three species: Caucasian ibex (*Capra caucasica* Guldenstaedt et Pallas), chamois (*Rupicapra rupicapra* L.) and wild boar (*Sus scrofa* L.) (SOKOLOV & TEMBOTOV 1993). Population density of these species is mainly restricted by the availability of winter food and illegal hunting. The intensive grazing of ibexes takes place on protected areas free from snow (rock outcrops, *Anemonion speciosae* - alpine heaths).

A vole *Pitymys majori* Thos. is the most abundant rodent in the alpine zone. This polyphagous vole includes the a large number of alpine plant species in its diet. Population density of this animal varies considerably among different plant communities (FOMIN *et al.* 1989). Moreover, the intensive burrowing activity of *Pitymys majori* as well as large mammals like wild boars and bears (*Ursus arctos* L.) plays an important role in disturbing the alpine grasslands (ONIPCHENKO & RABOTNOVA 1994).

## 2.6. History of human influence

The first evidence of human activity in the Teberda valley dates from the Bronze Age (Koban culture, XII-X century B.C., ALEKSEEVA 1992). There are numerous archaeological sites of early Middle Age settlements in the reserve area. It is safe to assume that the human influence on the vegetation in the area has lasted for at least two millennia. Alpine areas have been greatly transformed by cattle and sheep grazing. Cattle number was never too high due to the restricted area of winter pastures until XX century. Moreover, the rate of grazing has fluctuated considerably. Periods of brutal wars and devastating plague epidemics with consequently negligible grazing alternated with periods of peace, when number of cattle increased (TSEPKOVA 1986, DINESMAN 1992). The last plague epidemic in the Teberda region took place at the beginning of the XIX century.

Intense use of the area resumed at the end of the last century due to building of the War-Sukhumian Highway across the Klukhor pass. The town of Teberda was founded at this time as a summer cottage village.

Teberda Reserve was founded in 1936. Cattle grazing in the alpine area of the reserve continued, however, until 1943. Many of the alpine communities show signs of former grazing in their structure and composition.

Recent economic difficulties exert an adverse effect on nature protection in the region. The administration of the reserve has had to permit grazing in several areas within its boundaries (Kyshkadzhar, Goralykol, and bottom of Teberda valley), leading to further transformation of the vegetation in such areas.

## 2.7. Methods

We collected releves of different vegetation types during 1980-95. The total number of releves is about 700. The studied area covers the Teberda reserve and adjacent neighbouring valleys and crests (Mukhu, Gidam, Epchik, Kyr-kol, etc.). The size of releve area ranged between 9 and 100 square m depending on the type of community. For herbaceous vegetation MIRKIN & ROZENBERG (1978) recommended using plots which contain about 80% of species from 100 sq.m- plots. We tried to follow this rule. Our study of floristic richness of the alpine communities (ONIPCHENKO & SEMENOVA 1988, 1995) showed that such plot size lies mainly within 10-25 sq.m. As a rule, larger plots were used for sparse vegetation (rocks, pebbles, screes etc). The Braun-Blanquet scale was used as a value of species abundance.

Samples of bryophytes and epigeal lichens were collected from releve plot. All bryophytes were determined by E.A. Ignatova.

The Nomenclature of the Caucasian plants is not well developed. Most regional floras (GROSSGEIM 1949; KOSENKO 1970; GALUSHKO 1978-80; VOROB'EVA & KONONOV 1991), as well as the general vascular plant checklist for Russia (CZEREPA NOV 1995), use the "micro-species" (splitting) approach. We had to study nomenclature of each species separately in different publications, including a current review of some groups and floras of neighbouring countries (DAVIS 1965-1980). Full names and main synonyms of vascular plants are represented in the species index.

We use WIRTH (1980) as a main source of lichen names. Bryophyte nomenclature is based on checklists for the former Soviet Union (IGNATOV & AFONINA 1992, KONSTANTINOVA *et al.* 1992).

Special IBM-program "Syntaxon" (OVCHINNIKOV & ONIPCHENKO 1992) was created for data processing according to the classical table method of Braun-Blanquet. The program allows a numerical approach to be combined with hand procedures in a colour visual regime. MVSP software was used for Cluster and Detrended Correspondence Analysis (KOVACH 1995).

The general category of diagnostic species (characteristic and differential species together) was used in our work. Several monographs and syntaxonomic reviews (OBERDORFER 1977, 1978, 1983, 1992, MATUSZKIEWICZ 1981, MORAVEC *et al.* 1983, MIRKIN *et al.* 1989, JULVE 1993, MUCINA *et al.*, 1993) served as a source of information on the diagnostic species combinations for the European syntaxa.

### 3. Scree and pebbles - *Thlaspietea rotundifolii*

#### Prodromus

*Thlaspietea rotundifolii* BRAUN-BLANQUET 1948

*Chaerophylletalia humilis* ord.nov.

*Chaerophyllion humilis* all.nov.

*Veronico minutae-Chaerophylletum humilis* ass.nov.

*V.t.-C.h. typicum* subass.nov.

*V.t.-Ch.h. lamietosum tomentosum* subass.nov.

*V.t.-Ch.h. saxifragetosum flagellaris* subass.nov.

*Androsacetalia alpinae* BRAUN-BLANQUET in BRAUN-BLANQUET & JENNY 1926

*Murbeckiellion huetii* all.nov.

*Hyalopoo ponticae-Oxyrietum digynae* ass.nov.

*H.p.-O.d. typicum* subass.nov.

*H.p.-O.d. ranunculetosum oreophili* subass.nov.

*Scrophulario variegatae-Epilobietum dodonaei* ass.nov.

*Allosuro-Athyrium alpestris* NORDHAGEN 1936

*Dicranoweisio crispulae-Rubetum idaei* ass.nov.

*Epilobietalia fleischeri* MOOR 1958

*Salicion incanae* AICHINGER 1933

*Silene compactae-Salicetum purpureae* ass.nov.

*Thlaspietea rotundifolii* BRAUN-BLANQUET 1948

This class comprises open plant communities on unstable stony substrates (scree, rock streams, pebbles along rivers etc.). They can be relatively stable, but their stability depends upon permanent disturbance regime and/or extremely hard climatic conditions (in the subnival zone).

There exists a problem with diagnostic species combination for this class: practically all diagnostic species of the class are absent from the Caucasus. Therefore, we had to suggest an alternative regional species combination for the class (Table 3.1). Some diagnostic species from the European orders and alliances are well represented, so we were able to use one of the recent systems proposed for the class (ENGLISCH *et al.* 1993, VALACHOVIC *et al.* 1997).

**Table 3.1.**  
Diagnostic table of *Thlaspietea rotundifolii*

	1	2	3	4	5	6	7	8
D.sp. <i>Veronico minutae</i> - <i>Chaerophylletum humilis</i> , <i>Chaerophyllion humilis</i> , <i>Chaerophylletalia humilis</i>								
<i>Chaerophyllum humile</i>	V	II	IV	II	-	-	-	-
<i>Delphinium caucasicum</i>	III	III	I	-	-	-	-	-
<i>Corydalis alpestris</i>	IV	III	I	-	-	-	-	-
<i>Dentaria bipinnata</i>	II	III	III	-	-	-	-	-
<i>Eunomia rotundifolia</i>	II	I	II	-	-	-	-	-
<i>Noccaea pumila</i>	II	II	-	-	-	-	-	-
<i>Draba scabra</i>	II	I	III	-	-	-	-	-
<i>Draba siliquosa</i>	I	I	III	-	-	-	-	-
<i>Alopecurus dasyanthus</i>	II	I	V	-	-	-	-	-
<i>Potentilla gelida</i>	II	I	V	-	-	-	-	-
<i>Cruciata valentinae</i>	II	-	II	-	-	-	-	-
D.sp. V.t.-Ch.h. <i>lamietosum tomentosum</i>								
<i>Lamium tomentosum</i>	-	V	-	-	-	I	-	I
<i>Alopecurus glacialis</i>	I	II	I	I	-	-	-	-
D.sp. V.t.-Ch.h. <i>saxifragetosum flagellaris</i>								
<i>Saxifraga flagellaris</i>	-	-	V	-	-	-	-	-
<i>Minuartia circassica</i>	-	-	III	-	-	-	I	-
<i>Primula algida</i>	-	-	III	-	-	-	-	-
<i>Dactylina madreporiformis</i>	-	-	III	-	-	-	-	-
<i>Campanula ciliata</i>	-	-	III	-	-	-	-	-
<i>Campanula saxifraga</i>	-	-	III	-	-	-	-	-
<i>Minuartia recurva</i>	-	-	III	-	I	I	I	-
D.sp. <i>Hyalopoo ponticae</i> - <i>Oxyrietum digynae</i>								
<i>Carex atrata</i>	-	-	-	III	III	I	I	-
<i>Gnaphalium supinum</i>	-	-	-	I	IV	-	I	-
<i>Hyalopoa pontica</i>	III	I	-	V	III	I	I	-
<i>Primula meyeri</i>	I	I	-	III	II	-	-	-
<i>Cladonia pyxidata</i>	I	-	-	III	IV	-	V	-
<i>Senecio taraxacifolius</i>	-	-	-	III	II	-	-	-
<i>Carex pyrenaica</i>	-	-	-	I	III	-	-	-
D.sp. H.p.-O.d. <i>ranunculetosum oreophili</i>								
<i>Ranunculus oreophilus</i>	-	I	I	V	-	I	I	-
<i>Sanionia uncinata</i>	-	-	-	V	-	-	II	-
<i>Valeriana alpestris</i>	-	I	-	V	I	-	-	-
<i>Carum caucasicum</i>	II	II	IV	V	I	I	-	-
<i>Ranunculus caucasicus</i>	-	-	-	IV	-	-	-	-
D.sp. <i>Scrophulario variegatae</i> - <i>Epilobietum dodonaei</i>								
<i>Scrophularia variegata</i>	I	I	I	-	I	IV	-	II
<i>Trifolium spadiceum</i>	-	-	-	-	I	III	-	I
<i>Pohlia filum</i>	-	-	-	-	-	III	-	-
<i>Betula litwinowii</i>	-	-	-	-	-	III	I	III
<i>Poa nemoralis</i>	-	I	-	-	-	IV	V	III
D.sp. <i>Dicranoweisio crispulae</i> - <i>Rubetum idaei</i> , <i>Allosuro</i> - <i>Athyrium alpestris</i>								
<i>Dryopteris filix-mas</i>	-	-	-	I	I	I	V	-
<i>Rubus idaeus</i>	-	-	-	-	-	I	V	II
<i>Calamagrostis arundinacea</i>	-	-	-	-	-	I	V	-
<i>Dicranoweisia crispula</i>	-	-	-	I	II	I	IV	-

Table 3.1. (continued)

	1	2	3	4	5	6	7	8
<i>Dicranum scoparium</i>	-	-	-	-	-	-	III	-
<i>Lescurea saxicola</i>	I	-	-	I	-	I	III	-
<i>Juniperus communis</i>	-	-	-	-	-	-	III	-
<i>Hypnum cupressiforme</i>	-	-	I	-	-	-	II	-
<i>Sempervivum caucasicum</i>	-	-	-	-	-	-	II	-
<i>Polygonum alpinum</i>	I	-	-	-	-	-	II	-
<i>Cladonia mitis</i>	-	-	-	-	-	-	II	-
<i>Cryptogramma crispa</i>	-	-	-	-	-	-	II	-
<i>Deschampsia flexuosa</i>	-	-	-	II	-	I	III	-
D.sp. <i>Silene compactae</i> - <i>Salicetum purpureae</i>								
<i>Salix purpurea</i>	-	-	-	-	-	I	-	V
<i>Rumex acetosella</i>	-	-	-	-	-	-	-	IV
<i>Silene compacta</i>	-	-	-	-	-	-	-	IV
<i>Taraxacum officinale</i> aggr.	-	-	-	-	I	-	-	IV
<i>Trifolium repens</i>	-	-	-	-	-	-	-	IV
<i>Agrostis stolonifera</i>	-	-	-	-	-	II	-	IV
<i>Anthyllis vulneraria</i>	-	-	-	-	-	I	-	III
<i>Cicerbita racemosa</i>	-	I	-	-	II	I	-	III
<i>Lotus corniculatus</i>	-	-	-	-	-	I	-	III
<i>Alnus incana</i>	-	-	-	-	-	I	-	III
<i>Cerastium holosteoides</i>	-	-	-	-	-	I	-	III
<i>Gnaphalium sylvaticum</i>	-	-	-	-	-	I	-	III
<i>Pinus silvestris</i>	-	-	-	-	-	-	I	III
<i>Poa palustris</i>	-	-	-	-	-	-	-	III
D.sp. <i>Murbeckiellion huetii</i>								
<i>Alopecurus ponticus</i>	I	-	-	I	V	III	-	-
<i>Oxyria digyna</i>	I	-	-	V	V	V	-	I
<i>Phleum alpinum</i>	-	-	-	IV	I	III	-	-
D.sp. <i>Androsacetalia alpinae</i>								
<i>Sibbaldia procumbens</i>	-	-	-	IV	-	-	-	-
<i>Cerastium cerastioides</i>	II	-	-	II	III	III	-	-
<i>Sagina saginoides</i>	-	-	-	I	I	-	-	I
D.sp. <i>Salicion incanae</i> , <i>Epilobietalia fleischeri</i>								
<i>Erigeron podolicus</i>	-	-	-	-	-	-	-	IV
<i>Myricaria germanica</i>	-	-	-	-	-	I	-	IV
D.sp. <i>Thlaspietea rotundifolii</i> (reg.)								
<i>Saxifraga sibirica</i>	II	I	-	III	IV	IV	II	-
<i>Sedum tenellum</i>	I	I	III	V	IV	III	IV	-
<i>Veronica minuta</i>	III	II	IV	I	V	III	-	II
<i>Cerastium polymorphum</i>	II	I	-	II	II	III	-	III
<i>Chamerion dodonaei</i>	-	-	-	I	IV	V	-	V
<i>Matricaria caucasica</i>	III	I	-	IV	V	IV	-	III
<i>Vicia caucasica</i>	-	I	-	-	-	III	-	IV
<i>Racomitrium canescens</i>	-	-	-	I	III	III	II	V
<i>Poa badensis</i>	-	-	-	I	III	III	I	I
<i>Murbeckiella huetii</i>	II	I	-	I	IV	III	IV	-
<i>Minuartia imbricata</i>	I	I	II	I	IV	II	-	-
<i>Calamagrostis epigeios</i>	-	-	-	-	-	IV	I	IV

Syntaxa:

1 - *Veronico minutae*-*Chaerophylletum humilis typicum*, 2 - *V.t.-Ch.h. lamietosum tomentosum*, 3 - *V.t.-Ch.h. saxifragetosum flagellaris*, 4 - *Hyalopoo ponticae*-*Oxyrietum digynae ranunculetosum oreophilii*, 5 - *H.p.-O.d. typicum*, 6 - *Scrophulario variegatae*-*Epilobietum dodonaei*, 7 - *Dicranoweisio crispulae-Rubetum idaei*, 8 - *Silene compactae*-*Salicetum purpureae*

### 3.1. *Chaerophylletalia humilis*

This order combines communities of the upper alpine and subnival zones developing on loose siliceous screes and stone fields. Floristic distinctiveness of the communities is very high. Many Caucasian endemics are well represented in it (VOROB'EVA 1977). In relation to the restricted study area we lumped all such communities within one alliance (*Chaerophyllion humilis*) and one association (*Veronico minutae-Chaerophylletum humilis*) with a unified set of diagnostic species (Table 3.1). We don't know of any other syntaxonomic publication describing similar communities from the area, therefore we consider all syntaxa new.

#### Floristic features

Among diagnostic species the role of *Brassicaceae* (*Dentaria bipinnata*, *Eunomia rotundifolia*, *Noccaea pumila*, *Draba scabra*, *D. siliquosa*) is very important. Most of the species are polycarpic perennials with special adaptation to loose scree environment (deep roots, creeping shoots and stolons). The ecology and biology of subnival plants in the Caucasus is discussed in some detail in NAKHUTSRISHVILI & GAMTSEMLIDZE (1984).

The mean number of vascular plant species per releve in this syntaxon is low (13). Species composition varies considerably: the ratio of the total number of species to the mean number of species is about 8 for 24 releves (Table 3.2). The role of bryophytes and epigeal lichens is low in terms of species number and cover.

According to floristic composition, we distinguish three subassociations with small ecological differentiation: ***V.t.-Ch.h. typicum*** (typus, or nomenclature type, No. 11/89), ***V.t.-Ch.h. lamietosum tomentosum*** (typus, or nomenclature type, No. 134/90), ***V.t.-Ch.h. saxifragetosum flagellaris*** (typus, or nomenclature type, No. 57/95). The typical subassociation is characterized by absence of *Lamium tomentosum* and species of *V.t.-Ch.h. saxifragetosum flagellaris* group. The rate of stone mobility decreases in the order: *V.t.-Ch.h. lamietosum tomentosum* > *V.t.-Ch.h. typicum* > *V.t.-Ch.h. saxifragetosum flagellaris*. There are several species of rock and stable dry stonefields in the last syntaxon.

## **Ecological features**

Plant communities of the association occupy slopes of varying aspect and steepness (from horizontal ridges to 35°, with the mean 23°). They are typical for the upper reaches of vegetation in the region within both alpine and subnival zones. This community is found between 2750 and 3540 m elevation (mean 3090 m). Boulders of siliceous rocks (granites, gneises, shists) cover 50-95% of the area. Winter snow cover is low or moderate.

Plant cover is scarce (about 10%). In contrast with other associations the communities are not connected with permanent or temporary water flows.

Human influence on these communities is not very important due to their low productivity. There are many rare and endemic species belonging to this association, so a stronger protection regime preventing sheep grazing might be necessary in some areas.

### **3.2. *Androsacetalia alpinae***

This order includes open communities on siliceous pebble and screes within the alpine and subalpine zones. *Sibbaldia procumbens*, *Cerastium cerastioides* and *Sagina saginoides* are noted as diagnostic species of the order (ENGLISCH *et al.* 1993). Two alliances with contrast ecological features were distinguished within the order.

#### **3.2.1. *Murbeckiellion huetii***

Open communities on alpine moraines, talus slopes and flood plain pebble beds belong to the alliance. All of them occupy areas near permanent or seasonal water bodies, such as rivers, streams of glacial origin, etc. There is no water deficit, but flooding is also unusual. Fluctuating water courses, stony and mud streams, are the main factor of disturbance there.

The diagnostic species combination of the alliance includes *Alopecurus ponticus*, *Oxyria digyna*, *Phleum alpinum* (Table 3.3).

Typus, or nomenclature type, is *Scrophulario variegatae-Epilobietum dodonaei*.





Sporadic species (number of releve in parenthesis, abundance are shown after ":", unless it is not "+", Braun-Blanquet scale) *Aetheopappus caucasicus* (53/95:1, 11/95), *Agrostis vinealis* (55/95), *Alchemilla caucasica* (41/91:r, 53/95), *Alopecurus ponticus* (36/95:1), *Androsace lehmanniana* (53/95), *Anemone speciosa* (37/94), *Anthemis cretica* (36/95), *Astragalus brachytrypis* (53/95, 111/95), *Astragalus levieri* (111/95), *Botrychium lunaria* (21/89), *Bryum imbricatum* (93/95), *Campanula collina* (36/95, 37/94) *Campanula tridentata* (51/95), *Campylopus schimperi* (51/95), *Carex sempervirens* (37/94), *Catabrosella variegata* (21/89:1), *Cerastium cerastifoides* 93/95, 14/89:1), *Cerastium kazbek* (43/94, 162/94), *Cerastium undulatifolium* (43/94), *Ceratodon purpureus* (37/95, 55/95), *Cetraria islandica* (160/94, 111/95), *Cicerbita racemosa* (50/91:r), *Cladonia pyxidata* (42/94:1), *Corniculana divergens* (51/95), *Cruciata laevipes* (134/90), *Dillichium flexicaule* (21/89), *Draba rigida* (49/91), *Erigeron alpinus* (111/95), *Euphrasia ossica* (49/91:r), *Festuca brunnescens* (51/95), *Festuca varia* (50/91:r), *Galium verum* (37/94), *Grimmia incurva* (37/04), *Gypsophila tenuifolia* (111/95), *Hedysarum caucasicum* (111/95), *Heracleum freynianum* (36/95, 50/91:1), *Hypnum cupressiforme* (111/95), *Hypnum revolutum* (37/94), *Jurinella moschus* (111/95), *Kobresia schoenoides* (37/94), *Koeleria eriostachya* (53/95), *Leontodon hispidus* (36/95:1), *Lescuraea saxicola* (14/89), *Leskeella nervosa* (37/94), *Lloydia serotina* (26/89), *Minuartia inamoena* (53/95:1), *Nepeta supina* (134/90:1), *Orfhotrichum rupestre* (37/94), *Oxyria digyna* (26/89:2), *Pedicularis comosa* (53/95, 111/95), *Pedicularis crassirostris* (51/95), *Poa nemoralis* (49:91), *Poa sp.* (37/95), *Pogonatum urnigerum* (37/95, 51/95), *Pohlia longicollis* (55/95), *Pohlia nutans* (42/94, 93/95), *Polygonum alpinum* (36/95), *Polygonum bistorta* (37/94, 111/95), *Polytrichastrum alpinum* (93/95), *Polytrichum piliferum* (37/95, 55/95), *Primula meyeri* (26/89:1, 21/89), *Pulsatilla albana* (53/95), *Ranunculus oreophilus* (37/94, 53/95), *Senecio vernalis* (36/95, 50/91:1), *Solidago virgaurea* (36/95), *Taraxacum stevenii* (23/89), *Taraxacum tenuisectum* (53/95), *Thamnolia vermicularis* (160/94), *Tortella tortuosa* (21/89), *Tortula ruralis* (14/89, 37/95), *Trifolium polyphyllum* (53/95), *Valeriana alpestris* (37/94:1), *Veronica monticola* (49/91).

Date (day month), size (sq.m) and location of the releves (all releves were made by V. Onipchenko, unless other author is noted). 26/89 - 14.08, 25, Kyrkol; 42/94 - 11.07, 100, Kyskhkadzher, permafrost polygonal relief; 93/95 - 25.07, 50, Khadzhibey; 14/89 - 13.08, 25, Kyrkol; 12/89 - 13.08, 25, Epchik; 11/89 - 13.08, 25, Epchik; 37/95 - 07.07, 50, Chuchkhur; 36/95 - 07.07, 50, Chuchkhur; 23/89 - 14.08, 25, Kyrkol; 19/89 - 14.08, 100, Kyrkol; 50/91 - 19.08, 9, Gonachkhir; 37/94 - 10.07, 25, Kyskhkadzher; 43/94 - 11.07, 50, Kyskhkadzher; 162/94 - 05.09, 25, Oriuchat; 95/95 - 25.07, 100, Khadzhibey; 134/90 - 16.08, 25, Khadzhibey; 49/91 - 19.08, 25, Gonachkhir; 160/94 - 05.09, 25, Oriuchat; 55/95 - 10.07, 25, Epchik; 57/95 - 10.07, 25, Epchik; 53/95 - 10.07, 25, Epchik; 51/95 - 19.08, 25, M.Khatipara.

Table 3.3.

*Murbeckiellion huetii*

Releve No.	0 0 0 0 0	1 1 1 1 0 0 0	0 1 0 0 0 1 0 1 1 1
	49 27 29 72 28	52 53 87 89 80 56 40	94 10 26 27 44 26 6 97 13 36
Year	89 88 88 93 88	90 90 94 94 95 91 93	94 94 95 94 95 95 95 94 94 90
Altitude (* 10)	2 2 2 2 2	2 2 2 2 2 2 2	2 2 2 1 2 2 2 1 2 2
	65 90 85 50 90	90 90 75 70 60 20 20	40 68 05 90 10 60 00 98 30 33
Steepness	25 35 35 25 35	20 15 7 2 20 20 2	2 30 10 2 2 2 10 1 2 2
Exposition	ne ne ne ne ne	ne ne w nw ne ne n	n ne ne w nw sw se nw ne se
Vascular plant cover	50 80 35 20 20	10 10 30 15 10 5 5	10 10 10 10 15 5 15 10 15 3
Bryophyte cover	10 20 10 5 5	10 2 10 5 10 2 -	1 + + 3 + 1 5 10 + -
Lichen cover	+ + + + +	2 + + + 3 + -	0 0 0 0 0 1 0 0 0 -
Stone cover	30 10 40 80 70	60 90 60 70 75 85 90	90 85 70 70 80 95 70 75 70 90
Bryophyte spec. number	8 4 7 15 7	4 3 1 3 5 4 0	4 6 7 3 4 5 5 2 1 0
Lichen spec.number	1 1 3 4 3	2 2 1 2 3 0 0	0 0 0 0 0 3 0 0 0 0
Vasc.pl.spec. number	29 25 40 34 22	18 9 21 21 33 20 28	33 18 37 25 47 18 23 27 57 22
<i>D.sp. Hyalopoo ponticae-Oxyrietum digynae</i>			
<i>Carex atrata</i>	+ + +	+ + +	r
<i>Gnaphalium supinum</i>	+ +	+ r 1 2 +	
<i>Hyalopoa pontica</i>	1 1 1 + 1	1 1 +	+ +
<i>Primula meyeri</i>	+ + + 1	+ + + +	
<i>Cladonia pyxidata</i>	+ + + +	+ + + + +	
<i>Carex pyrenaica</i>	+ + + +	+ + + +	
<i>Senecio taraxacifolius</i>	2 2 1	+ + + +	
<i>D.sp. H.p.-O.d. ranunculetosum oreophili</i>			
<i>Ranunculus oreophilus</i>	+ 1 1 + +		+ +
<i>Sanionia uncinata</i>	+ 1 1 1 1		
<i>Valeriana alpestris</i>	1 2 1 + +		+ +
<i>Carum caucasicum</i>	1 + 1 + +		r +
<i>Ranunculus caucasicus</i>	+ 1 1 +		
<i>D.sp. Scrophulario variegatae-Epilobietum dodonaei</i>			
<i>Betula litwinowii</i>			+ + + 1 +
<i>Poa nemoralis</i>			+ + + + + + + +
<i>Scrophularia variegata</i>		+ + + + +	+ + +
<i>Trifolium spadiceum</i>		+ + + + +	+ + + +
<i>Pohlia filum</i>			+ + + + 1
<i>D.sp. Murbeckiellion huetii</i>			
<i>Alopecurus ponticus</i>		+ 1 2 + + 1	+ + + 1
<i>Oxyria digyna</i>	1 1 1 + 2	+ 1 2 + + 1 1	1 + + 1 + 1 + +
<i>Phleum alpinum</i>	+ + + +		+ + + + + +
<i>D.sp. Androsacetalia alpinae</i>			
<i>Sibbaldia procumbens</i>	1 1 1 +		
<i>Cerastium cerastioides</i>	+ + + 1	+ + + +	1 + + + + +
<i>D.sp. Thlaspietea rotundifolii (reg.)</i>			
<i>Murbeckiella huetii</i>		+ + + + +	+ + + + + + +
<i>Poa badensis</i>	+ + + +	+ + + + +	+ + + + + + +
<i>Saxifraga sibirica</i>	1 2 + 1	+ + + + +	+ + + + + + +
<i>Sedum tenellum</i>	+ + + + 1	+ + + + +	+ + + + + + +
<i>Veronica minuta</i>		+ + + + +	+ + + + + + +
<i>Calamagrostis epigeios</i>			1 1 + 1 1 + +
<i>Cerastium polymorphum</i>	+ + + +	+ + + +	+ + + + 1 +
<i>Chamerion dodonaei</i>		1 + + 2 +	+ 1 1 2 1 2 1 1 1



Table 3.3. (continued)

Releve No.	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	1	0	1	1	1
Year	49	27	29	72	28	52	53	87	89	80	56	40	94	10	26	27	44	26	6	97	13	36
Year	89	88	88	93	88	90	90	94	94	95	91	93	94	94	95	94	95	95	95	94	94	90
<i>Polytrichum juniperinum</i>	1			+									+					+				
<i>Polytrichum piliferum</i>				+		1	+			+						+	+		+			
<i>Rumex alpestris</i>									+								+					+
<i>Salix caprea</i>											+					+			+		+	
<i>Salix kazbekensis</i>				+		1														+		
<i>Saxifraga kolenatiana</i>			+	1	+	+									+			1				
<i>Saxifraga moschata</i>				+						+			+					1				
<i>Silene saxatilis</i>										+								+	+			
<i>Silene vulgaris</i>																+	+				+	+
<i>Stereocaulon alpinum</i>	+			+		1	+		+	+								+				
<i>Taraxacum stevenii</i>	1		+							1										+		r
<i>Trisetum flavescens</i>				+									+								+	
<i>Veronica gentianoides</i>			+	+	+					+	r	r			+		+	+				

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

*Acer trautvetteri* (6/95), *Achillea millefolium* (113/94), *Aconitum nasutum* (27/88), *Aconitum orientale* (40/93:r), *Ajuga orientalis* (113/94), *Alchemilla caucasica* (40/93), *Alchemilla sericea* (28/88), *Alnus incana* (27/94), *Alopecurus glacialis* (49/89:2), *Alyssum murale* (113/94), *Alyssum repens* (94/94), *Anemone speciosa* (29/88), *Anthemis macroglossa* (27/94, 6/95), *Anthemis marshalliana* (26/95, 44/95), *Anthyllis vulneraria* (197/94, 113/94), *Arenaria lychnidea* (26/95, 44/95), *Arenaria rotundifolia* (40/93, 44/95), *Astragalus brachytropis* (94/94, 113/94), *Astragalus levieri* (126/95), *Astragalus oreades* (27/94), *Astragalus psoraloides* (113/94), *Athyrium distentifolium* (56/91:r, 26/95), *Barbilophozia barbata* (27/88, 80/95), *Barbilophozia lycopodioides* (72/93), *Bartramia ithyphylla* (27/88:1, 28/88), *Brachythecium velutinum* (27/88:1, 28/88), *Briza marcoviczii* (49/89), *Bryum argenteum* (94/94, 26/95), *Bryum caespiticium* (110/94, 26/95), *Bryum capillare* (49/89, 44/95), *Bryum imbricatum* (153/90, 80/95), *Bryum pallescens* (56/91), *Bryum schleicheri* (94/94), *Bryum weigelii* (26/95), *Bupleurum falcatum* (44/95, 113/94), *Calamagrostis arundinacea* (26/95), *Carduus adpressus* (27/94), *Carum meifolium* (197/94), *Centaurea cheiranthifolia* (113/94), *Cerastium holosteoides* (94/94), *Cerastium purpurascens* (49/89), *Chaerophyllum humile* (29/88, 28/88), *Cichorium intybus* (27/94), *Cirsium simplex* (44/95), *Crepis glabra* (40/93:r), *Cruciata laevipes* (40/93, 113/94), *Cystopteris fragilis* (72/93:r), *Dicranum congestum* (29/88:1, 72/93), *Dryopteris filix-mas* (72/93, 153/90:r), *Empetrum nigrum* (29/88, 72/93), *Epilobium algidum* (94/94, 136/90), *Eritrichium caucasicum* (29/88), *Eurhynchium pulchellum* (28/88), *Galium verum* (94/94, 113/94), *Gentiana septemfida* (80/95), *Geranium gymnocaulon* (44/95), *Geranium sylvaticum* (26/95, 113/94), *Gnaphalium sylvaticum* (44/95, 6/95), *Grimmia sessitana* (80/95), *Gymnocarpium dryopteris* (110/94), *Helictotrichon versicolor* (29/88), *Heracleum leskovii* (187/94), *Hesperis matronalis* (94/94), *Hieracium pilosella* (197/94), *Huperzia selago* (80/95), *Hygrohypnum luridum* (26/95), *Hylocomium splendens* (72/93), *Hypnum vaucheri* (126/95), *Kemulariella caucasica* (56/91:r), *Lamium tomentosum* (94/94), *Lapsana communis* (27/94, 44/95), *Lescurea saxicola* (72/93), *Ligusticum alatum* (136/90:r), *Lotus comiculatus* (197/94, 113/94), *Minuartia recurva* (80/95, 44/95), *Myricaria germanica* (197/94), *Myurella julacea* (29/88), *Onchophorus virens* (110/94), *Orthodicranum montanum* (72/93), *Pedicularis comosa* (126/95, 113/94), *Pedicularis wilhelmsiana* (72/93), *Peltigera rufescens* (72/93, 126/95), *Petasites albus* (26/95, 27/94), *Phleum phleoides* (94/94, 113/94), *Poa caucasica* (136/90), *Poa longifolia* (40/93:r), *Pogonatum umigerum* (110/94, 6/95), *Pohlia cruda* (29/88, 110/94), *Polygonum viviparum* (29/88, 113/94), *Polytrichum sexangulare* (189/94), *Ranunculus brachylobus* (187/94, 44/95), *Ranunculus subtilis* (26/95, 44/95), *Rhinanthus minor* (72/93), *Rhododendron caucasicum* (29/88, 72/93), *Rhynchocorys elephas* (6/95), *Rhytidadelphus triquetrus* (49/89, 28/88), *Rhytidium rugosum* (28/88), *Rubus idaeus* (113/94), *Rumex alpinus* (44/95), *Sagina saginoides* (28/88, 187/94), *Salix apoda* (72/93), *Salix purpurea* (113/94), *Salix pantosericea* (44/95), *Salix pentandroides* (113/94), *Scapania imigua* (29/88), *Scrophularia ruprechtii* (40/93), *Sedum hispanicum* (40/93), *Senecio vernalis* (110/94, 113/94), *Silene alba* (26/95), *Solidago virgaurea* (72/93, 44/95), *Solorina crocea* (80/95), *Stellaria anagalloides* (94/94), *Taraxacum confusum* (113/94), *Taraxacum officinale* aggr. (40/93), *Tayloria serrata* (49/89), *Thymus nummularius* (44/95), *Tortula ruralis* (72/93), *Trifolium ambiguum* (197/94:1, 113/94), *Trifolium polyphyllum* (44/95).

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

49/89 - 01.09, 25, M.Khatipara; 27/88 - 19.08, 9, Gigam; 29/88 - 19.08, 15, Gidam; 72/93 - 17.08, 25, Baduk; 28/88 - 19.08, 15, Gidam; 152/90 - 19.08, 9, Baduk; 153/90 - 19.08, 20, Baduk; 187/94 - 09.09, 100, Kichi-Murudzhu; 189/94 - 09.09, 100, Kichi-Murudzhu; 80/95 - 07.07, 25, Chuchkhur; 56/91 - 31.08, 25, Sev.Ptysh; 40/93 - 31.07, 25, Azgek; 94/94 - 20.07, 30, Goralykol; 110/94 - 22.07, 100, Goralykol; 26/95 - 05.07, 50, Amanauz; 27/94 - 09.07, 50, Dombai-Ulgen; 44/95 - 07.07, 100, Buul'gen; 126/95 - 29.08, 100, Nazalykol; 6/95 - 02.07, 32, Alibek; 197/94 - 11.09, 100, Klukhor; 113/94 - 22.07, 50, Goralykol; 136/90 - 17.08, 25, Khadzhibey

### 3.2.1.1. *Hyalopoo ponticae-Oxyrietum digynae*

#### Floristic features

Open communities of the alpine zone on unstable stony substrates belong to this association. The cold and moist environment is responsible for a significant floristic similarity between these and *Salicetea herbaceae*-communities. Floristic composition of the communities is complex. Three main groups of species can be distinguished: species of disturbed areas (*Matricaria caucasica*, *Oxyria digyna*, *Saxifraga sibirica*, *Chamerion dodonaei*, *Murbeckiella huetii*, *Minuartia imbricata*, *Cerastium polymorphum*), species of snowbed communities (*Sibbaldia procumbens*, *Gnaphalium supinum*, *Carex pyrenaica*, *Hyalopoa pontica*), and species of alpine grasslands (*Leontodon hispidus*, *Anthoxanthum odoratum*, *Phleum alpinum*). Mosses (*Racomitrium canescens*) and lichens (*Stereocaulon alpinum*) are well represented in several communities.

We separate two subassociations: ***H.p.-O.d. typicum*** (typus, or nomenclature type, No. 187/94) and ***H.p.-O.d. ranunculetosum oreophili*** (nom. type, or typus, No. 29/88) (Table 3.3). Communities of the second subassociation are typical of steep (25-35°) moist screes on the northeastern slopes. Diagnostic species of the subassociation are represented by *Ranunculus oreophilus*, *Sanionia uncinata*, *Valeriana alpestris*, *Ranunculus caucasicus*, *Carum caucasicum*.

Overall, we registered 101 vascular plant species, 31 bryophytes and 6 macrolichens in 12 relevés of this association. Mean numbers per relevé were 25, 5, and 2 species respectively.

#### Ecological features

The communities are common within the altitude range of 2200-2900 m (mean 2670 m). They were developed on slopes of northern (northeast, northwest) exposure and varying steepness (2-35°, mean 20°). Stone cover varies greatly (10-90%, mean 63%), and so does the percentage of plant cover (5-80%). Moss cover is about 5-10%. Soils are rather stable and rich due to some organic matter accumulation from the upper slopes and high water availability. Slow creeping of stones and mud-stream disturbance preclude development of closed communities and competitive exclusion of species by dominants. Therefore, these communities have the highest

production rate and moderate species richness among all the communities of *Thlaspietea rotundifolii*.

### **3.2.1.2. *Scrophulario variegatae-Epilobietum dodonaei***

#### **Floristic features**

This association includes flood plain pebble communities of the lower part of alpine, subalpine and upper part of forested zones. Diagnostic species are *Scrophularia variegata*, *Trifolium spadiceum*, *Pohlia filum*, *Betula litwinowii* (juveniles), and *Poa nemoralis* (Table 3.1). Species of *Murbeckiellion huetii* as well as regional combination of the class are well represented. *Chamerion dodonaei* and *Oxyria digyna* are very typical species with highest frequency.

*Racomitrium canescens* is the most common bryophyte. The role of lichens is negligible.

Due to frequent disturbances, floristic richness of the communities is high. We registered 125 vascular plant species, 19 bryophytes and 3 macrolichens in 10 relevés. Average values per relevé were 31, 4 and 0.3 species respectively.

#### **Ecological features**

The communities occupy stony banks along rivers and small streams. The steepness of slopes varies from 1° to 30°, but gentle slopes (about 2°) are more common. Aspect is not a significant factor for the communities, they can occupy either northern or southern slopes.

Compared with previous associations, these communities are typical at a lower elevation. Altitude range is narrow (1900-2680 m, mean 2230 m), while stony cover percentage is high (70-95%, mean 80%) and plant cover percentage is low (3-15%, mean 10%).

### **3.2.2. *Allosuro-Athyrium alpestris***

Communities on large stone-stabilized mounds belong to this alliance. ENGLISCH *et al.* (1993) noted *Cryptogramma crispa* as the only characteristic species of the order. We consider all communities within one association - *Dicranoweisio crispulae-Rubetum idaei* (Table 3.4.).

### **Floristic features**

The association occupies a rather separate position among other syntaxa of the class due to specific ecological conditions. There are several "forest" species growing here (*Dryopteris filix-mas*, *Dicranum scoparium*, *Rubus idaeus*), which belong to the diagnostic set of the association (Table 3.4.). Floristic richness of the community is lowest among other associations of the class. We registered only 81 vascular plant species, 30 bryophytes and 12 macrolichens for 12 relevés. Mean species numbers per relevé were 17, 6, and 3 respectively. Floristic composition varies significantly between the communities due to their isolated position and the influence of surrounding closed vegetation.

The role of bryophytes and lichens is prominent in term of their species number. The ratio vascular plants / (bryophytes + lichens) is the lowest for the association (1.9).

### **Ecological features**

The communities of the association were described from within the lower part of the alpine, subalpine and upper part of forest zones. The elevation ranges between 1970 and 2650 m (mean 2270 m). They occupy lower parts of the alluvial zone where the largest boulders are found (from 0.5 to 3-5 m in diameter). Few plants can survive in the small amount of fine soil between the stones. Plants are dispersed mainly by wind and animals. Plant cover percentage is low (1-15%, mean 7%), but stone cover is the greatest within the class (80-98%, mean 91%). Steepness varies considerably (5-30°, mean 17°). It seems that there is no preferable aspect for these communities, they occur on both southern and northern slopes.

Table 3.4.

*Dicranoweisia crispulae-Rubetum idaei* and *Silene compactae-Salicetum purpureae*

Releve No.	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
	83	58	82	31	37	21	81	15	21	61	89	59	74	47	96	25	26	27	28	30	24
Year	95	95	95	95	95	95	95	95	95	95	95	95	93	95	94	93	93	93	93	93	95
Altitude (* 10)	2	1	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
	20	97	15	65	25	45	10	50	38	25	30	00	40	13	98	36	36	36	36	75	70
Steepness	15	20	10	20	20	10	5	15	30	30	20	10	-	-	1	-	2	-	-	3	2
Exposition	ne	ne	s	w	ne	s	s	s	nw	s	se	s	-	-	nw	-	sw	-	-	sw	n
Vascular plant cover	5	3	15	7	1	10	10	5	3	15	5	5	20	5	15	20	5	30	10	15	5
Bryophyte cover	5	3	1	2	1	3	+	5	5	+	1	2	3	10	70	7	1	40	-	2	5
Lichen cover	3	+	1	2	+	+	+	0	2	+	+	+	-	0	1	-	-	3	-	-	0
Stone cover	95	95	85	90	98	90	90	90	90	80	95	90	80	80	25	80	90	30	20	60	70
Bryophyte spec. number	8	7	5	3	10	2	5	3	14	3	7	6	6	3	2	1	2	3	0	3	5
Lichen spec. number	3	1	2	1	6	1	4	0	6	0	3	3	0	0	1	0	0	4	0	0	0
Vasc.pl.spec. number	18	11	13	27	14	7	24	13	19	22	17	20	31	31	27	35	39	34	22	34	28
D.sp. <i>Dicranoweisia crispulae-Rubetum idaei</i> , <i>Allosuro-Athyrium alpestris</i>																					
<i>Dryopteris filix-mas</i>			+	+	+	1	1	1	+	1	1	+									
<i>Rubus idaeus</i>		+	+	+	1	+	1	1	1	1	1	+			+				+		
<i>Calamagrostis arundinacea</i>			+	1		+	+	1	+	+	1	+									
<i>Dicranoweisia crispula</i>		+	+		+	+			1	+	+	+									
<i>Dicranum scoparium</i>			+			+			+			+									
<i>Lescurea saxicola</i>			+		1	+	1		1	1											
<i>Juniperus communis</i>					+					+	1	1									
<i>Deschampsia flexuosa</i>		+			+					+	+	+									
<i>Hypnum cupressiforme</i>		1						+		+											
<i>Sempervivum caucasicum</i>					+			+				+									
<i>Polygonum alpinum</i>					+				+		+	+									
<i>Cladonia mitis</i>						+		+		+		+									
<i>Cryptogramma crispa</i>		1	1	1																	
D.sp. <i>Silene compactae-Salicetum purpureae</i>																					
<i>Salix purpurea</i>													+	+		+	+	1	+	+	+
<i>Rumex acetosella</i>													+	1		+	+	1	+	+	
<i>Silene compacta</i>															+	+	+	1	r	1	1
<i>Taraxacum officinale aggr.</i>													+			+	+	1	+	+	+
<i>Trifolium repens</i>													+			1	+	+	+	+	+
<i>Agrostis stolonifera</i>														+	+	+		+	+	1	
<i>Anthyllis vulneraria</i>																1	1	+		1	+
<i>Cicerbita racemosa</i>																+	+		+	+	+
<i>Lotus corniculatus</i>																1			+	+	+
<i>Alnus incana</i>													1	1			+				+
<i>Cerastium holosteoides</i>													+			+	+	+			
<i>Gnaphalium sylvaticum</i>													+			+	+				+
<i>Pinus silvestris</i>								+					r	+						r	1
<i>Poa palustris</i>																	+	+	+	+	
D.sp. <i>Salicion incanae</i> , <i>Epilobietalia fleischeri</i>																					
<i>Erigeron podolicus</i>													r		+	+	+	1	+		
<i>Myricaria germanica</i>													1	+		+	+	1	1		
D.sp. <i>Thlaspietea rotundifolii</i> (reg.)																					
<i>Chamerion dodonaei</i>													2	+	1	+	+	+	1	1	1
<i>Racomitrium canescens</i>					+			+		+		+	1	2	4	2	+	2		1	1
<i>Calamagrostis epigeios</i>												+	+	+	1			+	1	+	+

Table 3.4. (continued)

Releve No.	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0					
Year	83	58	82	31	37	21	81	15	21	61	89	59	93	95	94	93	93	93	93	28	30	24	
<i>Vicia caucasica</i>													+		1	+		+				1	+
<i>Cerastium polymorphum</i>													+		+		+					+	+
<i>Matricaria caucasica</i>													+			r	+					+	+
<i>Veronica minuta</i>													r										+
<i>Poa badensis</i>									+			+											r
<i>Murbeckiella huetii</i>	+	r	+		+		+	+	+	+	+	+											+
<i>Saxifraga sibirica</i>	+	r			+					+													
<i>Sedum tenellum</i>	+	+		+			+	+	+	+	+	+											+
Other species																							
<i>Achillea millefolium</i>																+	+		+				
<i>Agrostis vinealis</i>	+		+		+			1					+										
<i>Alchemilla vulgaris</i>	1		+	+						+	+		r			+	+	+				+	
<i>Astragalus sp.</i>															+		r			+		+	
<i>Barbilophozia barbata</i>					+				+	+		+											+
<i>Betula litwinowii</i>					+								+		+	r	+						+
<i>Bupleurum falcatum</i>								+															+
<i>Campanula collina</i>				+		+										+							
<i>Carex sempervirens</i>	+				+											+							
<i>Cetraria islandica</i>	+		+		+		+		1									r					
<i>Chamerion angustifolium</i>			1		+		+	+		1	+												+
<i>Cladonia pyxidata</i>	+	+	+	+	+	+	+	+		+	+	+											+
<i>Dactylis glomerata</i>																+	r					r	
<i>Deschampsia caespitosa</i>													+			+							+
<i>Euphrasia ossica</i>					+											+		+					+
<i>Festuca ovina</i>		+		+	+		+		+	+	+	+											+
<i>Festuca varia</i>				1							+	+											+
<i>Geranium sylvaticum</i>				+				+				+											+
<i>Hieracium cymosum aggr.</i>																	+	1		+			
<i>Hieracium macrolepis</i>				+	+	+		+		+		+											+
<i>Leontodon hispidus</i>				+											+			1					
<i>Picea orientalis</i>													+			r	+						
<i>Plantago major</i>													r			+	+						
<i>Poa annua</i>															+	r				+			
<i>Poa nemoralis</i>	+	+	1		+	+	+		1	+	+	+	+			+						+	+
<i>Pogonatum umigerum</i>					+				+														+
<i>Polytrichum juniperinum</i>		+	+		+		+																
<i>Polytrichum piliferum</i>	+	+	+		+		+		+	+	+	+	+	+	1			1				+	+
<i>Rumex alpestris</i>								+			+							1		+			
<i>Salix caprea</i>																	+					+	+
<i>Sanionia uncinata</i>	+	1	+		+																		
<i>Saxifraga moschata</i>					+					+	+												
<i>Scrophularia variegata</i>															+	+							+
<i>Silene saxatilis</i>							+		+			+			+								
<i>Silene vulgaris</i>					+											+							+
<i>Solidago virgaurea</i>				+		+							r										+
<i>Stereocaulon alpinum</i>					+		+								1			+					
<i>Taraxacum stevenii</i>	+										+					+					+		
<i>Veronica gentianoides</i>							+		+							+							r
<i>Viola tricolor</i>																	+	+	+				

For Table 3.4.

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

*Abies nordmanniana* (25/93:r, 24/95), *Acer trautvetteri* (24/95), *Agropyron caninum* (30/93:r), *Agropyron repens* (47/95, 26/93), *Alchemilla caucasica* (196/94), *Alnus glutinosa* (26/93), *Amelanchier rotundifolia* (27/93:r), *Anthemis macroglossa* (30/93), *Anthemis marshalliana* (81/95), *Anthoxanthum odoratum* (131/95, 30/93), *Anthriscus velutina* (89/95), *Arenaria lychnidea* (59/95), *Arenaria rotundifolia* (27/93), *Artemisia campestris* (47/95), *Asperula* sp. (47/95), *Asplenium septentrionale* (59/95), *Aster alpinus* (61/95), *Athyrium distentifolium* (24/94), *Atrichum undulatum* (24/95), *Barbilophozia hatcheri* (58/95:1), *Betula pendula* (30/93), *Brachythecium albicans* (89/95, 74/93), *Brachythecium salebrosum* (121/95), *Brachythecium velutinum* (89/95), *Bromus tectorum* (47/95), *Bryum argenteum* (74/93, 47/95), *Bryum caespiticium* (74/93, 24/95), *Bryum subelegans* (121/95), *Bunias orientalis* (47/95), *Campanula tridentata* (81/95, 121/95), *Carex atrata* (131/95), *Carex umbrosa* (74/93), *Cerastium arvense* (47/95), *Ceratodon purpureus* (59/95, 27/93:1), *Cerintho minor* (24/95), *Chaerophyllum aureum* (21/95:r), *Chenopodium album* (47/95, 27/93:r), *Chenopodium botrys* (47/95), *Cirsium arvense* (47/95, 25/93), *Cirsium chlorocomos* (196/94), *Cirsium obvallatum* (25/93), *Cirsium vulgare* (27/93), *Cladonia chlorophaea* (27/91:1), *Cladonia coniocraea* (89/95), *Cladonia fimbriata* (89/95), *Cladonia furcata* (137/95), *Cladonia gracilis* (83/95:1, 121/95), *Cladonia squamosa* (59/95), *Cruciata laevipes* (15/95, 47/95), *Desmatodon latifolius* (89/95), *Dicranum spadiceum* (83/95, 82/95), *Dryopteris carthusiana* (83/95, 137/95), *Echium vulgare* (47/95), *Empetrum nigrum* (83/95, 121/95), *Festuca brunnescens* (131/95), *Festuca djimilensis* (15/95:1), *Festuca* sp. (27/93), *Fragaria vesca* (26/93, 27/93), *Galium verum* (61/95, 47/95), *Geranium gymnocaulon* (131/95), *Geranium renardii* (81/95), *Gnaphalium supinum* (131/95), *Grimmia ovalis* (121/95), *Grimmia sessitana* (83/95), *Gymnocarpium dryopteris* (131/95, 15/95), *Gypsophila elegans* (47/95), *Heracleum asperum* (81/95), *Heracleum freynianum* (131/95, 30/93), *Heterocladium dimorphum* (89/95), *Hieracium pilosella* (196/94, 30/93:r), *Hieracium prenanthoides* (83/95), *Hyalopoa pontica* (121/95), *Hylocomiastrum pyrenaicum* (83/95), *Hypericum perforatum* (25/93, 26/93:r), *Hypnum revolutum* (121/95:1), *Juncus* sp. (26/93:r), *Kemulariella caucasica* (15/95), *Lamium tomentosum* (74/93:r), *Lapsana communis* (25/93, 24/95), *Lescureaea incurvata* (21/95:1), *Lescureaea mutabilis* (83/95:1), *Leucanthemum vulgare* (30/93), *Linaria genistifolia* (47/95), *Lloydia serotina* (83/95), *Luzula pallescens* (25/93), *Luzula spicata* (131/95), *Melica nutans* (27/93), *Minuartia circassica* (81/95, 61/95), *Minuartia recurva* (81/95), *Mnium spinosum* (137/95), *Myosotis alpestris* (131/95, 24/95), *Oxyria digyna* (74/93), *Paraleucobryum enerve* (137/95, 121/95), *Peltigera canina* (121/95), *Peltigera rufescens* (137/95), *Peltigera* sp. (27/93), *Petasites albus* (24/95), *Phleum pratense* (26/93), *Pleurozium schreberi* (121/95:1, 59/95), *Poa annua* (25/93, 26/93:r), *Poa compressa* (28/93), *Poa longifolia* (131/95), *Poa pratensis* (47/95), *Pohlia nutans* (74/93), *Pohlia wahlenbergii* (30/93), *Polygonum aviculare* (26/93), *Polygonum convolvulus* (27/93), *Polypodium vulgare* (59/95), *Polytrichastrum alpinum* (26/93), *Prunella vulgaris* (25/93:1, 26/93), *Pyrethrum corymbosum* (74/93:r), *Racomitrium sudeticum* (131/95, 15/95:1), *Radula complanata* (89/95), *Ranunculus oreophilus* (121/95, 61/95), *Ranunculus subtilis* (28/93:r), *Rhinanthus minor* (121/95), *Sagina saginoides* (74/93:r, 26/93), *Salix apoda* (24/95), *Salix pentandroides* (25/93, 26/93), *Salvia verticillata* (47/95), *Saxifraga kolenatiana* (81/95), *Scorzonera cana* (131/95), *Scrophularia ruprechtii* (74/93, 30/93), *Sedum album* (196/94), *Sedum hispanicum* (74/93, 27/93), *Sedum spurium* (89/95, 59/95), *Sedum telephium* (58/95), *Seseli alpinum* (83/95, 131/95), *Seseli petraeum* (47/95), *Sorbus aucuparia* (58/95, 196/94), *Thamnolia vermicularis* (121/95), *Thesium alpinum* (24/95), *Thymus nummularius* (81/95, 61/95), *Tragopogon reticulatus* (196/94), *Trifolium ambiguum* (196/94), *Trifolium arvense* (27/93:r, 28/93), *Trifolium spadiceum* (30/93), *Trifolium pratense* (47/95), *Vaccinium myrtillus* (83/95, 121/95), *Vaccinium vitis-idaea* (121/95), *Valeriana cardamines* (59/95), *Valeriana officinalis* (25/93), *Veratrum album* (131/95), *Veronica chamaedrys* (26/93), *Veronica officinalis* (27/93), *Veronica peduncularis* (27/93), *Vicia cracca* (47/95), *Vicia tetrasperma* (26/93:r), *Viola canina* (83/95, 82/95).

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

83/95 - 17.07, 25, Khuty (A.Egorov); 58/95 - 12.07, 100, Baduk; 82/95 - 17.07, 25, Khuty (A.Egorov); 131/95 - 30.08, 100, Ullu-Murudzhu; 137/95 - 30.08, 225, Ullu-Murudzhu; 21/95 - 04.07, 30, Alibek; 81/95 - 18.07, 100, Khuty (A.Egorov); 15/95 - 03.07, 100, Alibek; 121/95 - 29.08, 100, Nazalykol; 61/95 - 12.07, 100, Baduk; 89/95 - 24.07, 100, Khadzhibey; 59/95 - 12.07, 100, Baduk; 74/93 - 13.07, 25, Baduk; 47/95 - 08.07, 100, Teberda flood plain; 196/94 - 11.09, 100, Klukhor; 25/93 - 09.07, 25, Teberda flood plain (N.Illarionova); 26/93 - 10.07, 25, Teberda flood plain (D.Sukhova); 27/93 - 10.07, 25, Teberda flood plain (E.Kuraeva), 28/93 - 10.07, 25, Teberda flood plain (N.Drenova); 30/93 - 24.07, 20, Gonachkhir; 24/95 - 05.07, 50 Amanauz.

### 3.3. *Epilobietalia fleischeri*, *Salicion incanae*

Mountain communities on flood plain pebble beds form this order and the alliance. Several diagnostic species are shared with the Alps, namely *Myricaria germanica*, *Chamerion dodonaei*, *Erigeron podolicus* (*E. acris* group). Abundant regional species allow us to distinguish a new association - *Silene compactae*-*Salicetum purpureae* (Table 3.4.).

#### Floristic features

The diagnostic set of the association includes species of varying ecology, with all, nevertheless, adapted to the disturbed regime of alluvial deposits. *Salix purpurea*, *Rumex acetosella*, *Silene compacta*, *Trifolium repens*, *Agrostis stolonifera*, *Calamagrostis epigeios*, *Racomitrium canescens* are the most frequent ones. Due to the lower elevation position of this community, it has many forest and meadow species well represented within it.

Floristic richness is high, we registered 124 vascular plant species, 11 bryophytes and 4 macrolichens for 9 releves. Mean values per releve were 31, 3 and 1 species respectively. The ratio vascular plants / (bryophytes + lichens) is the highest among the associations of the class (8.3). In spite of few bryophyte species present, the moss cover is considerable (mean 17%) and is often denser than the cover of vascular plants.

#### Ecological features

The association is the last along the elevation gradient of pebble communities in the Teberda reserve. The altitude for this association ranges between 1980 and 1130 m with the mean value of 1490 m. Communities of the association are especially well represented on the flood plain of the Teberda river. They occupy very gentle slopes (0-3°) of various aspects. Stones cover about 60% (20-90%) of the area. Vascular plant cover is low (5-30%), while cover of bryophytes (mainly *Racomitrium canescens*) varies from 0 to 70%. A significant area of bare soil (fine silt deposits) indicates frequent disturbances due to periodical flooding caused by spring snowmelt and summer rains. Most of the plants here are well adapted to disturbances. Modern human influence has little effect on the communities.

#### 4. Rocks - *Asplenieta trichomanis*

Prodromus

*Asplenieta trichomanis* (BRAUN-BLANQUET in MEIER & BRAUN-BLANQUET 1934)

OBERD 1977

*Androsacetalia multiflorae* BRAUN-BLANQUET in MEIER & BRAUN-BLANQUET 1934

*Gypsophilion tenuifoliae* ONIPCHENKO & GORBACHEVSKAYA all.nov.

*Potentilletum divinae* ONIPCHENKO & GORBACHEVSKAYA ass.nov.

*Astragaletum levieri* ONIPCHENKO & GORBACHEVSKAYA ass.nov.

*Thalictro foetidi-Asplenion* ONIPCHENKO & GORBACHEVSKAYA all.nov.

*Galio valantioides-Polypodietum vulgaris* ONIPCHENKO &  
GORBACHEVSKAYA ass.nov.

*Thymo-Seselietum petraei* ONIPCHENKO & GORBACHEVSKAYA ass.nov.

Plant communities of this class occupy rock outcrops in all vegetation zones. Except for alpine communities on northern cliffs, which belong to *Salicetea herbaceae*, we consider all other siliceous rock communities within the order *Androsacetalia multiflorae* Braun-Blanquet in Meier et Braun-Blanquet 1934. The diagnostic species set includes species common to Europe (OBERDORFER 1977; MATUSZKIEWICZ 1981; JULVE 1993; MUCINA 1993a), namely *Asplenium septentrionale*, *A. trichomanes*, *Cystopteris fragilis*, *Sedum telephium*, *Polypodium vulgare*, as well as regional rock species (Table 4.1). Rock vegetation is sparse, so the influence of the surrounding closed vegetation on the rock communities is considerable. It seems that elevation is a major factor controlling floristic composition of rock communities. We suggest two new alliances separated according to their elevation position.

##### 4.1. *Gypsophilion tenuifoliae*

The communities occupy siliceous rocks of warm sites from subnival to subalpine zones. We consider the alliance as a geographical vicariant of the European *Androsacion multiflorae* BRAUN-BLANQUET in BRAUN-BLANQUET & JENNY 1926 (MUCINA 1993a). Typical plants of rock fissures (*Campanula saxifraga*, *Gypsophila tenuifolia*, *Saxifraga moschata*, *Draba rigida*) as well as alpine species of windward slopes (*Bromopsis variegata*, *Arenaria lychnidea*, *Aster alpinus*) form the diagnostic set for the alliance. Species composition of the communities varies significantly.

The ratio of total number of species to the mean number of species is about 4:1 for 10 relevés. We distinguish two associations within the alliance and consider *Astragaletum levieri* as a *typus*, or nomenclature type.

#### 4.1.1. *Potentilletum divinae*

##### Floristic features

A typical rock plant *Potentilla divina* and several alpine species of windward snowfree habitats form the diagnostic set of the association (Table 4.1, 4.2). Floristic richness is not great. We registered 85 vascular plant species, 33 bryophytes and 9 macrolichens in 11 relevés. Mean values per releve were 25, 6 and 2 species respectively. It should be pointed out that only species growing in or around fissures were included in the relevés. The ratio vascular plants/(bryophytes + lichens) is relatively low for this association (2.0), probably because of its severe environment. Vascular plant cover ranges from 2 to 15 % (mean 10%). Cushion plants (*Gypsophila tenuifolia*, *Arenaria lychnidea*, *Saxifraga juniperifolia*) are well-represented here (Table 4.2). *Typus*, or nomenclature type, No. 111/94.

##### Ecological features

The communities occupy the upper part of the alpine and subnival zones within the elevation range 2750-3100 m (mean 2920 m) on siliceous rocks in warm sites (mainly southern aspect). Slopes with rock outcrops are steep (70-90°, mean 78°), but significant humus accumulation in fissures allows many species to grow there. Due to often limited water supply and strong insolation, many plants have developed xeromorphic features, namely long-lived hard leaves (*Saxifraga juniperifolia*, *S. kolenatiana*), abundant pubescence (*Potentilla divina*, *Eritrichium caucasicum*) or succulent leaves (*Sempervivum pumilum*).

**Table 4.1.**  
Diagnostic table of *Asplenietea trichomanis*

	1	2	3	4
D.sp. <i>Potentilletum divinae</i>				
<i>Potentilla divina</i>	V	-	-	-
<i>Campanula tridentata</i>	V	I	I	-
<i>Carex sempervirens</i>	V	II	I	-
<i>Luzula spicata</i>	IV	-	-	-
<i>Carum caucasicum</i>	IV	-	I	-
<i>Trifolium polyphyllum</i>	IV	I	-	-
<i>Empetrum nigrum</i>	III	-	-	-
<i>Eritrichium caucasicum</i>	III	-	-	-
<i>Cetraria islandica</i>	III	-	-	-
<i>Anemone speciosa</i>	III	-	I	-
<i>Helictotrichon versicolor</i>	III	I	-	-
<i>Grimmia affinis</i>	II	-	-	-
<i>Saxifraga kolenatiana</i>	II	-	I	-
D.sp. <i>Astragaletum levieri</i>				
<i>Ranunculus oreophilus</i>	I	IV	-	-
<i>Alopecurus glacialis</i>	I	IV	-	-
<i>Festuca brunnescens</i>	I	IV	-	I
<i>Astragalus levieri</i>	I	IV	I	-
<i>Encalypta rhamnifolia</i>	-	III	-	-
<i>Thymus nummularius</i>	-	II	-	-
<i>Jurinea coronopifolia</i>	-	II	-	-
D.sp. <i>Gypsophilium tenuifoliae</i>				
<i>Campanula saxifraga</i>	V	V	II	I
<i>Saxifraga moschata</i>	V	IV	-	-
<i>Gypsophila tenuifolia</i>	III	V	I	-
<i>Bromopsis variegata</i>	II	V	I	-
<i>Arenaria lychnidea</i>	IV	II	-	-
<i>Aster alpinus</i>	II	III	-	-
<i>Juniperus communis</i>	II	III	-	-
<i>Draba rigida</i>	I	II	-	-
D.sp. <i>Galio valantioides</i> - <i>Polypodietum vulgare</i>				
<i>Polypodium vulgare</i>	I	I	V	I
<i>Homalothecium sericeum</i>	-	I	IV	I
<i>Galium valantioides</i>	-	-	III	I
<i>Grimmia elatior</i>	I	I	III	-
<i>Homalia besseri</i>	-	-	II	-
<i>Homalothecium philippeanum</i>	-	-	II	-
<i>Frullania dilatata</i>	-	-	II	-
<i>Senecio renifolius</i>	-	-	II	-
<i>Draba supranivalis</i>	I	-	II	-
D.sp. <i>Thymo-Seselietum petraei</i>				
<i>Thymus marschallianus</i>	-	-	-	V
<i>Seseli petraeum</i>	-	-	I	IV
<i>Centaurea salviifolia</i>	-	II	I	IV
<i>Stachys recta</i>	-	-	-	III
<i>Grimmia laevigata</i>	-	-	-	III
<i>Hedwigia ciliata</i>	-	-	-	III
<i>Melica ciliata</i>	-	-	-	III

**Table 4.1.** (continued)

	1	2	3	4
<i>Grimmia ovalis</i>	-	-	-	III
<i>Sedum telephium</i>	I	-	I	III
<i>Artemisia campestris</i>	-	-	-	II
<i>Onosma caucasica</i>	-	-	-	II
<i>Salvia canescens</i>	-	-	-	II
<i>Sisymbrium lipskyi</i>	-	-	-	II
<i>Veronica multifida</i>	-	-	-	II
<i>Agropyron intermedium</i>	-	-	-	II
<i>Polygonatum odoratum</i>	-	-	-	II
<i>Spiraea hypericifolia</i>	-	-	-	II
<i>Stipa capillata</i>	-	-	-	II
<i>Polygonum convolvulus</i>	-	-	-	II
<i>Carex humilis</i>	-	-	-	II
<i>Rhamnus pallasii</i>	-	-	-	II
<i>Scutellaria orientalis</i>	-	-	-	II
<i>Teucrium chamaedris</i>	-	-	-	II
<i>Cleistogenes bulgarica</i>	-	-	-	II
<i>Teucrium polium</i>	-	-	-	II
D.sp. <i>Thalictro foetidi-Asplenion</i>				
<i>Thalictum foetidum</i>	-	I	III	IV
<i>Leucodon sciuroides</i>	-	-	II	IV
<i>Campanula sarmatica</i>	-	I	III	III
<i>Bromopsis riparia</i>	-	-	II	III
<i>Silene kubanensis</i>	-	I	II	II
<i>Allium saxatile</i>	-	I	II	III
<i>Parietaria judaica</i>	-	-	I	I
<i>Juniperus sabina</i>	-	I	II	I
D.sp. <i>Asplenietea trichomanis, Androsacetalia multiflorae</i>				
<i>Cystopteris fragilis</i>	I	I	II	-
<i>Asplenium septentrionale</i>	-	I	III	V
<i>Asplenium trichomanes</i>	-	-	III	I
<i>Sedum spurium</i>	-	IV	II	V
<i>Sempervivum pumilum</i>	I	IV	II	III
<i>Silene saxatilis</i>	I	III	II	IV
<i>Saxifraga juniperifolia</i>	IV	III	III	-
<i>Amphidium mougeotii</i>	III	I	II	-
<i>Tortella tortuosa</i>	IV	III	III	I
<i>Poa nemoralis</i>	-	III	IV	II
<i>Paederotella teberdensis</i>	-	III	III	I
<i>Potentilla brachypetala</i>	-	III	II	I

Syntaxa:

1 - *Potentilletum divinae*, 2 - *Astragaletum levieri*, 3 - *Galio valantioides-Polypodietum vulgare*, 4 - *Thymo-Seseliatum petraei*

#### 4.1.2. *Astragaletum levieri*

##### Floristic features

These are typical rock communities of the low alpine and subalpine zone in the association. The diagnostic species set includes both rock plants (*Astragalus levieri*, *Alopecurus glacialis*, *Jurinea coronopifolia*) and alpine grassland species (*Festuca brunnescens*, *Ranunculus oreophilus*). Species of *Gypsophilion tenuifoliae* are also well represented. Floristic richness is higher than the previous association. There are 99 vascular plant species, 33 bryophytes, and 6 lichens in 10 relevés. Mean species numbers per relevé are 28, 6 and 1 respectively. The role of vascular plants increases in terms of species number as compared with *Potentilletum divinae*.

Typus, or nomenclature type, No. 79/93.

##### Ecological features

The main ecological difference from the previous association is the lower altitude of this association. The communities are typical for areas above or near the timberline within the elevation range of 2200 to 2950 m (mean 2620 m). They occupy steep (80-85°) siliceous rock outcrops on warm slopes (mainly southern aspect).

Vascular plant cover varies between 2 and 20% (mean 10%); cover of bryophytes is low (up to 5%). Due to strong insolation and high temperature of the substrate, significant water stress can occur. The role of leaf succulents (*Sedum spurium*, *Sempervivum pumilum*) as well as cushion plants is considerable (Table 4.2.).





Table 4.2. (continued)

Releve No.	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1	0	
Year	94	87	93	94	94	94	94	93	94	93	94	94	93	93	93	94	94	95	94	95
<i>Seseli alpinum</i>						+	+								+	+	+			
<i>Taraxacum stevenii</i>						+		+							+	+				
<i>Thamnolia vermicularis</i>	+	+	+					+			1				+					
<i>Tortula ruralis</i>														1		+				+
<i>Vaccinium vitis-idaea</i>		+						+	+	+										
<i>Valeriana alpestris</i>				+				+		+										+
<i>Veronica gentianoides</i>	+		+					+		+	+				+	+				+
<i>Weissia condensata</i>			1											+		+				

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

*Aconitum nasutum* (81/94), *Allium saxatile* (2/95), *Alopecurus vaginatus* (84/94, 2/95), *Asperula alpina* (164/94), *Asplenium viride* (104/94), *Bartramia ithyphylla* (84/94, 81/94), *Blindia acuta* (111/94), *Bryum caespiticium* (79/93, 90/95), *Bryum imbricatum* (83/93), *Bryum sp.* (80/94), *Calamagrostis arundinacea* (90/95), *Campanula samatica* (79/93, 2/95), *Carum meifolium* (81/94), *Centaurea cheiranthifolia* (85/93), *Cerastium polymorphum* (104/94, 171/94), *Cerastium purpurascens* (84/94), *Cetraria cucullata* (65/93), *Cetraria nivalis* (9/87, 61/93), *Cirsium munitum* (9/87:r), *Cladonia furcata* (111/94), *Cladonia gracilis* (9/87), *Comicularia divergens* (31/93), *Coronilla varia* (83/93), *Cruciata laevipes* (87/93), *Ctenidium procerimum* (84/94, 29/94:1), *Cuscuta sp.* (79/93, 83/93), *Daphne glomerata* (81/94, 104/94), *Desmatodon latifolius* (83/93, 87/93), *Desmatodon systylius* (83/93), *Dianthus cretaceus* (29/94, 2/95), *Dicranoweisia crispula* (80/94), *Ditrichum flexicaule* (84/94, 171/94:1), *Draba nemorosa* (2/95), *Draba scabra* (84/94, 171/94), *Draba supranivalis* (61/93), *Encalypta sp.* (90/95), *Encalypta streptocarpa* (29/94), *Encalypta vulgaris* (83/93, 85/93), *Erigeron alpinus* (81/94), *Euphrasia petiolaris* (104/94, 90/95), *Eurhynchium pulchellum* (81/94), *Festuca sommieri* (164/94, 2/95), *Galium verum* (83/93, 36/94), *Gentiana pyrenaica* (61/93), *Gentiana septemfida* (80/94), *Gentiana verna* (36/94, 164/94), *Geranium platypetalum* (87/93), *Gnaphalium supinum* (61/93:r, 84/94), *Grimmia funalis* (84/94, 31/93), *Grimmia montana* (65/93, 86/94:1), *Grimmia unicolor* (61/93), *Heracleum freynianum* (79/93), *Hieracium macrolepis* (111/94, 65/93), *Homalothecium sericeum* (90/95), *Hypericum linarioides* (83/93), *Hypnum revolutum* (171/94), *Iris aphylla* (79/93), *Juniperus sabina* (90/95), *Juninella moschus* (85/93), *Koeleria eriostachya* (36/94, 35/94), *Leontodon hispidus* (81/94, 104/94), *Leskeella nervosa* (81/94, 36/94), *Linum hypericifolium* (79/93), *Luzula multiflora* (171/94), *Macrotomia echioides* (81/94), *Matricaria caucasica* (61/93, 81/94), *Minuartia imbricata* (84/94), *Murbeckiella huetii* (81/94), *Muscari racemosum* (79/93, 36/94), *Myurella julacea* (86/94, 36/94), *Orthotrichum cupulatum* (79/93), *Orthotrichum rupestre* (2/95), *Peltigera rufescens* (29/94), *Physconia muscigena* (83/93), *Pinus silvestris* (87/93), *Plagiochila porelloides* (111/94), *Poa alpina* (31/93, 36/94), *Pohlia elongata* (85/93), *Pohlia longicollis* (111/94), *Pohlia nutans* (61/93:1), *Polygala alpicola* (79/93, 83/93), *Polygonum alpinum* (83/93, 85/93), *Polygonum bistorta* (85/93), *Polygonum viviparum* (171/94), *Polypodium vulgare* (104/94, 83/93), *Polytrichastrum alpinum* (171/94), *Potentilla crantzii* (87/93), *Potentilla gelida* (84/94), *Primula renifolia* (90/95), *Pterigynandrum filiforme* (31/93), *Rhamnus microcarpus* (79/93:1, 2/95), *Rhododendron caucasicum* (81/94, 80/94), *Rosa tomentosa* (83/93), *Saelania glaucescens* (61/93:1), *Salix kazbekensis* (171/94), *Saxifraga paniculata* (29/94), *Saxifraga sibirica* (104/94), *Scabiosa caucasica* (79/93), *Schistidium apocarpum* (79/93), *Sedum telephium* (84/94), *Senecio caucasicus* (85/93, 87/93:1), *Silene kubanensis* (2/95:1), *Solorina saccata* (29/94), *Sphenolobus minutus* (111/94), *Taraxacum confusum* (111/94, 84/94), *Thalictrum foetidum* (83/93), *Tragopogon brevirostris* (87/93), *Tragopogon reticulatus* (83/93), *Vaccinium myrtillus* (31/93), *Valeriana sisymbriifolia* (2/95), *Veronica peduncularis* (87/93), *Vicia cracca* (83/93, 87/93), *Viola altaica* (81/94), *Viola caucasica* (36/94, 35/94), *Weissia sp.* (36/94).

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

111/94 - 22.07, 25, Goralykol; 9/87 - 17.07, 25, Semenov-Bashi; 61/93 - 17.08, 20, Baduk; 84/94 - 17.07, 25, Khadzhibey (D.Sukhova); 81/94 - 17.07, 7, Bol.Khatipara (D.Sukhova); 104/94 - 21.07, 15, Goralykol; 171/94 - 06.09, 21, Oriuchat; 31/93 - 29.07, 6, Bol.Khatipara; 80/94 - 17.07, 16, Khadzhibey; 65/93 - 17.08, 8, Baduk; 86/94 - 17.07, 10, Khadzhibey; 29/94 - 10.07, 20, Dzhemagat; 79/93 - 22.08, 9, M.Khatipara; 83/93 - 23.08, 16, M.Khatipara; 85/93 - 26.08, 12, M.Khatipara; 87/93 - 26.08, 12, M.Khatipara; 36/94 - 11.07, 20, Kyshkadzher; 35/94 - 11.07, 21, Kyshkadzher; 90/95 - 25.07, 15, Khadzhibey; 164/94 - 06.09, 21, Oriuchat; 2/95 - 29.06, 15, M.Khatipara.

#### **4.2. *Thalictro foetidi-Asplenion***

This alliance, which combines the siliceous rock communities of the forest zone, may be considered as a vicarious altitudinal syntaxon for the previous alliance, and as a geographical vicariant of the European *Asplenion septentrionalis* Oberd. 1938 (MUCINA 1993a). The diagnostic species set of the alliance includes typical rock species (*Campanula sarmatica*, *Silene kubanensis*, *Allium saxatile*, *Parietaria judaica*, *Juniperus sabina*) as well as species common to forest and steppe communities (*Leucodon aff. sciuroides*, *Bromopsis riparia*, *Thalictrum foetidum*). Two associations can be easily distinguished according to their floristic and ecological features. Association *Thymo-Seseliatum petraei* is the typus, or nomenclature type, of the alliance.

##### **4.2.1. *Galio valantioides-Polypodietum vulgaris***

###### **Floristic features**

The diagnostic species set includes mosses of shaded habitats (*Homalothecium sericeum*, *H. philippeanum*, *Homalia besseri*, *Frullania dilatata*) and forest forbs (*Galium valantioides*, *Senecio renifolius*). *Polypodium vulgare* as well as other rock ferns are also well represented. There are 95 vascular plant species, 37 bryophytes and 10 lichens in 10 releves of the association (Table 4.3.). Mean species number per releve is relatively low, namely 20, 8, and 2 species respectively. The role of bryophytes is significant in terms of species number and especially in terms of percentage cover, which ranges between 1 and 60%. Typus, or nomenclature type, No. 87/94.

###### **Ecological features**

Communities of shaded rocks between 1350 and 2500 (mean 1670 m) elevation within the forested zone belong to this association. The mainly northern aspect of the rocks and tall tree canopy are responsible for low solar radiation input. Rock slopes are steep (70-90°, mean 82°), but the mean vascular plant cover is similar to other communities of the class (3-20%, mean 9%).

#### 4.2.2. *Thymo-Seselietum petraei*

##### Floristic features

The diagnostic set of the association includes a significant number of species. The most frequent species are *Thymus marschallianus* s.l., *Seseli petraeum*, and *Centaurea salviifolia*. Many steppe species from *Festuco-Brometea* BRAUN-BLANQUET & TÜXEN, 1943 (for instance, *Artemisia campestris*, *Stipa capillata*, *Carex humilis*) are also common in these communities. On the other hand, diagnostic species of *Asplenieta trichomanis* (especially *Asplenium septentrionale*) are also well represented.

Species richness is very high. We registered 129 vascular plant species, 27 bryophytes and 3 lichens in 11 relevés. Mean values per relevé are 27, 5 and less than 1 respectively. Therefore, the variation in species composition among communities is high. The role of bryophytes is less important than in the previous association. Ratio of vascular plants/(bryophytes+lichens) is the highest among the associations considered in this class (Tab. 4.3.).

##### Ecological features

The communities occupy rock outcrops on warm sites (mainly southern aspect) within the altitude range of 1100-1850m (mean 1390 m). Steepness of the rocks varies between 45° and 90° (mean 74°). Most of the relevés were obtained from the border and outside of the reserve area among intensively grazed forests and grasslands. The high floristic richness of the communities may be caused by the moderate level of grazing (hard-to-reach areas), and sufficient supply of species diaspores from the surrounding communities.

Communities of this association include some rare and protected species. Special protection is not required now, since the communities are confined to rocky and naturally-inaccessible sites. The only special measure we can recommend is restriction of intensive goat grazing on the rocks near villages.

Table 4.3.

*Thalictro foetidi-Asplenion*

Releve No.	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	
Year	88	5	87	4	15	17	17	44	89	36	1	16	2	6	7	8	29	29	45	46	30
	94	94	94	94	94	94	95	94	94	95	94	95	94	94	94	94	94	93	95	95	94
Altitude (* 10)	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
	45	35	45	40	55	35	42	72	45	25	35	38	40	10	20	25	85	40	20	25	90
Steepness	85	80	70	85	80	85	75	85	88	90	70	65	45	65	80	80	80	90	80	70	90
Exposition	nw	n	se	n	nw	nw	nw	e	w	ne	sw	sw	sw	se	se	e	sw	sw	sw	se	se
Vascular plant cover	10	10	10	3	10	15	20	5	5	3	10	10	15	20	10	5	10	10	20	10	1
Bryophyte cover	15	60	60	60	20	10	40	5	20	1	40	30	60	10	5	+	+	30	1	3	0
Lichen cover	4	20	+	40	1	+	10	1	+	+	20	+	20	10	20	5	3	50	0	0	0
Vascular plant species number	23	19	23	14	11	24	38	15	14	15	23	33	20	46	34	22	27	18	37	27	14
Bryophyte species number	9	6	10	7	6	11	9	7	11	4	7	9	5	9	4	4	4	7	3	5	0
Lichen specie number	1	0	2	0	3	1	6	2	0	1	2	1	0	0	0	0	0	0	0	0	0
Total number of species	33	25	35	21	20	36	53	24	25	20	32	43	25	55	38	26	31	25	40	32	14
D.sp. <i>Galio valantioides</i> - <i>Polypodietum vulgare</i>																					
<i>Polypodium vulgare</i>	+	+	+	1	1	+	+	+		+	+										
<i>Homalothecium sericeum</i>	1	1	2				1	1	1	+				+							
<i>Galium valantioides</i>		+	+	+			+		+											+	+
<i>Grimmia elatior</i>	1		1			1	1		1												
<i>Homalia besserii</i>	1	3	2	2																	
<i>Homalothecium philippeanum</i>	+	1								+											
<i>Frullania dilatata</i>			1	1		1	1														
<i>Senecio renifolius</i>		1		+		+															
<i>Draba supranivalis</i>	+		+		+																
D.sp. <i>Thymo-Seseliatum petraei</i>																					
<i>Thymus marschallianus</i>											+	+	+	+	+	+		+	+	+	
<i>Seseli petraeum</i>	+											+		+	+	+	+			+	+
<i>Centaurea salviifolia</i>							+				1		+			+	+		+	+	+
<i>Stachys recta</i>											+		+	+		r			+	+	
<i>Grimmia laevigata</i>													3	2	+	+	1				
<i>Hedwigia ciliata</i>											2	1	+		+			1	+		
<i>Melica ciliata</i>												+	+					+	+	+	
<i>Grimmia ovalis</i>											1	2	+	+	+			1			
<i>Sedum telephium</i>								+			+		+			+		1		+	
<i>Artemisia campestris</i>															+	+			+	+	
<i>Onosma caucasica</i>															1	+			+		+
<i>Salvia canescens</i>															1	+			+	+	
<i>Sisymbrium lipskyi</i>															+		+		+	+	
<i>Veronica multifida</i>															+	+	+		+		
<i>Agropyron intermedium</i>															+	+	+		+		
<i>Polygonatum odoratum</i>											+		+		+						
<i>Spiraea hypericifolia</i>											2		+						+		
<i>Stipa capillata</i>																			+	+	+
<i>Polygonum convolvulus</i>												+		+					+	+	
<i>Carex humilis</i>												+					+		+	+	
<i>Rhamnus pallasii</i>															+				1	1	
<i>Scutellaria orientalis</i>															+	+	+		+		
<i>Teucrium chamaedris</i>											+	+								+	
<i>Cleistogenes bulgarica</i>															+				+	+	
<i>Teucrium polium</i>															+	+			+		

Table 4.3. (continued)

Releve No.	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	
Year	88	5	87	4	15	17	17	44	89	36	1	16	2	6	7	8	29	29	45	46	30
	94	94	94	94	94	94	95	94	94	95	94	95	94	94	94	94	94	93	95	95	94
<i>D.sp. Thalictrio foetidi-Asplenion</i>																					
<i>Thalictrum foetidum</i>	+	+	+		+		+		+								1	+	+	+	
<i>Leucodon sciuroides</i>			2		2		1				2	1	2	+	1	+	+	1			
<i>Campanula sarmatica</i>	1		+		1		+	+	+									+	+	+	+
<i>Bromopsis riparia</i>	+						+		+						+	+	+				+
<i>Silene kubanensis</i>	+		1				1	1									+				+
<i>Allium saxatile</i>	+		+				1		+					+	+	+	+			+	+
<i>Parietaria judaica</i>	+				+												1				+
<i>Juniperus sabina</i>			+		1				+		2							2			
<i>D.sp. Asplenietea trichomanis, Androsacetalia multiflorae</i>																					
<i>Cystopteris fragilis</i>			+		+		+														+
<i>Asplenium septentrionale</i>	+		+		+		1	+			1	1	1	+	+	+	+	+	+	+	+
<i>Asplenium trichomanes</i>	+	+		+	1		+				+										+
<i>Sedum spurium</i>	+						+	+			+	+	+	+	+	+				+	+
<i>Sempervivum pumilum</i>	+						+				+		+	+	+	+					+
<i>Silene saxatilis</i>							+	+			+	+	+	+	+	+	+	+	1		
<i>Saxifraga juniperifolia</i>	+		+				+	+		+											
<i>Amphidium mougeotii</i>							1	1	1												1
<i>Tortella tortuosa</i>	1		1				1	1		+											+
<i>Poa nemoralis</i>	+	+	+		+		+	+		+	+	+					+				
<i>Paederotella teberdensis</i>	+		+				+		+	+	1										1
<i>Potentilla brachypetala</i>	+								+	1											+
Other species																					
<i>Alchemilla vulgaris</i> aggr.							+			+	+										
<i>Anthemis marshalliana</i>			+											+	+					+	
<i>Bryum argenteum</i>											1	1	+				+		1		+
<i>Bryum subelegans</i>	+	1		1	+						1										
<i>Calamagrostis arundinacea</i>			+		+			+													
<i>Campanula rapunculoides</i>											+	+		+							
<i>Campanula saxifraga</i>							+	1		+									1		
<i>Cladonia pyxidata</i>							+	1	1		+										+
<i>Dianthus pallens</i>								+							+	+					
<i>Digitalis ciliata</i>								+	r											+	
<i>Euphorbia leptocaula</i>			+												+						+
<i>Festuca ovina</i>	+		+							+											
<i>Festuca valesiaca</i>	+							+					1		+	+					
<i>Galium verum</i>															+	+	+	+		+	+
<i>Hypnum cupressiforme</i>				2	1		1						1								
<i>Hypnum vaucheri</i>	1						1			1											
<i>Minuartia circassica</i>								+			+										+
<i>Minuartia recurva</i>			+																+	+	+
<i>Myosotis alpestris</i>			+																r		
<i>Peltigera canina</i>	+		+		1			+			+										
<i>Porella platyphylla</i>					2					+	2										
<i>Rhytidium rugosum</i>								1				1		+							
<i>Sedum album</i>	+		+					1				+									
<i>Sempervivum caucasicum</i>																				1	1
<i>Tortula ruralis</i>			1		1			+							+					1	

For Table 4.3.

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

*Abies nordmanniana* (144/94), *Abietinella abietina* (6/94), *Achillea millefolium* (7/94), *Achillea nobilis* (6/94, 7/94), *Acinos arvensis* (45/95), *Aconitum nasutum* (117/94), *Agrostis vinealis* (87/94), *Ajuga orientalis* (2/94), *Allium rupestre* (1/94, 2/94), *Alyssum alyssoides* (6/94), *Alyssum murale* (115/95), *Anaptychia ciliaris* (117/95), *Anemone speciosa* (117/94), *Anoectangium aestivum* (29/94), *Artemisia absinthium* (8/94), *Artemisia chamaemellifolia* (7/94, 45/95), *Artemisia taurica* (6/94, 29/94), *Asperula alpina* (88/94), *Asplenium ruta-muraria* (46/95), *Asplenium viride* (144/94), *Astragalus captiosus* (45/95), *Astragalus demetrii* (1/94), *Astragalus falcatus* (1/94), *Astragalus levieri* (117/95:2), *Astragalus monspessulanus* (6/94, 7/94), *Asyneuma campanuloides* (4/94), *Bartramia ithyphylla* (144/94), *Berberis vulgaris* (1/94, 116/95), *Brachypodium pinnatum* (7/94), *Bromopsis variegata* (87/94), *Bryum capillare* (87/94:1, 116/95:1), *Bupleurum falcatum* (117/95, 6/94), *Campanula collina* (87/94, 136/95), *Campanula tridentata* (87/94), *Carex sempervirens* (117/94), *Carex supina* (6/94), *Carum caucasicum* (117/94), *Cetraria olivetorum* (115/94), *Chamaesciadium acaule* (117/94, 136/95), *Chenopodium album* (45/95), *Cicerbita racemosa* (144/94), *Cirsium vulgare* (7/94), *Cladonia chlorophaea* (117/95), *Cladonia* sp. (87/94), *Compositae* g. sp. (6/94, 7/94), *Convallaria majalis* (5/94), *Comicularia muricata* (117/95), *Coronilla varia* (6/94), *Cruciferae* g. sp. (30/94), *Descurainia sophia* (7/94), *Dianthus ruprechtii* (29/94:r), *Dianthus* sp. (29/93), *Distichium capillaceum* (117/94:1, 89/94:1), *Draba nemorosa* (29/93:r), *Draba siliquosa* (136/95), *Dryopteris filix-mas* (5/94, 4/94), *Echinops sphaerocephalus* (29/93), *Encalypta* sp. (89/94), *Encalypta spathulata* (46/95), *Encalypta vulgaris* (88/94), *Erysimum cuspidatum* (116/95), *Erysimum aureum* (6/94), *Euphrasia ossica* (117/95, 136/95), *Evemia divaricata* (1/94), *Fabronia ciliaris* (115/94, 29/93:1), *Festuca brunnescens* (29/93, 30/94), *Frullania* sp. (89/94, 29/93:1), *Fumana procumbens* (45/95), *Galium aparine* (5/94), *Genista angustifolia* (8/94), *Geranium platypetalum* (117/95, 144/94), *Geranium renardii* (116/96), *Geranium robertianum* (5/94, 4/94), *Grimmia funalis* (117/94:1, 136/95), *Grimmia tergestina* (46/95), *Gypsophila elegans* (45/95), *Gypsophila tenuifolia* (88/94, 117/94), *Hemiaria incana* (6/94), *Hieracium macrolepis* (116/95), *Hieracium murorum* aggr. (116/95), *Hieracium umbellatum* (117/95), *Hypericum nummularifolius* (117/95), *Isoetecium alopecuroides* (5/94:2, 4/94:2), *Jurinea alata* (8/94), *Leontodon hispidus* (45/95, 46/95), *Leptogium satuminum* (115/94), *Leucodon immersus* (89/94, 46/95:1), *Lloydia serotina* (117/94:1), *Lotus comiculatus* (6/94, 7/94), *Marrubium parviflorum* (6/94), *Medicago falcata* (45/95, 46/95), *Melampyrum arvense* (117/95), *Melica nutans* (5/94), *Metzgeria conjugata* (87/94:1, 4/94:1), *Metzgeria furcata* (144/94), *Minuartia imbricata* (117/94), *Mnium homum* (117/94), *Muscari racemosum* (2/94), *Mycelis muralis* (4/94), *Neckera complanata* (5/94:2, 117/94:1), *Neckera pennata* (89/94), *Orthotrichum anomalum* (88/94), *Orthotrichum rupestre* (144/94, 1/94:2), *Oxalis acetosella* (5/94, 4/94), *Oxystegus tenuirostris* (6/94), *Pedicularis comosa* (29/94), *Peltigera polydactyla* (117/95), *Peucedanum ruthenicum* (6/94, 29/93), *Phleum phleoides* (7/94, 29/94:r), *Physconia muscigena* (117/95), *Pinus silvestris* (116/95:1), *Plantago atrata* (29/94), *Plantago media* (6/94), *Poa alpina* (136/95), *Pogonatum urmigerum* (117/94), *Pohlia cruda* (144/94), *Polygonatum orientale* (5/94, 4/94), *Polygonum bistorta* (117/94), *Polystichum lonchitis* (117/94), *Polytrichastrum alpinum* (117/94), *Polytrichum piliferum* (117/95:1, 116/95), *Potentilla rupestris* (116/95), *Primula renifolia* (88/94, 89/94), *Pterigynandrum filiforme* (4/94:1), *Pyrethrum corymbosum* (116/95), *Radula complanata* (87/94:1), *Rosa canina* (1/94:1), *Rosa* sp. (6/94, 29/94:r), *Salvia glutinosa* (5/94), *Salvia pratensis* (7/94), *Salvia verticillata* (6/94), *Saxifraga kolenatiana* (117/94, 117/95), *Saxifraga sibirica* (117/94), *Scabiosa ochroleuca* (7/94), *Scorzonera stricta* (29/94), *Selaginella helvetica* (117/95, 89/94), *Senecio propinquus* (5/94, 4/94), *Seseli alpinum* (117/94, 117/95), *Seseli libanotis* (117/95, 144/94:r), *Sideritis montana* (45/89), *Silene compacta* (116/95, 2/94), *Silene pygmaea* (87/94, 89/94), *Solidago virgaurea* (117/95), *Stellaria media* (5/94), *Stipa pulcherrima* (6/94, 45/95), *Taraxacum confusum* (29/94), *Taraxacum officinale* (117/94), *Teucrium orientale* (6/94), *Thesium alpinum* (6/94, 7/94), *Thesium arvense* (1/94, 6/94), *Tortula sinensis* (8/94, 45/95), *Tortula subulata* (116/95:1), *Tragopogon filifolius* (45/95), *Tragopogon reticulatus* (117/95), *Trifolium alpestre* (29/94), *Trifolium canescens* (117/95), *Trifolium pratense* (2/94), *Urtica dioica* (115/94), *Valeriana alliariifolia* (5/94:1, 4/94), *Valeriana officinalis* (115/94), *Valeriana saxicola* (117/94), *Verbascum austriacum* (6/94, 30/94), *Veronica gentianoides* (117/95, 116/95), *Veronica peduncularis* (116/95, 2/94), *Veronica spicata* (29/93), *Veronica verna* (2/94), *Viola arvensis* (116/95), *Viola caucasica* (117/94:1, 116/95), *Viola rupestris* (6/94), *Viola tricolor* (2/94), *Weissia controversa* (45/95, 46/95), *Weissia* sp. (6/94), *Woodsia alpina* (117/94).

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

88/94 - 18.07, 15, Shumka; 5/94 - 02.07, 15, M.Khatipara; 87/94 - 18.07, 12, Shumka; 4/94 - 02.07, 10, M.Khatipara; 115/94 - 23.07, 18, Dzhemagat; 117/94 - 27.07, 15, M.Khatipara; 117/95 - 20.08, 18, Teberda valley; 144/94 - 03.09, 40, M.Khatipara; 89/94 - 18.07, 15, Shumka; 136/95 - 30.08, 24, Ullurudzh; 1/94 - 02.07, 16, M.Khatipara; 116/95 - 20.08, 24, Teberda valley; 2/94 - 02.07, 12, M.Khatipara; 6/94 - 03.07, 10, Teberda valley; 7/94 - 03.07, 24, Teberda valley (A.Egorov); 8/94 - 03.07, 20, Teberda valley; 29/94 - 10.07, 20, Dzhemagat; 29/93 - 12.07, 20, Teberda valley; 45/95 - 08.07, 15, Teberda valley; 46/95 - 08.07, 15, Teberda valley; 30/94 - 10.07, 20, Epchik.

## 5. Fens - *Scheuchzerio-Caricetea fuscae*

Prodromus

*Scheuchzerio-Caricetea fuscae* TÜXEN 1937

*Caricetalia fuscae* KOCH 1926 em BRAUN-BLANQUET 1949

*Caricion fuscae* KOCH 1926 em KLIKA 1934

*Caro caucasici-Caricetum nigrae* ass.nov.

*C.c.-C.n. salicetosum kazbekensis* subass.nov.

*C.c.-C.n. typicum* subass.nov.

*Swertio ibericae-Caricetum nigrae* ass.nov.

*Scheuchzerietalia palustris* NORDHAGEN 1937

*Caricion lasiocarpae* Vanden BERGHEN in LEBRUN *et al.* 1949

*Caricetum rostratae* OSVALD 1923 em DIERSSEN 1982

Communities of *Scheuchzerio-Caricetea fuscae* are common along small rivers and springs and near lakes on the flat bottoms of U-shaped valleys. They occupy few areas, but they are typical components of the vegetation. Among diagnostic species of the class (DIERSSEN 1982; STEINER 1993) are *Carex nigra*, *Aulacomnium palustre* and *Bryum pseudotriquetrum*, all well represented (Table 5.1.).

### 5.1. *Caricetalia fuscae*, *Caricion fuscae*

Most of the alpine and subalpine fens of the reserve belong to the alliance *Caricion fuscae*. *Carex echinata*, *Carex canescens*, *Sphagnum warnstorffii* and *Parnassia palustris* all are diagnostic species of the alliance. As typical fen species, we also consider *Primula auriculata*, *Cirsium simplex*, and *Briza marcowiczii*. Many meadow and grassland species are common in the fen communities (*Nardus stricta*, *Phleum alpinum*, *Anthoxanthum odoratum*, *Luzula multiflora*, *Carum caasicum* etc.). The fens are widespread in the Caucasus (KIMERIDZE 1963; AKATOV 1991).

Overall, floristic richness of the alpine fens is the lowest of all the alpine communities (ONIPCHENKO & SEMENOVA 1995). The mean number of vascular plant species was estimated as 4, 10 and 23 for 0.01, 1 and 100 m<sup>2</sup> plots respectively. Similar values were obtained for *Carex nigra* fens in Davos.

**Table 5.1.**  
Diagnostic table of *Scheuchzerio-Caricetea fuscae*

	1	2	3	4
<b>D.sp. <i>Caro caucasici-Caricetum nigrae</i></b>				
<i>Carum caucasicum</i>	III	V	II	-
<i>Polygonum viviparum</i>	V	III	-	-
<i>Cerastium cerastioides</i>	III	V	-	-
<i>Sibbaldia procumbens</i>	I	IV	-	-
<b>D.sp. <i>C.c.-C.n. salicetosum kazbebensis</i></b>				
<i>Salix kazbekensis</i>	V	I	-	-
<i>Ligularia sibirica</i>	III	-	I	I
<i>Saxifraga hirculus</i>	II	-	-	-
<b>D.sp. <i>C.c.-C.n. typicum</i></b>				
<i>Agrostis vinealis</i>	-	V	I	-
<i>Phleum alpinum</i>	II	V	-	-
<i>Taraxacum stevevii</i>	-	IV	I	II
<i>Epilobium anagallidifolium</i>	-	II	-	-
<b>D.sp. <i>Swertio ibericae-Caricetum nigrae</i></b>				
<i>Potentilla erecta</i>	-	-	V	IV
<i>Swertia iberica</i>	III	-	V	IV
<i>Crepis glabra</i>	-	I	IV	III
<i>Campylium stellatum</i>	I	I	III	-
<i>Dactylorhiza urvilleana</i>	-	II	IV	-
<i>Pinguicula vulgaris</i>	-	-	II	-
<i>Veratrum album</i>	-	I	III	-
<i>Geranium sylvaticum</i>	-	-	II	-
<i>Eleocharis quinqueflora</i>	-	-	II	-
<i>Scapania irrigua</i>	-	-	II	-
<b>D.sp. <i>Caricetalia fuscae, Caricion fuscae</i></b>				
<i>Carex echinata</i>	-	-	III	I
<i>Carex canescens</i>	II	-	-	II
<i>Epilobium palustre</i>	-	-	-	II
<i>Calliergon stramineum?</i>	-	I	-	-
<i>Sphagnum warnstorffii</i>	II	I	I	I
<i>Parnassia palustris</i>	III	-	II	-
<i>Rhizomnium pseudopunctatum</i>	I	-	-	I
<b>D.sp. <i>Scheuchzerietalia palustris, Caricion lasiocarpae, Caricetum rostratae</i></b>				
<i>Carex limosa</i>	-	-	I	V
<i>Carex rostrata</i>	-	-	-	V
<b>D.sp. <i>Scheuchzerio-Caricetea fuscae</i></b>				
<i>Carex nigra</i>	V	V	V	V
<i>Aulacomnium palustre</i>	IV	IV	III	III
<i>Bryum pseudotriquetrum</i>	III	III	II	I
<i>Eriophorum polystachyon</i>	I	-	I	III
<i>Sphagnum subsecundum</i>	I	-	II	I
<i>Warnstorffia exannulata</i>	I	-	I	II
<i>Fissidens adianthoides</i>	I	-	-	-
<i>Polytrichum commune</i>	-	I	-	-

**Table 5.1.** (continued)

	1	2	3	4
Other frequent species				
<i>Nardus stricta</i>	II	V	V	IV
<i>Primula auriculata</i>	I	IV	IV	III
<i>Cirsium simplex</i>	II	V	V	III
<i>Anthoxanthum odoratum</i>	-	V	V	II
<i>Briza marcowiczii</i>	I	V	IV	-
<i>Alchemilla vulgaris</i>	II	IV	II	I
<i>Luzula multiflora</i>	IV	V	IV	-
<i>Deschampsia caespitosa</i>	III	IV	II	II
<i>Pedicularis nordmanniana</i>	III	V	IV	II
<i>Euphrasia ossica</i>	II	IV	V	I

Syntaxa:

1 - *Caro caucasici-Caricetum nigrae salicetosum kazbekensis*; 2 - *C.c.-C.n. typicum*; 3 - *Swertio ibericae-Caricetum nigrae*; 4 - *Caricetum rostratae*.

As a rule, alpine fens have a thin peat layer (0.5-1m). We studied peat composition, succession dynamics and humus radiocarbon age of a fen near a small lake on Mt. Malaya Khatipara (PAVLOVA & ONIPCHENKO 1992). Radiocarbon age of the peat was estimated at 2480 and 1110 years for depth of 45-50 and 25-30 cm respectively. The calendar age should be considerably older due to addition of "young" carbon by the roots of modern plants. The botanical composition of the peat suggests that graminoids (especially *Carex nigra*) played the main role in peat formation from the beginning, with moss *Aulacomnium palustre* becoming a dominant more recently.

Alpine fens accumulate a significant soil (peat) seed bank (about 10 000 seeds per sq. m (SEMENOVA & ONIPCHENKO 1994). The most abundant species with permanent seed banks (about 1000 seed/m<sup>2</sup>) are: *Cerastium cerastioides*, *Luzula multiflora*, *Sagina saginoides*, *Alchemilla vulgaris* *aggr.*, *Cardamine uliginosa*.

In spite of hydromorphic conditions, alpine fens are relatively productive communities. Due to permanent water availability, rate of organic matter decomposition in fen soils is the highest among the communities of the alpine zone (LEINSOO *et al.* 1991).

Two associations can be distinguished according to the floristic and ecological features.

### 5.1.1. *Caro caucasici-Caricetum nigrae*

#### Floristic features

This association comprises the fens of the alpine zone. Common species of cold snowbeds (*Carum caasicum*, *Polygonum viviparum*, *Cerastium cerastioides*, *Sibbaldia procumbens*) form the diagnostic core of the association. *Carex nigra*, *Aulacomnium palustre* and *Nardus stricta* are the usual dominants. *Primula auriculata*, *Cirsium simplex*, *Deschampsia caespitosa* and *Pedicularis nordmanniana* play an important role in plant cover.

The association is similar to *Primulo auriculatae - Caricetum dacicae* AKATOV 1989 and to *Deschampsio-Caricetum dacicae* AKATOV 1989, which were described for the western Caucasus (AKATOV 1989). A distinctive floristic property of our association is that the role of snowbed species (*Cerastium cerastioides*, *Polygonum viviparum*, *Sibbaldia procumbens* etc.) as well as bryophytes (*Aulacomnium palustre*, *Brium pseudotriquetrum*) is much greater. These species are essentially absent in the associations described by AKATOV (1989).

The total number of species for 18 releves was 119, including 76 vascular plants, 41 bryophytes and 2 lichens. Average species richness per releve was 24, including 18 vascular plants and 6 bryophytes, so the species composition varies considerably among the communities. The role of bryophytes is important in terms of both species number and plant cover. Mean bryophyte cover is approximately the same as vascular plant cover (about 55%). The role of lichens is negligible.

Two subassociations can be separated on the basis of floristic differences, namely ***C.c.-C.n. typicum*** (typus, or nomenclature type, of the association - No. 128/90) and ***C.c.-C.n. salicetosum kazbekensis*** (typus, or nomenclature type, No. 33/89) (Table 5.2.). The role of grassland and snowbed species is higher in the typical subassociation.

#### Ecological features

The communities occupy flat (0-7°) areas near lakes and streams with poor drainage. Peat soils are typically saturated with water throughout the whole vegetative season. However, cold and oxygen-rich water often percolates through the soil horizontally, which prevents the upper part of the soil from

gleization. Due to their position at the bottoms of U-shaped mountain valleys, fens have a significant snowbank accumulation. Snow usually melts by the second half of June. The underground water table lies at about 3-10 cm. Although boulders cover only a small area within the communities (0-10%), the peat layer often contains some large stones.

The fens of the association can be found mainly within the alpine zone (elevation range 2350-2900 m, mean 2660 m).

### **5.1.2. *Swertia ibericae*-*Caricetum nigrae***

#### **Floristic features**

The association includes subalpine fens. The diagnostic set combines some typical species of moist soils (*Potentilla erecta*, *Swertia iberica*, *Dactylorhiza urvilleana*, *Campylium stellatum*, *Pinguicula vulgaris* etc.), as well as some species of *Mulgedio-Aconitetea* (*Veratrum album*, *Geranium sylvaticum*) class. Frequency of alpine grassland species (*Nardus stricta*, *Anthoxanthum odoratum*, *Luzula multiflora*) is high.

We registered 59 vascular plant species and 28 bryophytes in 10 relevés. Mean numbers of species per relevé were 21 and 5 correspondingly. There were no lichens found in the communities. In comparison with the previous association, vascular plant cover is better developed (50-90%, mean 70%), but moss cover is less dense (0-50%, mean 26%).

Typus, or nomenclature type, is relevé No. 71/93.

#### **Ecological features**

The fens of the association are typical of the subalpine zone within the elevation range of 1900-2600 m (mean 2340 m). They develop on slopes of varying exposure and steepness (from 0 to 30°). A permanently abundant, but stagnant, water supply is a necessary condition for the community development. They occupy local areas on alluvial fans near streams, on slopes with springs, as well as on flat floodplains at the bottom of U-shaped valleys. The underground water table can be found at 5-15 cm depth.

**Table 5.2.**  
*Caro caucasici-Caricetum nigrae*

Releve No.	0	0	0	0	0	1	1	0	1	0	0	0	0	1	1	0	0	0
	19	46	34	25	33	70	02	46	42	21	1	18	7	27	28	3	6	58
Year	88	94	91	91	89	94	94	93	90	83	89	83	88	90	90	86	88	93
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Altitude (* 10)	65	85	90	40	70	75	70	75	75	65	70	70	60	60	60	80	40	35
Steepness	3	0	0	0	0	7	0	3	0	5	3	0	0	0	0	0	3	0
Exposition	n	-	-	-	-	ne	-	e	-	n	ne	-	-	-	-	n	-	
Vascular plant cover	25	60	35	30	35	60	40	70	90	60	50	70	30	80	70	25	50	80
Bryophyte cover	90	15	90	40	60	60	80	40	10	50	60	50	90	40	60	70	70	10
Lichen cover	+	+	0	0	0	0	0	0	0	+	0	0	+	0	+	0	0	0
Stone cover	0	0	0	0	0	1	0	3	0	5	5	0	10	0	0	0	0	0
Lichen species number	1	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
Bryophyte species number	11	11	2	5	3	7	3	4	2	5	6	7	5	8	5	3	8	5
Vascular plant species number	17	14	12	11	13	13	19	22	19	26	21	19	22	22	25	16	21	20
D.sp. <i>C.c.-C.n. salicetosum kazbebensis</i>																		
<i>Salix kazbekensis</i>	1	+	2	1	2	3	2						1					
<i>Ligularia sibirica</i>				r	+		+											
<i>Saxifraga hirculus</i>	1				+													
D.sp. <i>C.c.-C.n. typicum</i>																		
<i>Agrostis vinealis</i>									1	+	1	1	1	1	+	+	1	1
<i>Phleum alpinum</i>		+				+			+	1	1	2	+	r	+	+	1	+
<i>Taraxacum stevevii</i>								+		+	+	+	+	+	+			1
<i>Epilobium anagalidifolium</i>														+	r			+
D.sp. <i>Caro caucasici-Caricetum nigrae</i>																		
<i>Carum caucasicum</i>		2	+		+		+	1	1	1	1	1	1	1	1	1	2	1
<i>Polygonum viviparum</i>	1	2	1	+	+	1	+		+		1	+			1	1		
<i>Cerastium cerastioides</i>	1		+				+		+		+	1	+	+	r	1	+	+
<i>Sibbaldia procumbens</i>		+						1	+		1	1	+		r	1		
D.sp. <i>Caricetalia fuscae, Caricion fuscae</i>																		
<i>Carex echinata</i>																		
<i>Carex canescens</i>				r	+													
<i>Epilobium palustre</i>																		
<i>Calliargon stramineum?</i>																		+
<i>Sphagnum wamstorffii</i>					1		1							2	2			
<i>Parnassia palustris</i>					r	+	+											
<i>Rhizomnium pseudopunctatum</i>							+											
D.sp. <i>Scheuchzerio-Caricetea fuscae</i>																		
<i>Carex nigra</i>	3	4	2	1	2	3	3		1		2	2	2	2	2	2	2	1
<i>Aulacomnium palustre</i>	3	1	5	+			4	3			3		4	2	3	4	2	2
<i>Bryum pseudotriquetrum</i>	1	1				+		+	1		1						+	+
<i>Eriophorum polystachyon</i>					2													
<i>Sphagnum subsecundum</i>					1													
<i>Warnstorfia exannulata</i>	+																	
<i>Fissidens adianthoides</i>						+												
Other species																		
<i>Alchemilla vulgaris</i>	1						1		1	+	2	1	+	1			1	1
<i>Anthoxanthum odoratum</i>								+	+	1	1			1	1	1	1	1
<i>Briza marcowiczii</i>						+		2	+	1	1	+	1	1	1		1	
<i>Campanula tridentata</i>								1		+			+					

Table 5.2. (continued)

Releve No.	0	0	0	0	0	1	1	0	1	0	0	0	1	1	0	0	0	
Year	88	94	91	91	89	94	94	93	90	83	89	83	88	90	90	86	88	93
<i>Campylium stellatum</i>	1													+				+
<i>Cardamine uliginosa</i>	1	1		+			+				+	1		r	+			
<i>Carex oreophila</i>		1						+										+
<i>Carex sempervirens</i>								+	2		+							1
<i>Cetraria islandica</i>	+	+								+					+			
<i>Cirsium simplex</i>						+	+	3	4	2	2	1	1	3	2		3	3
<i>Climacium dendroides</i>						+					1	2		+				
<i>Deschampsia caespitosa</i>	+	+	r			+				1	1	2		r	+		2	1
<i>Eriophorum vaginatum</i>			r	+			+											+
<i>Euphrasia ossica</i>	+				+			+	+	+	+			+	+		+	+
<i>Festuca ovina</i>				+	+	+				+								+
<i>Gentiana biebersteinii</i>					+					+								+
<i>Gentiana pyrenaica</i>			r					+	+	+		+	+	+	+	+	+	+
<i>Geranium gymnocaulon</i>								+	+					r				
<i>Luzula multiflora</i>	+	1	+			+	+	1	+	+	1	2	1	+	1	+	1	+
<i>Nardus stricta</i>			+			+		1	+	1	2	2	1	1	2	+	1	2
<i>Onchophorus virens</i>	2					+	3	+		2								
<i>Dactylorhiza urvilleana</i>														+	+		+	+
<i>Pedicularis nordmanniana</i>	+		r			+		1	+	1	1	+	1	+	+		1	
<i>Philonotis fontana</i>	1	1				4			1	2	1	1	+		+			
<i>Plagiomnium ellipticum</i>	1	+									1							
<i>Primula auriculata</i>						1		1		2	1	1	+	2	+		2	
<i>Ranunculus oreophilus</i>							+	+										1
<i>Sanionia uncinata</i>	1	+		3		+				1	2	1						
<i>Sphagnum capillifolium</i>			1		2											2	3	
<i>Swertia iberica</i>	+				+	+												
<i>Trifolium spadiceum</i>						+							1			2	1	

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

*Barbilophozia lycopodioides* (21/83:1, 18/83), *Betula litwinowii* (25/91:r), *Bryum caespiticium* (21/83:1), *Bryum cyclophyllum* (58/93), *Caltha polypetala* (19/88), *Carex atrata* (142/90:1, 21/83), *Carex pyrenaica* (127/90, 128/90), *Carum meifolium* (46/93), *Catabrosella variegata* (142/90), *Cephaloziella* sp. (58/93), *Cerastium purpurascens* (46/94, 6/88), *Cirsium ciliatum* (102/94), *Coeloglossum viride* (128/90:r), *Cratoneuron commutatum?* (19/88), *Cratoneuron filicinum* (127/90), *Crepis glabra* (58/93), *Deschampsia flexuosa* (128/90), *Desmatodon latifolius* (46/94, 46/93), *Drepanocladus fluitans?* (21/83:1), *Drepanocladus intermedius?* (25/91), *Empetrum nigrum* (7/88:1), *Festuca brunnescens* (46/93), *Gagea fistulosa* (46/93), *Gentiana septemfida* (21/83), *Geum rivale* (102/94:2), *Hedysarum caucasicum* (46/93, 21/83), *Hieracium macrolepis* (7/88), *Hyalopoa pontica* (19/88), *Juncus triglumis* (25/91:1), *Leontodon hispidus* (21/83), *Leptodictyum riparium?* (127/90, 128/90), *Lescurea saxicola* (18/83), *Ligusticum caucasicum* (19/88), *Lophozia* sp. (46/94), *Matricaria caucasica* (58/93), *Meesia uliginosa* (19/88:1, 33/89:2), *Minuartia imbricata* (21/83:1), *Palustriella commutata* (170/94:1), *Pedicularis condensata* (46/93, 127/90), *Pellia endiviifolia* (127/90, 6/88), *Poa alpina* (170/94, 21/83), *Pohlia nutans* (127/90), *Pohlia wahlenbergii* (46/94:1), *Polygonum bistorta* (46/94, 33/89), *Polytrichastrum alpinum* (46/94, 3/86), *Polytrichum commune* (7/88:1, 6/88), *Polytrichum juniperinum* (46/94), *Polytrichum longisetum* (128/90:1), *Potentilla crantzii* (142/90, 1/89:1), *Potentilla gelida* (102/94), *Primula algida* (46/94), *Primula ruprechtii* (19/88), *Pterigynandrum filiforme* (18/83), *Ranunculus brachylobus* (7/88), *Rhizomnium punctatum* (19/88), *Rhododendron caucasicum* (7/88, 6/88:1), *Rhytidium rugosum* (18/83), *Scapania* sp. (7/88, 6/88), *Sedum tenellum* (1/89), *Sphagnum russowii?* (6/88:2), *Stereocaulon alpinum* (7/88), *Vaccinium vitis-idaea* (102/94), *Valeriana alpestris* (33/89), *Veratrum album* (128/90:r, 58/93), *Veronica gentianoides* (19/88).

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

19/88 - 17.07, 9, Gidam; 46/94 - 11.07, 15, Kyshkadzher; 34/91 - 17.08, 25, Nazlalykol; 25/91 - 16.08, 25, Nazlalykol; 33/89 - 19.08, 25, Kyshkadzher (N.Lubeznova); 170/94 - 06.09, 15, Oriuchat; 102/94 - 21.07, 25, Goralykol; 46/93 - 12.08, 8, M.Khatipara; 142/90 - 17.08, 9, Khadzhibey; 21/83 - 24.08, 15, M.Khatipara; 1/89 - 04.08, 100, M. Khatipara; 18/83 - 24.08, 16, M.Khatipara; 7/88 - 31.07, 15, Ullu-Murudzhu; 127/90 - 16.08, 16, Bol.Khatipara; 128/90 - 16.08, 8, Bol.Khatipara; 3/86 - 09.08, 25, M.Khatipara; 6/88 - 31.07, 25, Ullu-Murudzhu; 58/93 - 16.08, 16, Baduk.

## 5.2. *Scheuchzerietalia palustris*

Communities of this order are not well represented in the reserve, because of existing relief features and the low concentration of nutrients in water. We treat several communities with significant role of *Carex rostrata* and *C. limosa* as part of the European association *Caricetum rostratae* OSVALD 1923 em DIERSSEN 1982 (*Caricion lasiocarpae*).

### Floristic features

Floristic composition of the communities resembles the previous association. The presence of *Carex rostrata* and *C. limosa* is the main diagnostic feature. The role of grassland species is low.

We registered 35 vascular plant species and 16 bryophytes in 6 relevés of the association. As in the previous association, there are no lichens in the communities. Mean floristic richness per releve is 17 species (including 4 bryophytes). This value is significantly lower than in other fens. Overall, the bryophyte cover (5-100%, mean 68%) is better developed than the vascular plant cover (20-75%, mean 47%).

AKATOV (1989) described a new association *Primulo auriculatae-Caricetum rostratea* for the Caucasian Reserve (the Western Caucasus). Their composition is very similar to our communities within *Caricetum rostratae*.

### Ecological features

These communities develop within the subalpine zone (2150-2450 m a.s.l., mean 2200 m). They occupy flat or very gentle (up to 5°) slopes with water saturated soils. The water table lies near the soil surface. Open water areas may be present within the communities. Poor drainage causes peat formation. Stones are completely absent from the surface.

The communities are widespread in the Western Caucasus (AKATOV 1991).

**Table 5.3.**

*Swertio ibericae-Caricetum nigrae, Caricetum rostratae*

Releve No.	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0
	42	92	13	67	71	04	22	52	50	39	10	12	19	20	43	23
Year	95	94	93	94	93	94	95	91	93	91	88	93	93	93	95	95
Altitude (* 10)	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2
	20	52	45	40	45	40	20	90	60	30	15	45	18	15	20	20
Steepness	5	2	0	20	15	30	2	1	5	5	0	0	0	0	5	0
Exposition	nw	nw	-	se	s	e	sw	nw	se	w	-	-	-	-	e	-
Vascular plant cover	80	70	55	60	80	50	60	90	70	70	40	20	30	45	70	75
Bryophyte cover	40	10	15	30	40	30	20	0	20	50	80	80	90	99	5	50
Stone cover	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Lichen spec.number	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryophyte spec. number	5	12	4	3	7	5	6	0	6	4	3	4	4	3	6	3
Vasc.pl.spec. number	13	16	16	27	29	23	17	25	25	18	15	14	13	16	12	9
<b>D.sp. Swertio ibericae-Caricetum nigrae</b>																
<i>Potentilla erecta</i>	+	+	1	1	2	+	2	2	1	2	2	+	+	1		
<i>Swertia iberica</i>	2	+	2	2	1	1	+	+	+	+	1	1	+	+		
<i>Crepis glabra</i>		+		+	2	+		+	+	2	1		1	1		
<i>Campylium stellatum</i>	+		+	2	+	+				1						
<i>Dactylorhiza urvilleana</i>	+		1	1	+	+	1		+							
<i>Pinguicula vulgaris</i>	+			+	+					+						
<i>Veratrum album</i>				+	+		+	r	+							
<i>Geranium sylvaticum</i>			+					+		1						
<i>Eleocharis quinqueflora</i>				+	+					+						
<i>Scapania irrigua</i>		+					+	2								
<b>D.sp. Caricetalia fuscae, Caricion fuscae</b>																
<i>Carex echinata</i>		+					+	+		+	2	+				
<i>Carex canescens</i>														1		2
<i>Epilobium palustre</i>															+	+
<i>Sphagnum wamstorffii</i>					1									3		
<i>Parnassia palustris</i>		+			+		+									
<i>Rhizomnium pseudopunctatum</i>																+
<b>D.sp. Scheuchzenetalia palustris, Caricion lasiocarpae, Caricetum rostratae</b>																
<i>Carex limosa</i>		+								+	+	+	1	+		+
<i>Carex rostrata</i>											2	1	2	2	2	3
<b>D.sp. Scheuchzerio-Caricetea fuscae</b>																
<i>Carex nigra</i>	4	2	1	2	2	3	2		1	1	1	1	1	1	3	2
<i>Aulacomnium palustre</i>			1	1		2		1	1	+	+	3	1			
<i>Bryum pseudotriquetrum</i>	+	+								1						+
<i>Eriophorum polystachyon</i>							+				1	1	2			
<i>Sphagnum subsecundum</i>	2						2	1								2
<i>Wamstorfia exannulata</i>	+	+													1	3
<b>Other species</b>																
<i>Alchemilla vulgaris</i>		+			+			+								+
<i>Anthoxanthum odoratum</i>			+	+	+	1	+	+	2	+	+			+	+	
<i>Briza marcowiczii</i>			1	+	+	+	+			+	+					
<i>Carex sempervirens</i>					2	1	+									
<i>Carex umbrosa</i>						+			1				+			

**Table 5.3.** (continued)

Releve No.	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	
Year	42	92	13	67	71	04	22	52	50	39	10	12	19	20	43	23
Year	95	94	93	94	93	94	95	91	93	91	88	93	93	93	95	95
<i>Carum caucasicum</i>				+	1				+							
<i>Cirsium simplex</i>	+	2	3	2	2	1	2	3	2	2		1	+	2		
<i>Deschampsia caespitosa</i>		+		+				+							+	+
<i>Eriophorum vaginatum</i>									2		1	1		+		
<i>Euphrasia ossica</i>		+	r	+	+	+	+	+	+	+				+		
<i>Gentiana pyrenaica</i>				1	+	+			+	+	+	+	+	1		
<i>Gentiana septemfida</i>							+	+	+							
<i>Helictotrichon versicolor</i>				+	r					r						
<i>Hypnum lindbergii</i>	2				+	2										
<i>Ligularia sibirica</i>									+	+					1	
<i>Luzula multiflora</i>		+	+	+	+		1	r	+							
<i>Nardus stricta</i>	1	2	2	1	2	1	1	1	2	2	2	1	1	1		
<i>Pedicularis condensata</i>				+	r	+										
<i>Pedicularis nordmanniana</i>		+	1	+	+	+			+	+	1	+				
<i>Primula auriculata</i>	2	+	2	2	1	1			1	1	2	+			1	
<i>Ranunculus oreophilus</i>		+	+	+	+									1		
<i>Ranunculus subtilis</i>						1		1								+
<i>Sphagnum capillifolium</i>										3	4	2		3		
<i>Sphagnum platyphyllum?</i>	1									2		2	3			
<i>Taraxacum stevevii</i>			+									+		+		
<i>Trifolium spadiceum</i>	1						+	+		1						

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

*Acer trautvetteri* (42/95), *Agrostis vinealis* (192/94, 52/91:1), *Astrantia maxima* (22/95), *Barbilophozia barbata* (39/91), *Betula litwinowii* (10/88, 12/93), *Blindia acuta* (204/94), *Blysmus compressus* (50/93), *Brachythecium rivulare* (192/94, 43/95), *Bryum pallens* (71/93), *Cardamine uliginosa* (43/95, 23/95), *Carex pallescens* (204/94, 52/91), *Centaurea salicifolia* (52/91), *Cephaloziella* sp. (192/94), *Chiloscyphus pallescens* (192/94), *Climacium dendroides* (22/95:2, 50/93:1), *Cratoneuron filicinum* (43/95), *Daphne glomerata* (67/94), *Dicranum bonjeanii* (71/93, 50/93), *Festuca brunnescens* (20/93), *Festuca gigantea* (43/95), *Festuca ovina* (71/93:1), *Filipendula ulmaria* (52:91), *Gentiana biebersteinii* (52/91:r), *Geranium renardii* (71/93:r), *Juncus alpigenus* (204/94), *Juncus articulatus* (50/93), *Juncus effusus* (52/91), *Lophozia* sp. (67/94:1), *Molinia caerulea* (204/94:2, 52/91:r), *Palustriella commutata* (67/94:1), *Pellia* sp. (43/95), *Philonotis fontana* (192/94), *Plagiomnium ellipticum* (22/95, 23/95:1), *Polytrichum formosum* (19/93), *Potentilla crantzii* (10/88), *Ranunculus caucasicus* (67/94), *Rhinanthus minor* (71/93, 52/91:1), *Rhizomnium punctatum* (192/94), *Rhododendron caucasicum* (204/94, 50/93), *Rhynchocorys elephas* (43/95), *Rhytidadelphus triquetrus* (22/95), *Salix pantosericea* (43/95), *Scapania* sp. (71/93, 50/93:1), *Selaginella selaginoides* (71/93, 204/94), *Sphagnum centrale* (13/93:1, 10/88:2), *Sphagnum girgensohnii* (192/94:1, 20/93:1), *Sphagnum quinquefarium?* (12/93:2, 19/93:3), *Sphagnum squarrosum* (192/94:1, 13/93:1), *Stellaria anagalloides* (23/95), *Stellaria persica* (23/95), *Thalictrum minus* (52/91), *Trollius ranunculinus* (67/94, 71/93), *Vicia cracca* (22/95:1, 52/91), *Vicia sepium* (43/95), *Viola canina* (52/91).

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

42/95 - 07.07, 25, Buul'gen; 192/94 - 10.09, 25, Kichi-Murudzhu; 13/93 - 08.07, 25, Ullu-Murudzhu (L.Rasran); 67/94 - 16.07, 15, Bol.Khatipara; 71/93 - 17.08, 16, Baduk; 204/94 - 11.09, 25, Klukhor; 22/95 - 04.07, 25, Alibek; 52/91 - 31.08, 25, Dombay-Ulgen; 50/93 - 10.08, 10, M.Khatipara; 39/91 - 18.08, 25, Ullu-Murudzhu; 10/88 - 31.07, 25, Ullu-Murudzhu; 12/93 - 08.07, 25, Ullu-Murudzhu (S.Sukhov); 19/93 - 08.07, 25, Ullu-Murudzhu (D.Sukhova); 20/93 - 08.07, 25, Ullu-Murudzhu (E.Kuraeva); 43/95 - 07.07, 25, Buul'gen; 23/95 - 04.07, 25, Alibek.

## 6. Cold water springs -*Montio-Cardaminetea*

Prodromus

*Montio-Cardaminetea* BRAUN-BLANQUET & TÜXEN ex KLIKA & HADAC 1944 em  
ZECHMEISTER 1993

*Montio-Cardaminetalia* PAWLOWSKI 1928 em ZECHMEISTER 1993

*Cardamino-Montion* BRAUN-BLANQUET 1926 em ZECHMEISTER 1993

*Cerastio cerastioidis-Cardaminetum uliginosi* ass.nov.

*Cerastio cerastioidis-Cardaminetum uliginosi*

### Floristic features

These moss-rich communities have a well-represented set of diagnostic species of higher syntaxa (*Montio-Cardaminetea*, *Montio-Cardaminetalia*, *Cardamino-Montion*, see ZECHMEISTER 1993). *Philonotis fontana*, *Palustriella commutata*, *Bryum pseudotriquetrum*, *B. schleicheri* and *Brachythecium rivulare* are the most common (Table 6.1.).

Regional specificity of this community type depends on the vascular plants. All diagnostic species of the association (*Cardamine uliginosa* s.l., *Epilobium algidum*, *Cerastium cerastioides*, *Hyalopoa pontica*, and *Saxifraga sibirica*) are typical species of cold and moist habitats.

Typus, or nomenclature type, is the releve No. 96/95.

KOROTKOV (1990) described a similar association (*Primulo auriculatae-Cardaminetum raphanifoliae* Korotkov 1990) from the Adylsu valley (the Central Caucasus). He placed the association within the union *Cratoneurion commutati*. The communities of this alliance are typical of water with high (basic) pH (ELLENBERG 1988, POTT 1995). Our association significantly differs in both ecological (acidic water) and floristic features (presence of *Cerastium cerastioides*, *Hyalopoa pontica*, *Bryum schleicheri*, high frequency of *Philonotis fontana* and low frequency of *Primula auriculata*) from Korotkov's syntaxon.

We registered 33 vascular plant species, 25 bryophytes and 1 macrolichen (*Dermatocarpon* sp.) in the eleven releves of our association. The mean floristic richness per releve is very low (8 vascular plants and 5 bryophytes). The ratio vascular plants/(bryophytes + lichens) is the lowest among all the

**Table 6.1.**

*Montio-Cardaminetea*

Releve No.	185	54	79	20	211	96	167	135	131	56	121	
Year	94	94	94	88	94	95	94	95	94	94	94	
Altitude (* 10)	285	283	240	260	275	290	268	285	295	283	245	
Steepness	10	2	5	2	10	7	5	5	2	2	5	
Exposition	w	nw	n	ne	e	sw	nnw	ne	wnw	nw	ne	
Vascular plant cover	25	10	60	30	20	10	20	20	50	10	40	
Bryophyte cover	40	60	50	40	15	60	70	70	60	70	40	
Lichen cover	0	0	0	0	+	0	0	0	0	0	0	
Stone cover	20	0	20	10	60	25	15	5	5	5	+	
<i>D.sp. Cerastio cerastioidis-Cardaminetum uliginosa</i>												
<i>Cardamine uliginosa</i>	1	2	3	3	2	1	2		3	1	3	V
<i>Cerastium cerastioides</i>	+	+	+	1	+	1	+	+	1	1	+	V
<i>Epilobium algidum</i>	1	+	+		1	+	1	2				IV
<i>Hyalopoa pontica</i>	1		1	1	+	1		1	1		+	IV
<i>Saxifraga sibirica</i>	+		+			+		1		+		III
<i>D.sp. Montio-Cardaminetea, Montio-Cardaminetalia, Cardamino-Montion</i>												
<i>Philonotis fontana</i>	3	3	1		2	2	1	+	1	3		V
<i>Bryum pseudotriquetrum</i>		1		2			1	+	2	+	+	IV
<i>Palustriella commutata</i>	1	1			1	1	2		2	3	+	IV
<i>Bryum schleicheri</i>			1			3	3	4			2	III
<i>Brachythecium rivulare</i>	1		2	2	+			+			+	III
<i>Cratoneuron filicinum</i>			1	2								I
<i>Scapania uliginosa</i>	1											I
<i>Wamstorfia exannulata</i>		1										I
Other species												
<i>Alopecurus ponticus</i>			1		+			1				II
<i>Carex nigra</i>		+								+	+	II
<i>Cirsium simplex</i>	+	+	+			+						II
<i>Deschampsia caespitosa</i>		+		1			1		+	1	+	III
<i>Primula auriculata</i>	2				+		+					II
<i>Taraxacum stevevii</i>						+		+	+			II

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

*Agrostis stolonifera* (185/94:1, 211/94), *Agrostis vinealis* (167/94, 121/94), *Alchemilla vulgaris* (79/94:2, 167/94), *Bryum weigeli* (79/94), *Carex atrata* (185/94, 56/94), *Carex canescens* (121/94), *Carex oligantha* (131/94), *Cephalozia sp.* (185/94), *Cerastium polymorphum* (121/94), *Chyloscyphus sp.* (79/94:1), *Climacium dendroides* (121/94), *Ctenidium molluscum* (135/95), *Dermatocarpon sp.* (211/94), *Drepanocladus aduncus* (131/94:3), *Erigeron caucasicus* (79/94), *Fontinalis antipyretica* (121/94:1), *Gagea fistulosa* (96/95), *Geranium gymnocaulon* (79/94), *Gnaphalium supinum* (135/95), *Hypnum lindbergii* (79/94), *Juncus triglumis* (131/94), *Luzula multiflora* (185/94), *Matricaria caucasicus* (211/94), *Meesia longiseta* (56/94), *Onchophorus virens* (96/95:1, 131/94), *Pellia sp.* (185/94, 79/94:1), *Poa alpina* (54/94, 56/94), *Poa longifolia* (54/94), *Pohlia ludwigii* (185/94), *Pseudoleskea incurvata* (79/94:2, 211/94), *Racomitrium macounii* (185/94), *Ranunculus brachylobus* (211/94), *Ranunculus caucasicus* (54/94, 79/94), *Rhizomnium punctatum* (135/94), *Rumex alpestris* (79/94), *Rumex alpinus* (79/94:1, 211/94), *Salix kazbekensis* (56/94), *Scapania sp.* (135/95), *Tortula ruralis* (211/94), *Veronica beccabunga* (54/94:1).

Date (day.month), size (sq.m) and location of the releves (all releves were made by V.Onipchenko, unless other author is noted).

185/94 - 09.09, 12, Kichi-Murudzhu; 54/94 - 12.07, 8, Kyshtkadzher; 79/94 - 16.07, 9, Bol.Khatipara; 20/88 - 17.08, 9, Gidam; 211/94 - 12.09, 10, Klukhor; 96/95 - 25.07, 15, Khadzhybey; 167/94 - 06.09, 16, Nazalykol; 135/95 - 30.08, 10, Ullu-Murudzhu; 131/94 - 30.07, 20, Mukhu; 56/94 - 12.07, 10, Kyshtkadzher; 121/94 - 29.07, 15, Mukhu.

associations of the reserve (1.3). The role of bryophytes is especially significant in terms of their cover, which ranges between 15 and 70% (mean 52%). Vascular plant cover is considerably lower (10-60%, mean 27%).

### **Ecological features**

The communities develop along cold (snowmelt) streams and springs in the alpine zone within the elevation range of 2400-2950 m (mean 2750 m). They occupy both boulders, and the spaces in between. Moss cover and roots of plants are submerged in running water during all or most of the vegetative season. Long narrow stripes of the communities are typical on rather gentle (2-10°, mean 5°) slopes of different aspect. The existence of a more or less permanent source of water (snowbeds, glaciers) in the upper part of the slopes is a necessary condition for the development of these communities.

## 7. *Kobresia* grasslands -***Carici rupestris-Kobresietea bellardii***

Prodromus

*Carici rupestris-Kobresietea bellardii* OHBA 1974

*Oxytropido-Kobresietalia* OBERDORFER ex ALBRECHT 1969

*Oxytropido-Elyinion* BRAUN-BLANQUET 1949

*Drabo scabri-Kobresietum schoenoidis* ass.nov.

*Alchemillo-Kobresietum capilliformis* TSEPKOVA 1987.

This is a circumpolar class of cold steppe-type grasslands, developing on windward crests and slopes (OBERDORFER 1978, GRABHERR 1993a). Species of *Kobresia* are common dominants of the communities. The class is not well represented in the Northwestern Caucasus due to mild winters and high precipitation. We suggest two associations within the alliance *Oxytropido-Elyinion*, order *Oxytropido-Kobresietalia*. *Lloydia serotina*, *Polygonum viviparum*, *Potentilla crantzii*, *P. gelida*, *Aster alpinus* and *Oxytropis kubanensis* (vicarious species of *O. campestris*) represent the diagnostic species set of the syntaxa (Table 7.1.). The communities have a considerable floristic similarity with the communities of *Anemonion speciosae* (*Juncetea trifidi*, see below), but we consider the *Kobresia*-communities in a separate class according to European tradition (GRABHERR 1993a).

### 7.1. *Drabo scabri-Kobresietum schoenoidis*

#### Floristic features

Diagnostic species of the association are represented by *Kobresia schoenoides* (dominant), *Draba scabra*, *Polygonum bistorta*, *Pedicularis caucasica*. Significant abundance is recorded also for *Campanula tridentata*, *Festuca ovina*, *Cetraria islandica*. Overall species richness is high. We found 70 vascular plant species, 30 bryophytes and 13 macrolichens in 9 relevés of the association (Table 7.1.). Mean species number per relevé was 25, 5, and 6 species respectively. The ratio vascular plants / (bryophytes + lichens) is low due to high diversity of mosses and lichens. Vascular plant cover ranges between 20% and 70% (mean 40%), lichen cover ranges between 5 and 50% (mean 21%). Thus, the role of fruticose lichens is also prominent in terms of plant cover. The most common lichens are *Cetraria islandica*, *C. cucullata*, *C. nivalis*, *Cladonia pyxidata*, *C. mitis* and *Thamnolia vermicularis*. Typus (nomenclature type) is relevé No. 163/94.

Table 7.1.

*Carici rupestris-Kobresietea*

Releve No.	1	0	0	1	1	1	0	0	1	0	1	1	0	1	1	1	1
Year	24	59	60	54	55	63	57	23	26	32	48	72	55	22	24	25	27
	94	94	94	94	94	94	83	88	90	91	94	94	94	95	95	95	95
Altitude (* 10)	2	2	3	2	3	2	3	3	3	2	2	2	2	2	2	2	2
	58	80	00	90	00	90	10	00	00"	70	65	62	70	40	45	50	75
Steepness	25	5	32	5	30	25	15	10	5	15	25	5	2	5	10	10	10
Exposition	nw	nw	sw	sw	sw	nw	w	n	se	ne	sw	e	nw	ne	w	n	ne
Vascular plant cover	50	70	40	60	40	30	20	30	20	30	30	40	70	40	80	60	60
Bryophyte cover	5	1	20	30	1	5	1	5	0	10	5	5	1	40	10	10	10
Lichen cover	30	5	5	10	15	30	30	50	10	30	20	50	20	15	5	30	30
Lichen species number	8	3	7	4	8	6	7	7	6	8	9	8	3	6	5	5	7
Bryophytes number	14	2	2	6	2	11	1	3	0	1	4	7	2	3	7	7	2
Vascular plant number	24	32	26	15	37	28	24	16	19	24	30	33	44	25	25	32	19
Stone cover	0	5	5	0	30	15	50	15	80	5	10	1	3	3	1	0	20
Bare soil	20	3	10	0	5	1	0	0	0	0	2	0	1	1	1	0	1

D.sp. *Drabo scabri-Kobresietum schoenoidis*

<i>Kobresia schoenoides</i>	+	2	3	3	2	2	2	2	2	V				+	+			II
<i>Draba scabra</i>	+	+		+		1	+	1	1	IV								-
<i>Polygonum bistorta</i>			1	+	+	+		+		III								-
<i>Pedicularis caucasica</i>		+				+	+	+	+	III								-

D.sp. *Alchemillo-Kobresietum capilliformis*

<i>Kobresia capilliformis</i>										-	2	2	3	3	3	3	3	V	
<i>Vaccinium vitis-idaea</i>	+				1	1				II	1	1	2	1	1	3	+	1	V
<i>Rhizidium rugosum</i>	1			2			+			II	2	1	1	+	3	2	2	2	V
<i>Carex caryophyllea</i>										-			+	1	+	+	+	IV	
<i>Antennaria dioica</i>					+					I		+	1	+	1		+	IV	
<i>Hypnum cupressiforme</i>										-	+				+	+	+	III	
<i>Bromopsis variegata</i>				2	1					II	1	+	+	+	+	1	+	IV	
<i>Primula ruprechtii</i>		+	+		1	+				III	+	+	+	+	+	1	1	IV	
<i>Valeriana alpestris</i>	1				1	1				II				+				I	

D.sp. *Carici rupestris-Kobresietea bellardii*,

*Oxytropido-Kobresietalia, Oxytropido-Elynyon*

<i>Lloydia serotina</i>		+			+	+				II	+	+		+		+		III
<i>Polygonum viviparum</i>	1	+								II	+	+	+	+		+	1	IV
<i>Potentilla gelida</i>	+	+	+	2	+	+	+	+		V				+		+		II
<i>Potentilla crantzii</i>										-					+			I
<i>Oxytropis kubanensis</i>							1			I				+				I
<i>Aster alpinus</i>					+			+		II		+	+					II

Other species

<i>Abietinella abietina</i>				1						I			+	+		+		II	
<i>Agrostis vinealis</i>	+									I		+	+			+		II	
<i>Alchemilla caucasica</i>	2	+	+		+	1	1			IV	+	+	+	+	+	+		IV	
<i>Alopecurus glacialis</i>					+		+	1		II								-	
<i>Anemone speciosa</i>		1	+		1	+	+	2	+	IV	1	1	1	+	2	1	1	2	V
<i>Arenaria lychnidea</i>			+		+	1	1		+	III	1	1	+	+			+	III	
<i>Astragalus levieri</i>			1				1	1		II	1						2	II	
<i>Campanula collina</i>	+				+					II		1	+		+	1		III	
<i>Campanula tridentata</i>		1	2	+	2	2	1	2	1	V	1	+	1	+	+		+	1	V
<i>Carex sempervirens</i>	2	+	1		1	1	2	1		IV	1		1	+			+	1	IV
<i>Carex umbrosa</i>	1	2		1		1		1		III	1					+	1	1	III

Table 7.1. (continued)

Releve No.	1	0	0	1	1	1	0	0	1	0	1	1	0	1	1	1	1		
	24	59	60	54	55	63	57	23	26	32	48	72	55	22	24	25	27		
Year	94	94	94	94	94	94	83	88	90	91	94	94	94	95	95	95	95		
<i>Carum caucasicum</i>	+	+	+		1	1	+	1	+	V	1		+	+	+		+	+	IV
<i>Cephalozia sp.</i>	+									II						+			I
<i>Cerastium purpurascens</i>		+						+	+	II									-
<i>Cetraria cucullata</i>	+		+		1		1	1	1	IV	1	+	+			+	+	1	IV
<i>Cetraria islandica</i>	2	+	1	1	2	2	2	4	1	V	2	2	2	2	2	1	2	2	V
<i>Cetraria nivalis</i>			+		1	+	1	+	1	IV	1	+	+	+			+	1	IV
<i>Cladonia furcata</i>										-		+			+			+	II
<i>Cladonia gracilis</i>	+				+	+		+		III	1	+	+						II
<i>Cladonia mitis</i>	+	+		1	1	2		1		IV	1	2	3		2	+		2	IV
<i>Cladonia pyxidata</i>		+	+	1	+	+	+	1	+	V	1		+		+	+	2	+	IV
<i>Cladonia rangiferina</i>										-		+	1				+		II
<i>Comicularia muricata</i>				+	+					II	+				+				II
<i>Dactylina madreporiformis</i>				+				+	+	II									-
<i>Dicranum spadicum</i>	1	1		+		+		1		III			+			+			II
<i>Erigeron alpinus</i>		+			+					II		+	+	+					II
<i>Eritrichium caucasicum</i>		+				+		+	+	III	+			+			+	+	III
<i>Euphrasia ossica</i>	+		+		+	+				III	+	+	+		+		+	+	IV
<i>Eurhynchium pulchellum</i>	+				+					II		+							I
<i>Festuca ovina</i>	2	1	1	1	1	1	2	1	+	V	1	1	1	1	+	+	1	1	V
<i>Festuca varia</i>				1						I			+			1			II
<i>Fritillaria lutea</i>		+								I	+			+	+				II
<i>Gentiana biebersteinii</i>										-		+	+			+			II
<i>Gentiana pyrenaica</i>	+	+	+	+	+	+		+		IV	+	+	+	+		+	+	+	V
<i>Gentiana septemfida</i>				+	+					II	+	+		+	+	+	+		IV
<i>Hedysarum caucasicum</i>		1								I			+			+			II
<i>Helictotrichon versicolor</i>	+	+	+	1	1	+				IV	+	+	1	+	1	+	+	+	V
<i>Juniperus communis</i>										-		+	+		+				II
<i>Luzula spicata</i>	+	+	+	+	+		+	+	+	V				+	+	+	+		III
<i>Minuartia circassica</i>		+	+		1		1		+	III	+	+	+	+			+	+	IV
<i>Myosotis alpestris</i>				+	+	+	+			III			+	+	+	+	+		IV
<i>Pedicularis comosa</i>	+	+			+	+	+	+	+	IV	+	+	+	+	+			+	IV
<i>Peltigera rufescens</i>	+									I				+	+				II
<i>Polytrichastrum alpinum</i>	+					+				II					+				I
<i>Ranunculus oreophilus</i>					+		+			II		+	+			+	+		III
<i>Silene saxatilis</i>		+				+	+			II					+				I
<i>Taraxacum porphyranthum</i>	+	1								II			+						I
<i>Taraxacum stevenii</i>					+	+		+	+	III			+	+	+	+	+		IV
<i>Thamnolia vermicularis</i>	+		+	+	1	1	1	1	1	V	1	1	2	+				2	IV
<i>Trifolium polyphyllum</i>		+								I		+	+						II
<i>Veronica gentianoides</i>		+	+		+	+		+		III	+	+	+		+	+	+	+	V
<i>Viola altaica</i>		+		+	1	+				III			+	+			+		II

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

*Aetheopappus caucasicus* (155/94), *Anthemis cretica* (163/94), *Anthemis marshalliana* (172/94, 55/94), *Anthoxanthum odoratum* (155/94), *Anthyllis vulneraria* (155/94), *Astragalus* sp. 124/94, *Bartramia ithyphylla* (60/94:2), *Blepharostoma trichophyllum* (163/94), *Bryum caespiticium* (172/94), *Bryum* sp. (154/94), *Bryum subelegans* (125/95), *Bupleurum falcatum* (55/94), *Campanula ciliata* (57/83, 55/94), *Campanula saxifraga* (55/94), *Campylopus schimperi* (163/94), *Carex humilis* (148/94:1), *Cerastium cerastioides* (59/94), *Ceratodon purpureus* (124/95), *Cetraria laevigata* (57/83:2), *Chamaesciadium acaule* (148/94, 127/95), *Cladonia uncialis* (148/94), *Climacium dendroides* (124/94), *Dicranum congestum* (125/95), *Didymodon fallax* (154/94), *Distichium capillaceum* (124/94), *Ditrichum flexicaule* (163/94), *Doronicum oblongifolium* (124/95, 125/95:1), *Draba hispida* (124/94), *Empetrum nigrum* (32/91, 125/95), *Festuca brunnescens* (163/94:1), *Galium verum* (124/94, 55/94), *Gentiana verna* (59/94, 60/94), *Gypsophila tenuifolia* (127/95), *Helianthemum nummularium* (124/95), *Hylocomium splendens* (125/95), *Hypnum revolutum* (59/94, 163/94:1), *Isopterygiopsis pulchella* 124/94, *Jungermannia* sp. (23/88), *Lophozia* sp. (163/94), *Meesia uliginosa* (163/94), *Minuartia recurva* (155/94), *Mnium hornum* (124/94), *Pedicularis condensata* (155/94, 163/94), *Pedicularis crassirostris* (59/94), *Pedicularis nordmanniana* (60/94, 55/94), *Peltigera aphthosa* (124/94), *Plagiochila porelloides* (124/94), *Plantago atrata* (148/94), *Pleurozium schreberi* (172/94, 125/95), *Poa longifolia* (55/94), *Pohlia cruda* (124/94, 155/94), *Pohlia nutans* 60/94:2), *Polytrichum juniperinum* (23/88, 127/95), *Primula algida* (60/94), *Ptilidium ciliare* (172/94), *Ptilidium pulcherrimum* (125/95), *Rhodobryum roseum* (172/94), *Rhytidadelphus triquetrus* (124/94), *Rumex alpestris* (125/95), *Salix kazbekensis* (124/94:2, 32/91), *Sanionia uncinata* (124/95), *Saxifraga flagellaris* (60/94, 57/83), *Scabiosa caucasica* (172/94), *Scapania* sp. (163/94), *Sedum tenellum* (126/90, 55/94), *Selaginella selaginoides* (163/94), *Senecio aurantiacus* (155/94), *Silene lychnidea* (122/95, 125/95), *Solorina saccata* (124/94), *Taraxacum confusum* (60/94, 55/94), *Thalictrum alpinum* (124/94:1), *Tortella tortuosa* (163/94, 124/95), *Tortula ruralis* (154/94:2), *Vaccinium myrtillus* (55/94), *Weissia* sp. (148/94), *Weissia wimmeriana* (124/94).

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

124/94 - 30.07, 16, Mukhu; 59/94 - 12.07, 16, Kyshtkadzher; 60/94 - 12.07, 9, Kyshtkadzher (D.Sukhova); 154/94 - 05.09, 16, Oriuchat; 155/94 - 05.09, 16, Oriuchat; 163/94 - 06.09, 16, Nazalykol; 57/83 - 10.09, 25, Kynyr-Chat; 23/88 - 18.08, 25, Gidam; 126/90 - 16.08, 25, Bol.Khatipara; 32/91 - 17.08, 12, Nazalykol; 148/94 - 04.09, 16, Oriuchat; 172/94 - 07.09, 25, Oriuchat; 55/94 - 12.07, 16, Kyshtkadzher; 122/95 - 29.08, 16, Nazalykol; 124/95 - 29.08, 15, Nazalykol; 125/95 - 29.08, 16, Nazalykol; 127/95 - 29.08, 16, Nazalykol.

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## Ecological features

These communities typically develop in the upper part of the alpine zone at elevations of 2580-3100 m (mean 2920 m). They occupy windward ridgetops and slopes of various aspect and steepness (5° - 32°, mean 18°). Plant productivity is limited by severe ecological conditions, namely deep winter freezing, frequent summer droughts, shallow soil profile, and great day-night temperature fluctuations. Boulders and bare soil may take up a considerable percentage of space in the communities.

### 7.2. *Alchemillo-Kobresietum capilliformis*

#### Floristic features

The association was described by TSEPKOVA (1987) from the Central Caucasus. She considered the syntaxon within the new class, alliance and order (*Carici buschiori - Bromopsietea variegatae*, *Kobresietalia capilliformis*,

*Kobresion capilliformis*). We do not share this view and consider the association within European syntaxa.

The main floristic feature of the association is the dominance of *Kobresia capilliformis* (Table 7.1.). Diagnostic species of the association include species of cold and dry habitats (*Vaccinium vitis-idaea*, *Rhytidium rugosum*, *Carex caryophyllea*, *Antennaria dioica*, *Hypnum cupressiforme*, *Bromopsis variegata*). Lichens (*Cetraria* spp., *Cladonia mitis*, *Thamnolia vermicularis*) are well represented.

Eurytopic alpine species (*Campanula tridentata*, *Festuca ovina*, *Carum caucasicum*), as well as species of *Anemonion speciosae* (*Anemone speciosa*, *Luzula spicata*, *Helictotrichon versicolor*) are also very common in the association.

Floristic richness of the communities is high and resembles that of the previous association. There were 68 vascular plant species, 19 bryophytes and 12 lichens found in 8 relevés (Table 7.1.). Average values per releve are 29, 4 and 6 species respectively.

Vascular plant cover ranges between 30% and 80% (mean 51%), while the values of bryophyte and lichen cover are 1-40% (11%) and 5-50% (25%) respectively.

### **Ecological features**

These communities are not common in the Reserve, occurring only in its northeastern part (Nazalykol, Goralykol, and Kyshkadzher). They are typically found on the alluvial fans and moraine debris at the bottom of U-shaped alpine valleys. Overall, they occupy more gentle (2-25°, mean 10°) and less stony (0-20%, mean 5%) slopes of northern aspect, when compared with the previous association. The elevation ranges between 2400 and 2750 m (mean 2600 m).

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

**Table 8.1.** (continued)

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

Synonym: *Pediculari chroorrhynchae-Eritrichietum caucasicum* 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*, *Rhizidium 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. <i>Campanulo ciliatae-Chamaesciadietum acaulis</i>									
<i>Anthyllis vulneraria</i>	1	2	1	1	1	1	1	1	1
<i>Dactylina madreporiformis</i>	+	+	1	+	+	+	+	+	
<i>Chamaescadium acaule</i>	+	+	1	+	1	+	1	1	+
<i>Primula algida</i>	+		+	+	+	+	+	+	+
<i>Pulsatilla albana</i>	+	1	+		+	+	+	1	+
<i>Aetheopappus caucasicus</i>	1	1	+	+	1	+	1	1	
<i>Campanula ciliata</i>	+	+	+	1	1	1			+
<i>Gentiana aquatica</i>	+	+	+		+	+	+	+	
<i>Thymus nummularius</i>	+	+		+	1				+
<i>Jurinella moschus</i>		+		+	1		1	+	
<i>Campanula saxifraga</i>	+			+	1				
D.sp. <i>Anemonion speciosae</i>									
<i>Arenaria lychnidea</i>	+	1	1	1	1	1	1	1	+
<i>Carex sempervirens</i>	1		1	1	1	1	2	1	1
<i>Carex umbrosa</i>	+	+			1		+	1	1
<i>Eritrichium caucasicum</i>	+	+	+	+	+	+	+		+
<i>Minuartia circassica</i>		1	1	1	1	1	+		1
<i>Anemone speciosa</i>	1	1	+	+	+	1		1	+
<i>Pedicularis comosa</i>	1	1	+	+	+	+	+	+	+
<i>Thamnolia vermicularis</i>	+	1	1	+		1	1	1	1
<i>Cetraria nivalis</i>	+	+	1	+	+	1	+	1	
<i>Cetraria cucullata</i>	+	+	1	+	+	1		1	+
D.sp. <i>Caricetalia curvulae, Juncetea trifidi</i>									
<i>Trifolium polyphyllum</i>	+		1			1		1	1
<i>Euphrasia ossica</i>	+	+		+	+		1	+	+
<i>Luzula spicata</i>	+			1		+	+		+
<i>Helictotrichon versicolor</i>	1	+	1	+	+	+	+		+
<i>Minuartia recurva</i>	+				+		+		+
Other species									
<i>Alchemilla caucasica</i>		1	1		1		1	1	2
<i>Antennaria dioica</i>	1	+	1	+		+			2
<i>Anthemis marshalliana</i>	1	+	1	+	+	+	1	+	+
<i>Aster alpinus</i>	1	1	1	+	1	+	+	+	+
<i>Astragalus levieri</i>	+	+						+	
<i>Bromopsis variegata (dom.)</i>	1	2	1	+	1		1	2	1
<i>Campanula collina</i>	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
<i>Campanula tridentata</i>			1	+	+	1	1	+	1
<i>Carum caucasicum</i>	+			+		+			
<i>Cetraria islandica</i>	1	1	1	1	+	1	+	1	1
<i>Cetraria laevigata</i>	+	+	2	+	+	1			1
<i>Cladonia gracilis</i>		+	1				+	1	+
<i>Cladonia mitis</i>			+			1		1	1
<i>Cladonia pyxidata</i>	1	+	+	+	1	1	1	1	+
<i>Erigeron alpinus</i>	+	+	+	+	+	+	+	1	
<i>Festuca ovina</i>	1	1	1	1	+	1	1	1	1
<i>Gentiana biebersteinii</i>	+	+	+	+	+	+	+	+	+
<i>Gentiana septemfida</i>		+			+	+	+	1	
<i>Gentiana verna</i>	+					+	+	+	+
<i>Lloydia serotina</i>	+			+	+				
<i>Myosotis alpestris</i>	+	+			+			+	
<i>Oxytropis kubanensis</i>	1		1			1		1	
<i>Plantago atrata</i>		1						1	+
<i>Polygonum bistorta</i>	1	1	+	+	+	+	+	+	
<i>Polytrichum juniperinum</i>	+					+			+
<i>Potentilla gelida</i>	1			+		+		+	
<i>Potentilla nivea</i>		+	+					+	
<i>Primula ruprechtii</i>	+	+							+
<i>Ranunculus oreophilus</i>	+	1		+	+		+	+	
<i>Vaccinium vitis-idaea</i>	2			1		1			1
<i>Veronica gentianoides</i>	1	1	+	+	+	+	1	1	+

Sporadic species (number of releve in parenthesis, abundance are shown 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), *Comicularia 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 relevés.

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.









## 9. Alpine grasslands - *Calluno-Ulicetea*

### Prodromus

*Calluno-Ulicetea* BRAUN-BLANQUET & TÜXEN ex KLIKA & HADAC 1944

*Nardetalia* OBERDORFER ex PREISING 1949

*Viola altaicae-Festucion variae* all.nov.

*Viola altaicae-Festucetum variae* RABOTNOVA & ONIPCHENKO ass.nov.

*V.a.-F.v. typicum* subass.nov.

*V.a.-F.v. geranietosum renardii* subass.nov.

*V.a.-F.v. nardetosum* subass.nov.

*Hedysaro caucasicae-Geranium gymnocauli* ONIPCHENKO all.nov.

*Hedysaro caucasicae-Geranietum gymnocauli* RABOTNOVA &  
ONIPCHENKO ass.nov.

*H.c.-G.g. senecionetosum kolenatiani* subass.nov.

*H.c.-G.g. typicum* subass.nov.

### *Nardetalia*

The order combines mountain and lowland grasslands on poor acidic soils. The position of the alpine grasslands within the order and the class has been a matter of extensive discussion by different authors (OBERDORFER 1978, KRAHULEC 1983, 1988, PEPPLER 1992, GRABHERR 1993b, ELLMAUER 1993, JULVE 1993, KRAHULEC & MORAVEC 1995, POTT 1995). Due to the high frequency of the diagnostic species of the order and considerable ecological and floristic dissimilarity from the *Anemonion*, we treat alpine grasslands of the northwestern Caucasus within *Nardetalia*. *Anthoxanthum odoratum*, *Nardus stricta*, *Luzula multiflora*, *Antennaria dioica*, *Deschampsia flexuosa*, *Phleum alpinum* are all well represented as diagnostic species in the grasslands of Teberda. The communities have been exposed to different intensities of grazing. They occupy the most favourable slopes within the alpine zone, where winter snow accumulation is moderate (1-3 m). Therefore, production of the grasslands is relatively high. We suggest two new alliances with significant degrees of floristic and ecological specificity.

**Table 9.1.**  
Diagnostic table of *Calluno-Ulicetea*

	1	2	3	4	5
D.sp. <i>Viola altaicae-Festucetum variae</i> , <i>Viola altaicae-Festucion variae</i>					
<i>Festuca varia</i>	V	V	I	V	II
<i>Scorzonera cana</i>	III	IV	III	-	II
<i>Ajuga orientalis</i>	II	II	I	-	-
<i>Galium verum</i>	I	II	I	-	-
<i>Viola altaica</i>	II	III	III	-	-
<i>Carex umbrosa</i>	II	III	III	-	-
<i>Alchemilla caucasica</i>	IV	II	III	I	-
<i>Helictotrichon versicolor</i>	III	II	II	-	-
<i>Minuartia circassica</i>	III	II	II	-	-
<i>Silene saxatilis</i>	III	II	II	I	-
<i>Calamagrostis arundinacea</i>	II	II	I	-	-
D.sp. <i>Hedysaro caucasicae-Geranium gymnocauli</i> , <i>Hedysaro caucasicae-Geranion gymnocauli</i>					
<i>Geranium gymnocaulon</i>	I	II	II	V	V
<i>Pulsatilla aurea</i>	I	-	-	IV	III
<i>Hedysarum caasicum</i>	III	I	II	V	V
<i>Carum meifolium</i>	I	II	I	V	IV
<i>Pedicularis condensata</i>	II	I	-	IV	II
D.sp. <i>V.a.-F.v. geranietosum renardii</i>					
<i>Geranium renardii</i>	IV	-	-	I	-
<i>Bupleurum falcatum</i>	IV	-	I	II	-
<i>Aetheopappus vvedenskii</i>	III	-	-	II	-
<i>Sedum tenellum</i>	IV	I	I	II	I
<i>Thymus nummularius</i>	IV	-	-	-	-
<i>Centaurea cheiranthifolia</i>	II	-	-	-	-
<i>Alyssum murale</i>	II	-	-	-	-
<i>Eurhynchium pulchellum</i>	III	-	-	-	I
<i>Gentiana verna</i>	III	-	-	-	-
<i>Hypericum linarioides</i>	III	-	I	-	-
<i>Primula algida</i>	II	-	-	-	-
<i>Brachythecium velutinum</i>	III	I	I	I	I
<i>Bartramia ithyphylla</i>	II	-	-	I	I
<i>Tragopogon reticulatus</i>	II	-	-	-	-
D.sp. <i>V.a.-F.v. typicum</i>					
<i>Cladonia mitis</i>	-	IV	I	-	I
<i>Gentiana pyrenaica</i>	-	V	II	-	II
<i>Minuartia aizoides</i>	I	IV	II	I	V
<i>Sibbaldia procumbens</i>	I	V	III	II	V
D.sp. <i>V.a.-F.v. nardetosum</i>					
<i>Agrostis vinealis</i>	II	I	IV	I	II
<i>Dicranum scoparium</i>	-	-	II	-	-
<i>Barbilophozia lycopodioides</i>	-	-	II	-	-

Table 9.1. (continued)

	1	2	3	4	5
<i>D.sp. H.c.-G.g. senecionetosum kolenatiani</i>					
<i>Poa longifolia</i>	I	-	I	IV	-
<i>Senecio kolenatianus</i>	I	II	-	IV	-
<i>Cirsium munitum</i>	-	-	I	IV	-
<i>Rumex alpestris</i>	-	I	I	V	II
<i>Silene vulgaris</i>	I	-	-	III	-
<i>Sempervivum caucasicum</i>	II	II	-	II	-
<i>Trollius ranunculinus</i>	-	I	-	II	-
<i>D.sp. H.c.-G.g. typicum</i>					
<i>Campanula tridentata</i>	-	III	III	-	V
<i>Anthemis cretica</i>	III	IV	II	I	V
<i>Senecio taraxacifolius</i>	-	-	-	-	IV
<i>Pedicularis nordmanniana</i>	-	-	II	-	IV
<i>Gnaphalium supinum</i>	-	I	II	-	IV
<i>Catabrosella variegata</i>	-	-	I	-	III
<i>D.sp. Nardetalia, Calluno-Ulicetea</i>					
<i>Anthoxanthum odoratum</i>	V	V	IV	IV	V
<i>Nardus stricta</i>	-	IV	V	I	IV
<i>Luzula multiflora</i>	I	II	IV	I	V
<i>Deschampsia flexuosa</i>	III	V	III	II	V
<i>Phleum alpinum</i>	-	II	III	V	IV
<i>Antennaria dioica</i>	I	IV	II	I	I
<i>Coeloglossum viride</i>	-	-	I	I	-
<i>Hieracium lactucella</i>	I	-	II	-	-
<i>Botrychium lunaria</i>	IV	-	-	-	-
<i>Solidago virgaurea</i>	-	I	I	I	II
<i>Veratrum album</i>	-	I	I	I	I
<i>Polygala alpicola</i>	II	-	I	I	-
Other frequent species					
<i>Campanula collina</i>	V	V	V	IV	II
<i>Carex atrata</i>	II	V	III	IV	V
<i>Carum caucasicum</i>	I	IV	IV	-	I
<i>Cetraria islandica</i>	II	V	III	-	II
<i>Cladonia pyxidata</i>	III	IV	III	I	IV
<i>Erigeron caucasicus</i>	IV	II	I	II	III
<i>Euphrasia ossica</i>	IV	I	III	I	III
<i>Festuca brunnescens</i>	V	III	III	II	V
<i>Festuca ovina</i>	I	IV	III	I	-
<i>Gentiana septemfida</i>	II	IV	I	II	II
<i>Leontodon hispidus</i>	V	V	IV	III	IV
<i>Matricaria caucasica</i>	IV	III	II	III	III
<i>Minuartia recurva</i>	IV	III	II	I	II
<i>Myosotis alpestris</i>	III	III	III	IV	I
<i>Ranunculus oreophilus</i>	IV	II	IV	III	II
<i>Veronica gentianoides</i>	V	V	IV	IV	III

Syntaxa:

1 - *Violo altaicae-Festucion variae geranietosum renardii*, 2 - *V.a.-F.v. typicum*, 3 - *V.a.-F.v. nardetosum*, 4 - *Hedysaro caucasicae-Geranietum gymnocauli senecionetosum kolenatiani*, 5 - *H.c.-G.g. typicum*

### 9.1 *Violo altaicae-Festucetum variae*

The alliance includes alpine grasslands with dense tussock grasses (*Festuca varia*, *Nardus stricta*) as the main dominants. These communities are widespread in the Caucasus (GROSSGEIM 1948, SHIFFERS 1953; GULISASHVILLI *et al.* 1975, PYSEK & SRUTEK 1989, BEDOSHVILI 1988a). The alliance may be considered as a Caucasian vicarious syntaxon of *Festucion variae* GUINOCHET 1938 (GRABHERR 1993b). Because of the limited area of our investigation, all the communities studied fit into one association.

#### *Violo altaicae-Festucion variae*

Synonym: *Violo oreadis-Festucetum variae* RABOTNOVA 1987 in ONIPCHENKO *et al.* (1987)

#### Floristic features

The diagnostic species set of the association includes *Scorzonera cana*, *Viola altaica*, *Silene saxatilis*, as well as the species common to *Anemonion* (*Carex umbrosa*, *Alchemilla caucasica*, *Helictotrichon versicolor*, *Minuartia circassica*). As a rule, dense tussock grasses (*Festuca varia* or/and *Nardus stricta*) are dominants.

General floristic richness is high. We registered 161 vascular plant species, 38 bryophytes and 8 lichens in 30 relevés (Table 9.2.). Mean values per relevé were 35, 3 and 2 species respectively. More detailed study of the floristic richness showed that average numbers were 4.6, 24.4, and 56.8 vascular plant species in 0.01, 1 and 100 sq. m - plots (ONIPCHENKO & SEMENOVA 1995). The last figure was the highest for all investigated alpine communities.

Vascular plant cover ranges between 40% and 90% (mean 64%). As a rule, the role of bryophytes and lichens is low in terms of species richness, plant cover and biomass.

We distinguished 3 subassociations in the syntaxon:

***V.a.-F.v. typicum*** (Typus, or nomenclature type, No. 15/81). *Festuca varia* and *Nardus stricta* dominate the communities of this combination. *Cladonia mitis*, *Gentiana pyrenaica*, *Minuartia aizoides*, and *Sibbaldia procumbens* form the diagnostic set of the subassociation. The communities occupy mainly moderate southern slopes (5°-30°, mean 15°).

**V.a.-F.v. geranietosum renardii** (Typus, or nomenclature type, No. 8/93) consists of *Festuca varia* - dominated grasslands where *Nardus stricta* is absent. Xeromorphic species with dense pubescence or succulent leaves (*Geranium renardii*, *Aetheopappus vvedenskii*, *Sedum tenellum*, *Centaurea cheiranthifolia*, *Alyssum murale*) form the diagnostic set of the subassociation. The communities occupy steep (5°-35°, mean 29°) southern slopes.

**V.a.-F.v. nardetosum** (Typus, or nomenclature type, No. 127/94) are matgrass communities that arose as a result of overgrazing former *Festuca varia*-grasslands. Diagnostic species of the association are still present, but the role of *Agrostis vinealis* and mosses (*Dicranum scoparium*, *Barbilophozia lycopodioides*) increases.

### **General ecological features of the association**

The communities occupy extensive areas within the alpine zone (at elevation 2410-3100 m, mean 2710 m). As a rule, they occur on southern slopes ranging from moderate to steep. The dense and durable roots of *Festuca varia* allow this species to stabilize screes and to form dense communities on steep slopes. The species is well adapted to a dry and hot environment due to the xeromorphic structure of its leaves. Some authors suggest the steppe genesis of the communities during the late tectonic uplift of the Caucasian mountains (KONONOV 1957).

As a whole, bare soil and stones cover only a small area within the community (0-20%, mean 4%). Winter **snowpack accumulation** is not great (0.5-1.5 m), but snow cover is essential: it prevents deep freezing of soils. As a rule the communities become free from snow in the second half of May or the first half of June.

Aboveground **biomass** is about 350 g/sq.m (d.w.), belowground - 640 g/sq.m. Net annual productivity of the community was estimated at 400 g/sq.m. An important feature of the grasslands is dense litter accumulation (900 g/sq.m) caused by slow decomposition rate. *Festuca varia* often constitutes over the half of the total biomass of the community (ONIPCHENKO 1990).

The soil seed bank of the community is rather large (about 1190 seed/sq.m) (SEMENOVA & ONIPCHENKO 1994). The most common species contributing seeds to the bank are *Nardus stricta*, *Carex atrata*, *Gentiana spp.*, *Euphrasia ossica*, and *Cerastium purpurascens*. It is important to note that large seeds

of *Festuca varia* were practically absent from the seed bank despite very high seed production by this species.

Moderate grazing does not have a negative effect on the composition and floristic richness of the grassland. Severe grazing leads to exclusion of *Festuca varia* and to an increase in abundance of *Nardus stricta* on gentle slopes, or development of bare spots on steep slopes.











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

60/93 - 17.08, 25, Baduk; 10/93 - 08.07, 25, Ullu-Murudzhu; 72/95 - 13.07, 25, Baduk; 86/95 - 24.07, 25, Bol.Khatipara; 130/95 - 30.08, 25, Ullu-Murudzhu; 15/88 - 17.08, 25, Kynyrchat; 15/94 - 08.07, 16, Azgek; 8/93 - 08.07, 25, Ullu-Murudzhu; 15/85 - 17.08, 25, Azgek; 36/93 - 30.07, 25, Azgek; 9/81 - 30.07, 25, M.Khatipara; 13/81 - 31.07, 25, M.Khatipara; 12/94 - 07.07, 25, Azgek (A.Egorov); 40/81 - 08.09, 25, M.Khatipara; 15/81 - 31.07, 25, M.Khatipara; 10/87 - 17.08, 25, Alibek; 26/83 - 30.08, 25, M.Khatipara; 105/94 - 21.07, 25, Goralykol; 1/84 - 22.08, 100, M.Khatipara; 16/83 - 24.08, 25, M.Khatipara; 22/94 - 08.07, 25, Azgek (A.Egorov); 134/94 - 31.07, 16, Mukhu; 119/94 - 29.07, 25, Mukhu; 19/94 - 08.07, 16, Azgek; 24/94 - 08.07, 25, Azgek; 140/94 - 31.07, 25, Mukhu; 128/94 - 30.07, 16, Mukhu; 12/81 - 31.07, 25, M.Khatipara; 127/94 - 30.07, 16, Mukhu; 123/94 - 30.07, 25, Mukhu

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## 9.2. *Hedysaro caucasicae-Geranium gymnocauli*

The alliance combines highly productive grasslands, developing on slopes and in small depression with considerable snowpack accumulation (2-3 m). We consider all these communities within one association (ONIPCHENKO *et al.* 1987).

### *Hedysaro caucasicae-Geranium gymnocauli*

#### Floristic features

Five forb species (*Geranium gymnocaulon*, *Hedysarum caasicum*, *Carum meifolium*, *Pulsatilla aurea*, and *Pedicularis condensata*) form the diagnostic set of the alliance and the association (Table 9.3). Some dense tussock grasses (*Festuca varia*, *F. brunnescens*, *Nardus stricta*) are also common, but they are not dominants in the communities.

Floristic richness is slightly lower than in the previous association. We registered 112 vascular plant species, 23 bryophytes and 5 lichens in 20 relevés of the association. The mean values per releve were 28, 2, and 1 species respectively. Overall the role of bryophytes and lichens was negligible. Average floristic richness was estimated as 5.3, 19.5, and 35.0 species per 0.01, 1, and 100 sq.m-plots respectively. Vascular plant cover in this community is denser than in the previous association (50-97%, mean 81%). Cover of lichens and bryophytes is low.

We distinguish two subassociations within the association:

***H.c.-G.g. typicum*** (Typus, or nomenclature type, No. 43/83) unites more moist communities that have significant floristic similarity with *Salicetea herbacea* - communities. *Campanula tridentata*, *Anthemis cretica*, *Gnaphalium supinum*, *Pedicularis nordmanniana*, *Catabrosella variegata* and *Senecio taraxacifolius* form the diagnostic set of the subassociation.

**H.c.-G.g. senecionetosum kolenatianii** (Typus, or nomenclature type, No. 159/90) consists of the less moist communities of the association. *Poa longifolia*, *Senecio kolenatianus*, *Cirsium munitum*, *Rumex alpestris*, and *Silene vulgaris* represent the diagnostic species set.

SEMAGINA (1992) added one more subassociation (*H.c.-G.g. trollietosum ranunculinus* SEMAGINA 1992), with *Trollius ranunculinus* and *Veratrum album* as diagnostic species. She presented 5 releves of the subassociation from the Caucasian biosphere reserve.

### Ecological features

Generally the association is typical of the Western and Central Caucasus (VOROB'EVA 1977b, KIMERIDZE & MARDALEISHVILI 1980, KIMERIDZE 1985). In Teberda reserve the communities occupy the lower part of slopes of different aspect and steepness (3°-35°, mean 22°) within the alpine zone (altitude range 2600-3000 m, mean 2720 m). Due to considerable snowpack accumulation, the growing season here begins only in the second half of June or in the first half of July.

The communities have the highest **annual production** among all the alpine communities studied (about 550 g/sq.m). The aboveground vascular plant biomass is about 320 g/sq.m, belowground - 1390 g/sq.m (ONIPCHENKO 1990). These communities have high rate of soil respiration, nitrogen fixation and denitrification (STEPANOV & ONIPCHENKO 1989).

**Burrowing** and **grazing activity** of voles as well as wild boars has a profound impact on both community structure and composition. Population density of the vole *Pitymys (Microtus) majori* Thomas (*Glires, Microtinae*) can reach 940 animals per hectare during the "peak-years" in these communities (FOMIN *et al.* 1989). The animals can consume approximately 15% of the annual net production and dig up to 14,300 holes per hectare in such years. Such severe disturbances leave clearly visible "gaps" in the structure of the communities. Vascular plant species differ in their reaction to the different size of gaps (ONIPCHENKO & RABOTNOVA 1994).

About 3850 seed/ sq.m were detected in the soil **seed bank** (SEMENOVA & ONIPCHENKO 1994). *Luzula multiflora*, *Matricaria caucasica*, *Nardus stricta*, *Veronica gentianoides*, *Phleum alpinum*, *Anthoxanthum odoratum* and *Sibbaldia procumbens* were the main components of the seed bank, whereas seeds of the dominants (*Geranium gymnocaulon*, *Hedysarum caucasicum*) were completely absent.



Table 9.3. (continued)

Releve No.	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Year	1	68	43	59	42	59	37	19	88	80	42	20	43	4	3	8	16	7	30	61
Year	83	93	93	90	93	93	93	95	94	94	83	83	83	84	84	87	88	83	89	80
Other species																				
<i>Aetheopappus vvedenskii</i>		1					+		1											
<i>Agrostis vinealis</i>				+							+			+			1			
<i>Astrantia maxima</i>					1				2	+										
<i>Betonica macrantha</i>		1		1	+				1	+										
<i>Brachytecium velutinum</i>		1								+										+
<i>Briza marcowiczii</i>										+	+	+	+			1				
<i>Bupleurum falcatum</i>				+		1				+										
<i>Campanula collina</i>	+	1	+	1			+	+	+	1			+			1	+			
<i>Carex atrata</i>	1	+	1	1	+	+			+	+	1		+	1	1	1	1	1	+	1
<i>Cerastium purpurascens</i>	1	1		+					+				+			1				+
<i>Cetraria islandica</i>												+	1	1	1					
<i>Cirsium simplex</i>									+	+							2			
<i>Cladonia pyxidata</i>		+	+								+	+	+	+	1	+	+			
<i>Coronilla orientalis</i>	1	+						2												
<i>Daphne glomerata</i>		+				+	+													
<i>Draba hispida</i>	1	+	+	+					+	+		+				+				
<i>Erigeron caucasicus</i>		+		+		+	+				+	+	+	1						+
<i>Euphrasia ossica</i>				+							+	+	+	+		1	+			
<i>Festuca brunnescens</i>	1	+	+		+						1	1	1	1	2		1	1	1	1
<i>Festuca varia</i>	2	1	1	2	1	1	1	1	1	+					1	1	2			
<i>Gentiana pyrenaica</i>													+	+	+		+			
<i>Gentiana septemfida</i>		1		+					+			+	1			+				+
<i>Kemulariella caucasica</i>					+		+						+							
<i>Leontodon hispidus</i>		1	1	1		1	1		1		1	1	1	1	1	+	1			1
<i>Matricaria caucasica</i>	+	1	1		1	+			+			+		1	1	1		1	1	
<i>Minuartia aizoides</i>					+						1		+	1	1	1	1	+	+	1
<i>Minuartia recurva</i>		+												+	+					+
<i>Myosotis alpestris</i>	1	+		+		+		+	+	+		+				+				
<i>Polytrichum juniperinum</i>											1				+	+	+			
<i>Potentilla crantzii</i>	1								1	+	1	1	+		+	2		1		1
<i>Primula ruprechtii</i>		+		+										1	+					
<i>Ranunculus oreophilus</i>		2	1		2	+	+							1	+					1
<i>Scorzonera cana</i>														1	1					+
<i>Sedum tenellum</i>	+	+	+													1				+
<i>Sibbaldia procumbens</i>	+		1		+						2	1	1	1	1	2	2	1	1	2
<i>Stereocaulon alpinum</i>													+	1	1					
<i>Taraxacum stevenii</i>											+	+				1	1			2
<i>Trisetum flavescens</i>									1	+						+				
<i>Veronica gentianoides</i>				1	+	1	1	+	1	1	+	1		1	1	+	1			

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

*Aconitum nasutum* (37/93), *Alchemilla caucasica* (43/93, 42/93), *Alchemilla vulgaris* (1/83:1, 180/94:2), *Alopecurus glacialis* (1/83), *Alopecurus ponticus* (19/95), *Anemone narcissiflora* (19/95), *Anemone speciosa* (43/83), *Anthemis marshalliana* (59/93), *Arenaria rotundifolia* (68/93, 43/93), *Barbilophozia barbata* (16/88), *Bartramia ithyphylla* (188/94, 8/87), *Brachytecium salebrosum* (68/93:1), *Bryum caespitium* (8/87), *Bryum capillare* (59/93), *Bryum sp.* (188/94), *Carex nigra* (180/94), *Carex pyrenaica* (43/83, 61/80), *Carex sempervirens* (8/87), *Carum causicum* (16/88:1, 61/80:1), *Chaerophyllum roseum* (37/93), *Chamerion angustifolium* (19/95), *Cicerbita racemosa* (19/95), *Cladonia mitis* (43/83, 4/84), *Corydalis conorrhiza* (61/80), *Crocus reticulatus* (19/95), *Cruciata laevipes* (159/90, 19/95), *Desmatodon latifolius* (37/93:1, 19/95), *Empetrum nigrum* (43/83), *Encalypta vulgaris* (188/94), *Eurhynchium pulchellum* (8/87), *Festuca ovina* (188/94), *Fritillaria latifolia* (19/95), *Fritillaria lutea* (68/93, 159/90), *Gagea fistulosa* (30/89), *Geranium renardii* (159/90, 59/93:2), *Geranium sylvaticum* (19/95),

*Hieracium macrolepis* (43/93, 59/93), *Hieracium umbellatum* (4/84), *Hyalopoa pontica* (8/87:1), *Inula orientalis* (159/90:1), *Leskea polycarpa* (159/90), *Ligusticum caucasicum* (188/94:1, 180/94:1), *Luzula spicata* (4/84, 8/87:1), *Millium effusum* (180/94), *Minuartia imbricata* (37/93), *Orobanche purpurea* (59/93), *Pedicularis comosa* (4/84), *Peltigera rufescens* (8/87), *Philonotis fontana* (188/94), *Plagiothecium denticulatum* (16/88), *Plantago atrata* (43/93), *Pohlia cruda* (68/93), *Pohlia obtusifolia* (188/94), *Polygonum bistorta* (19/95:2), *Polytrichum piliferum* (16/88), *Primula veris* (19/95), *Pseudoleskea incurvata* (37/93:1, 188/94), *Pseudoleskea patens* (19/95), *Racomitrium canescens* (68/93, 188/94), *Ranunculus brachylobus* (180/94, 61/80), *Rhododendron caucasicum* (42/83, 43/83:1), *Rhynchosorys elephas* (19/95), *Rumex alpinus* (180/94:1), *Scabiosa ochroleuca* (68/93, 159/90), *Senecio aurantiacus* (19/95), *Senecio caucasicus* (37/93), *Seseli alpinum* (37/93), *Silene saxatilis* (37/93, 188/94), *Tetraplodon mnioides* (43/93), *Tortula ruralis* (43/93), *Vaccinium myrtillus* (37/93), *Veronica filiformis* (180/94), *Weissia* sp. (188/94).

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

1/83 - 16.07, 25, Klukhor pass; 68/93 - 17.08, 16, Baduk; 43/93 - 10.08, 16, M.Khatipara; 159/90 - 19.08, 16, Khutyy; 42/93 - 10.08, 16, M.Khatipara; 59/93 - 17.08, 16, Baduk; 37/93 - 30.07, 25, Azgek; 19/95 - 04.07, 25, Alibek; 188/94 - 09.09, 25, Kichi-Murudzhu; 180/94 - 09.09, 25, Kichi-Murudzhu; 42/83 - 06.09, 25, M.Khatipara; 20/83 - 24.08, 25, M.Khatipara; 43/83 - 06.09, 25, M.Khatipara; 4/84 - 23.08, 100, M.Khatipara; 3/84 - 23.08, 100, M.Khatipara; 8/87 - 17.08, 25, Alibek; 16/88 - 17.08, 25, Kynyrchat; 7/83 - 20.08, 15, M.Khatipara; 30/89 - 20.08, 25, M.Khatipara (I.Pavlova); 61/80 - 26.07, 5, Uzunkol.

## 10. Snowbeds - *Salicetea herbaceae*

Prodromus

*Salicetea herbaceae* BRAUN-BLANQUET 1948

*Hyalopoetalia ponticae* ord.nov.

*Hyalopoion ponticae* RABOTNOVA & ONIPCHENKO all.nov.

*Ranunculetum brachylobi* POKARZHEVSKAYA & ONIPCHENKO ass.nov.

*Hyalopoo ponticae-Pedicularietum nordmanniana* RABOTNOVA &  
ONIPCHENKO ass.nov.

*Saxifragion sibiricae* all.nov.

*Saxifragetum sibiricae* ONIPCHENKO & LUBEZNOVA ass.nov.

*S.s. typicum* subass.nov.

*S.s. primuletosum amoenae* subass.nov.

*S.s. saxifragetosum moschatae* subass.nov.

### *Hyalopoetalia ponticae*

This order combines alpine communities developing on siliceous rock on acid soils with considerable snow accumulation (snowbeds) and a short vegetation season. Some species of *Salicetea herbaceae* are typically found here (*Gnaphalium supinum*, *Sibbaldia procumbens*, *Cerastium cerastioides*, *Polytrichum sexangulare*, and *Kiaeria starkei*) (Table 10.1.). The class is a well-studied syntaxon in Europe (BRAUN-BLANQUET 1975, DIERSSEN 1984, SANDRA *et al.* 1988, ENGLISCH 1993). The diagnostic set of our order includes such Caucasian species as *Taraxacum stevenii*, *Sedum tenellum*, *Hyalopoa pontica*. The order can be considered as a geographical vicarious syntaxon of *Salicetalia herbaceae* BRAUN-BLANQUET 1926. We distinguish two alliances in the order, namely *Hyalopoion ponticae* (alpine closed "carpet"- like communities) and *Saxifragion sibiricae* (open rock and scree communities). The first alliance is the *typus* (nomenclature type) of the order. The system of Caucasian snowbed communities represented here is based on our previous invalid publication (ONIPCHENKO *et al.* 1987, 1992).

### 10.1. *Hyalopoion ponticae*

Synonym: *Sibbaldion* RABOTNOVA 1987 in ONIPCHENKO *et al.* 1987 p.p., *Sibbaldenion* ONIPCHENKO 1992 (ONIPCHENKO *et al.* 1992).

The alliance unites the original Caucasian snowbed communities, which are known in Russian literature as "alpine carpets" (alpiyskie kovry) due to their low and dense plant cover (NARINYAN 1962; MIKELADZE 1960). The alliance can be considered as a geographical vicarious syntaxon of *Salicion herbaceae* BRAUN-BLANQUET 1926, which occurs in Europe up to the Balkans. (BRAUN-BLANQUET 1975). The absence of dwarf *Salix*-species in the Caucasian communities is their main floristic distinction from Alpic vicarious syntaxa. Diagnostic species of the alliance include *Carex pyrenaica*, *Pedicularis nordmanniana*, *Minuartia aizoides*, *Carex atrata*, *Luzula multiflora* and *Potentilla crantzii* (Table 10.1.).

Two associations are proposed in the alliance according to their floristic and ecological peculiarities. Typus, or nomenclature type, is *Hyalopoo ponticae-Pedicularietum nordmannianae*

#### 10.1.1. *Ranunculetum brachylobi*

##### Floristic features

The association combines communities with *Ranunculus brachylobus* as a prominent dominant. *Corydalis conorhiza* and *Geranium gymnocaulon* are other diagnostic species (Tables 10.1., 10.2.). Floristic richness of this syntaxon is low. We registered only 39 vascular plant species, 15 bryophytes and 4 lichens in 10 releves of the association (Table 10.2.). Floristic similarity between releves is high and average numbers of species per releve was 16, 3 and 1 for vascular plants, bryophytes and lichens respectively. Vascular plant cover is dense (45-80%, mean 65%), while the bryophyte cover is poorly developed (from less than 1% to 30%, mean 7%). The role of lichens is negligible.

Typus, or nomenclature type, is releve No. 55/80.

##### Ecological features

The communities occupy leeward (mostly northern and eastern) slopes in the alpine and subnival zone within the elevation range 2700 to 3200 m (mean 2850 m). The steepness of the slopes ranges between 0° and 30° (mean 14°). Stones cover up to 40% (mean 17%).

The communities occur mainly in the southern part of the reserve near the Main Caucasian Range (Murudzhu, Klukhor, Alibek, Chuchkhur), where snow

**Table 10.1.**  
Diagnostic table of *Salicetea herbaceae*

	1	2	3	4	5
D.sp. <i>Ranunculetum brachylobi</i>					
<i>Ranunculus brachylobus</i>	V	-	-	-	-
<i>Corydalis conorrhiza</i>	IV	I	-	-	-
<i>Geranium gymnocaulon</i>	II	-	-	-	-
D.sp. <i>Hyalopoo ponticae</i> - <i>Pedicularietum nordmannianae</i>					
<i>Catabrosella variegata</i>	I	V	-	I	I
<i>Nardus stricta</i>	I	IV	-	-	-
<i>Stereocaulon alpinum</i>	I	III	I	I	I
<i>Desmatodon latifolius</i>	I	III	-	I	I
<i>Carex oreophila</i>	-	II	-	-	-
D.sp. <i>Hyalopoion ponticae</i>					
<i>Carex pyrenaica</i>	V	III	-	-	-
<i>Pedicularis nordmanniana</i>	V	IV	-	I	-
<i>Minuartia aizoides</i>	IV	IV	I	-	-
<i>Carex atrata</i>	IV	V	II	II	I
<i>Luzula multiflora</i>	III	II	-	-	-
<i>Potentilla crantzii</i>	IV	II	-	-	-
D.sp. <i>Saxifragion sibiricae</i> , <i>Saxifragetum sibiricae</i>					
<i>Saxifraga sibirica</i>	-	-	V	IV	III
<i>Minuartia imbricata</i>	I	-	V	II	IV
<i>Matricaria caucasica</i>	III	I	II	V	III
<i>Veronica telephiifolia</i>	I	-	I	IV	IV
<i>Murbeckiella huetii</i>	-	-	I	III	II
<i>Draba scabra</i>	-	-	III	I	II
D.sp. <i>S.s. primuletosum amoenae</i>					
<i>Primula amoena</i>	I	-	V	I	I
<i>Lloydia serotina</i>	-	-	IV	-	-
<i>Festuca ovina</i>	I	II	V	-	I
<i>Anemone speciosa</i>	-	-	IV	-	-
<i>Polytrichastrum alpinum</i>	I	-	IV	II	I
<i>Cetraria islandica</i>	I	I	IV	-	-
<i>Myosotis alpestris</i>	-	-	III	I	-
<i>Luzula spicata</i>	-	-	IV	I	-
<i>Veronica gentianoides</i>	I	-	IV	I	-
<i>Alchemilla vulgaris aggr.</i>	-	I	III	I	-
<i>Valeriana alpestris</i>	-	-	III	-	-
<i>Peltigera rufescens</i>	I	-	III	I	-
<i>Carex sempervirens</i>	-	-	III	-	I
<i>Arenaria lychnidea</i>	-	-	III	-	I
<i>Vaccinium vitis-idaea</i>	-	-	III	-	-
<i>Dicranoweisia crispula</i>	I	-	III	I	I
<i>Sanionia uncinata</i>	I	I	III	I	-
<i>Distichium capillaceum</i>	-	-	III	-	-
<i>Pedicularis crassirostris</i>	-	-	II	-	-
<i>Isopterygiopsis pulchella</i>	-	-	II	-	-

**Table 10.1.** (continued)

	1	2	3	4	5
D.sp. <i>S.s. saxifragetosum moschatae</i>					
<i>Saxifraga moschata</i>	-	-	II	-	V
<i>Senecio karjaginii</i>	-	-	I	-	IV
<i>Potentilla gelida</i>	-	-	II	-	IV
D.sp. <i>Hyalopoetalia ponticae</i>					
<i>Taraxacum stevenii</i>	V	V	V	II	I
<i>Sedum tenellum</i>	IV	II	II	IV	II
<i>Hyalopoa pontica</i>	IV	IV	III	III	I
<i>Polytrichum piliferum</i>	III	III	II	III	II
D.sp. <i>Salicetea herbaceae</i>					
<i>Gnaphalium supinum</i>	V	V	II	III	I
<i>Sibbaldia procumbens</i>	V	V	II	II	-
<i>Cerastium cerastioides</i>	I	I	I	II	I
<i>Kiaeria starkei</i>	-	-	-	I	-
<i>Polytrichum sexangulare</i>	II	II	I	I	I
Other frequent species					
<i>Campanula tridentata</i>	III	III	IV	I	I
<i>Carum caucasicum</i>	III	V	V	I	I
<i>Cladonia pyxidata</i>	III	IV	IV	III	I

Syntaxa:

1 - *Ranunculetum brachylobi*, 2 - *Hyalopoo ponticae-Pedicularietum nordmannianae*, 3 - *Saxifragetum sibiricae primuletosum amoenae*, 3 - *S.s. typicum*, 4 - *S.s. saxifragetosum moschatae*

accumulation is especially significant. They often occupy slopes under long-lived snowfields and have ample melt water supply during the whole or main part of a vegetation season. It seems that *Ranunculus brachylobus* shares some ecological properties with the Alpic *Ranunculus glacialis* which grows in the extreme "snowbed" environment (MOSER *et al.* 1977).

### 10.1.2. *Hyalopoo ponticae-Pedicularietum nordmannianae*

Synonym: *Hyalopoo ponticae-Pedicularietum crassirostris* RABOTNOVA 1987 in ONIPCHENKO *et al.* 1987 p.p.

#### Floristic features

The association combines snowbed communities where short rosette and dwarf trailing plants (*Sibbaldia procumbens*, *Minuartia aizoides*, *Gnaphalium supinum*, *Taraxacum stevenii*) and *Nardus stricta* dominate. The diagnostic species set includes *Catabrosella variegata*, *Nardus stricta*, *Stereocaulon alpinum*, *Desmatodon latifolius* and *Carex oreophila*. The diagnostic species of the alliance, the order and the class are abundant and frequent (Table 10.2.). The association can be considered as the Caucasian vicarious

syntaxon of *Salicetum herbaceae* (Rübel) BRAUN-BLANQUET 1913 (BRAUN-BLANQUET 1975).

Its overall floristic richness is low. We registered 36 vascular plant species, 13 bryophytes and 6 lichens in 10 relevés. The mean values per relevé were 15, 3 and 2 species correspondingly. More detailed study of floristic richness showed that average numbers were 5.1, 11.3 and 18.0 vascular plant species in 0.01, 1 and 25 sq. m - plots (ONIPCHENKO & SEMENOVA 1995). The values are among the lowest for alpine communities. The only other community with so few species is the alpine fen. Vascular plant cover is dense (25-95%, mean 68%) and cover of mosses is higher than in the previous association (1-60%, mean 22%).

The nomenclature type (typus) is relevé No. 31/83.

A similar association (*Pediculario crassirostris* - *Sibbaldietum semiglabrae* Bedoshvili 1988) was described from the Lagodekh reserve (the East Caucasus) (BEDOSHVILI 1988b). Due to lower precipitation and different bedrock composition, the soils are less acidic there. Among diagnostic species of the association there are some species (*Plantago saxatilis*, *Chamaescadium acaule*) which prefer soils with higher pH. These species, as well as *Pedicularis crassirostris*, are practically absent from our association.

### **Ecological features**

The communities occupy depressions and bottoms of nival and glacial cirques (corries) with heavy winter snow accumulation (4 metres and more). They are typical for the alpine and lower part of the subnival zone (altitude range 2720-3150 m, mean 2720 m). They prefer gentle slopes of various exposures and flat areas (from 0° to 10°, mean 3.5°). Bare soil and boulder cover is low.

The communities have a short vegetative season (about 2 - 2.5 months) from July to September. Aboveground vascular plant **biomass** is about 130 g/sq.m, belowground - 940 g/sq.m. Corresponding values for dead plant material are 180 and 590 g/sq.m (ONIPCHENKO 1990). Annual production was estimated as 200 g/sq.m. Most of the aboveground biomass is concentrated within the 0-1 cm layer and the height of most plants does not exceed 2-3 cm. Soil **seed bank** is abundant. We detected 2810 viable seeds/sq.m for the snowbed communities in Mt. M.Khatipara (SEMENOVA & ONIPCHENKO 1994).

**Table 10.2.**

*Hyalopoion ponticae*

Releve No.	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	
Year	50	55	2	5	2	57	3	23	03	82	45	11	44	38	22	31	6	17	32	8	
Year	80	80	87	87	83	90	83	83	94	94	94	83	94	94	88	83	91	94	94	83	
Altitude (* 10)	2	2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	
	80	80	92	82	20	90	70	70	80	85	85	75	15	72	95	85	90	80	80	75	
Steepness	10	25	30	3	10	25	0	30	5	5	3	0	3	2	3	5	2	5	2	10	
Exposition	w	n	sw	se	e	ne	-	ne	ne	ne	sw	-	se	ne	e	ne	se	s	w	n	
Vascular plant cover	50	70	50	70	70	70	70	45	80	70	80	95	30	80	70	70	25	70	70	90	
Bryophyte cover	1	1	5	30	5	10	3	1	5	10	1	10	60	30	1	30	30	1	50	5	
Lichen cover	+	0	5	0	0	+	0	+	+	+	1	1	3	2	5	5	25	0	1	1	
Stone cover	30	15	40	15	20	15	0	10	10	15	15	5	1	1	1	5	15	20	5	2	
Bare soil	0	0	0	0	0	0	0	0	3	5	10	1	5	5	10	1	1	10	5	3	
Lichen species number	1	0	3	0	0	2	0	2	1	0	2	0	1	2	1	3	4	0	4	1	
Bryophyte species number	1	1	3	1	1	5	1	0	6	7	4	3	2	6	2	4	4	3	2	1	
Vascular pl. sp. number	18	17	15	14	15	11	10	21	17	23	16	18	8	18	13	17	13	18	17	13	
<i>D.sp. Ranunculetum brachylobi</i>																					
<i>Ranunculus brachylobus</i>	3	4	3	3	2	3	3	2	2	2											
<i>Corydalis conorrhiza</i>	1	1	1	2	+		+		+	+											
<i>Geranium gymnocaulon</i>	+	+					2	1													
<i>D.sp. Hyalopoo ponticae-Pedicularietum nordmannianae</i>																					
<i>Catabrosella variegata</i>										+	1	+	+	1	1	1		2	+	1	
<i>Nardus stricta</i>										+	1	2		2		2	+	+	1	1	
<i>Stereocaulon alpinum</i>				+			+				+		1	1		1	2		+		
<i>Desmatodon latifolius</i>										+	+	1		2	+				+		
<i>Carex oreophila</i>											1	2			+				+		
<i>D.sp. Hyalopoion ponticae</i>																					
<i>Carex pyrenaica</i>	+	+	1	2	1	1		1	+	2				1		2	+		+	1	
<i>Pedicularis nordmanniana</i>	+	+	+	1	+	+		+	1	2	+	1		+	+	2	+		+	1	
<i>Minuartia aizoides</i>	1	1		+	+			1	2	2	2	1	+	+	2	1		+	1		
<i>Carex atrata</i>	+		+		1	+	2	+	1	+	+	1	+	+	1	+	1	+	+	+	
<i>Luzula multiflora</i>		+	1	2				1	+	+				+	+					1	
<i>Potentilla crantzii</i>	1	+			2	r	2	1	+	+	1							1		2	
<i>D.sp. Hyalopoetalia ponticae</i>																					
<i>Taraxacum stevenii</i>	2	1	1	1	3	2	2	+	2	2	2	2		2	3	2	1	2	2	2	
<i>Sedum tenellum</i>	+		1	1	+	+		+	+	+	+		+				+	+			
<i>Hyalopoa pontica</i>	+		2	2	2	2		+	1	+	+		+	+	2	1	1			1	
<i>Polytrichum piliferum</i>	+		1	2		1			+	+	+	2	1	1		2	2				
<i>D.sp. Salicetea herbaceae</i>																					
<i>Gnaphalium supinum</i>	1	+	2	2	2	1		1	+	1	+	2	+	+	+	2	r	+	1	2	
<i>Sibbaldia procumbens</i>	1	1	1	+	2	2	2	2	3	3	3	4	2	4	3	3	2	1	4	4	
<i>Cerastium cerastioides</i>				+										+					+		
<i>Polytrichum sexangulare</i>					2	+				2	+		4	1							
Other species																					
<i>Anthemis cretica</i>									+	+	+						+				
<i>Anthoxanthum odoratum</i>			1						1	+	+	+	+		+				+		
<i>Campanula tridentata</i>	+	+			+				+	1	1	r			1	1	1		+		
<i>Carum caucasicum</i>		+	+	1	+				2			+	+		+	3	+	+	+	1	+

**Table 10.2.** (continued)

Releve No.	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0
Year	50	55	2	5	2	57	3	23	03	82	45	11	44	38	22	31	6	17	32	8
	80	80	87	87	83	90	83	83	94	94	94	83	94	94	88	83	91	94	94	83
<i>Carum meifolium</i>	+						2			+	+					+				
<i>Cladonia pyxidata</i>	+		2				+		+	+	+			1	2	1	+		+	+
<i>Festuca ovina</i>														+	1		+		+	
<i>Matricaria caucasica</i>	+	+	+	+	1														+	
<i>Phleum alpinum</i>								1	+	+	1		+					+		+
<i>Polytrichum juniperinum</i>			1				1	1		1	+					2	2		3	2
<i>Sanionia uncinata</i>										+				+		+				

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

*Agrostis vinealis* (45/94, 22/88), *Alchemilla vulgaris* aggr. (17/94:1), *Anthemis marshalliana* (132/94), *Bartramia ithyphylla* (182/94), *Blindia acuta* (182/94), *Brachythecium* sp. (182/94), *Brachythecium velutinum* (22/88), *Briza marcowiczii* (182/94, 31/83), *Bryum imbricatum* (6/91), *Campanula collina* (17/94), *Carex umbrosa* (132/94), *Cetraria islandica* (23/83), *Chamaescidium acaule* (12/83:1), *Cladonia elongata* (6/91), *Cladonia gracilis* (31/83), *Cladonia mitis* (6/91:1, 132/94), *Crocus scharojanii* (182/94), *Deschampsia flexuosa* (11/83:1, 31/83:1), *Dicranoweisia crispula* (157/90), *Dicranum congestum* (31/83), *Draba hispida* (2/87), *Draba sibirica* (50/80), *Euphrasia ossica* (138/94, 132/94), *Festuca brunnescens* (11/83, 17/94:r), *Gagea fistulosa* (11/83, 17/94), *Gentiana pyrenaica* (11/83, 132/94), *Grimmia sessitana* (17/94), *Leontodon hispidus* (23/83), *Lescurea radicata* (157/90), *Lophozia* sp. (103/94, 138/94), *Minuartia imbricata* (103/94), *Peltigera rufescens* (2/87), *Poa alpina* (50/80), *Pohlia gracilis* (2/87), *Pohlia nutans* (45/94, 6/91), *Pohlia obtusifolia* (182/94), *Polytrichastrum alpinum* (55/80), *Primula amoena* (55/80:1), *Pseudoleskea incurvata* (103/94, 182/94), *Racomitrium canescens* (138/94, 132/94:2), *Rhododendron caucasicum* (23/83), *Rumex alpestris* (3/83), *Senecio taraxacifolius* (55/80, 157/90:r), *Taraxacum confusum* (44/94:1), *Tortula ruralis* (17/94), *Veronica gentianoides* (23/83), *Veronica telephiifolia* (2/87).

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

50/80 - 20.07, 5, Baduk; 55/80 - 20.07, 8, Baduk; 2/87 - 16.08, 25, Alibek; 5/87 - 16.08, 15, Alibek; 2/83 - 16.07, 12, Kichi-Murudzhu; 157/90 - 19.08, 9, Khutyy; 3/83 - 16.07, 15, Kichi-Murudzhu; 23/83 - 27.08, 16, Ullu-Murudzhu; 103/94 - 21.07, 12, Goralykol; 182/94 - 09.09, 12, Kichi-Murudzhu; 45/94 - 11.07, 9, Kyshkadzher; 11/83 - 24.08, 16, M.Khatipara; 44/94 - 11.07, 25, Kyshkadzher; 138/94 - 31.07, 15, Mukhu; 22/88 - 18.08, 16, Gidam; 31/83 - 31.08, 16, M.Khatipara; 6/91 - 03.08, 9, M.Khatipara; 17/94 - 08.07, 9, Azgek; 132/94 - 30.07, 16, Mukhu; 8/83 - 20.08, 15, M.Khatipara

The most common species in the seed bank were *Gnaphalium supinum*, *Sibbaldia procumbens* and *Taraxacum stevenii*.

The communities in depressions are very dependent on snowbank regime and may be susceptible to climate change. They have not been particularly stable during the Holocene as demonstrated by pollen and phytolith analysis (PAVLOVA & ONIPCHENKO 1992, BLINNIKOV 1994).

## 10.2. *Saxifragion sibiricae*

The alliance combines open alpine and subnival snowbed communities on rocks and moist screes. There exists some floristic similarity between these communities and *Chaerophyllion humilis* and *Murbeckiellion huetii* (*Thlaspietea rotundifolii*), but in the former the species of *Salicetea herbaceae* as well as *Hyalopoetalia ponticae* are well represented. Therefore we treat these communities within *Salicetea herbaceae*, where they form one association (ONIPCHENKO *et al.* 1992).

### *Saxifragetum sibiricae*

#### Floristic features

The diagnostic species set of the association is represented by the species of cold, wet and open habitats, namely *Saxifraga sibirica*, *Minuartia imbricata*, *Matricaria caucasica*, *Veronica telephiifolia*, *Murbeckiella huetii*, and *Draba scabra*. Most of them are also common in *Hyalopoo ponticae*-*Oxyrietum digynae* (*Thlaspietea rotundifolii*, see Table 3.1.). Several typical species (*Oxyria digyna*, *Chamerion dodonaei*, *Alopecurus ponticus*) of that association are however practically absent from *Saxifragetum sibiricae*. This gives us a basis for distinguishing these two syntaxa in spite of their significant floristic similarity.

We describe 3 subassociations within the association.

**S.s. *primuletosum amoenae*** represents rock communities developing on steep (30°-80°) mainly northern slopes within the alpine and subnival zones (2800-3120 m a.s.l.). The communities are relatively rich (144 species in 10 relevés!) due to great variation in microhabitat conditions. The diagnostic set is large and includes species adapted to temporary freezing. The most common diagnostic species are *Primula amoena*, *Lloydia serotina*, *Anemone speciosa*, *Festuca ovina*, *Polytrichastrum alpinum*, *Luzula spicata*.

**Table 10.3.**

*Saxifragetum sibiricae*

Releve No.	0 0 0 0 0 1 0 1 0 1	1 0 1 0 0 1 0 0 1 0	0 0 0 0 0 1 0 0 0 0	0 0 0 0 0 1 0 0 0 0	15 17 18 19 12 51 38 36 55 12	86 86 86 86 87 90 89 89 90 86
Year	91 91 89 91 91 95 91 95 89 95	90 86 90 91 91 90 81 95 90 95	90 86 90 91 91 90 81 95 90 95	90 86 90 91 91 90 81 95 90 95	86 86 86 86 87 90 89 89 90 86	86 86 86 86 87 90 89 89 90 86
Altitude (* 10)	2 3 2 3 2 2 2 2 2 2	2 3 2 3 3 3 3 3 3 2	2 3 2 3 3 3 3 3 3 2	2 3 2 3 3 3 3 3 3 2	3 3 3 3 3 2 3 3 3 3	3 3 3 3 3 2 3 3 3 3
Steepness	96 12 80 10 95 88 10 80 80 95	70 05 95 10 25 05 10 10 90 90	70 05 95 10 25 05 10 10 90 90	70 05 95 10 25 05 10 10 90 90	40 50 60 75 15 90 54 50 15 28	40 50 60 75 15 90 54 50 15 28
Exposition	50 70 40 45 60 80 30 75 40 80	35 35 15 15 5 15 15 20 15 0	35 35 15 15 5 15 15 20 15 0	35 35 15 15 5 15 15 20 15 0	5 45 20 ? 30 15 40 10 10 2	5 45 20 ? 30 15 40 10 10 2
Vascular plant cover	20 10 20 20 15 7 15 5 20 2	15 1 10 2 5 40 10 10 10 2	15 1 10 2 5 40 10 10 10 2	15 1 10 2 5 40 10 10 10 2	s sw se se sw ne s ne se w	s sw se se sw ne s ne se w
Bryophyte cover	3 5 10 5 5 5 1 5 20 10	5 0 2 1 3 2 1 2 2 1	5 0 2 1 3 2 1 2 2 1	5 0 2 1 3 2 1 2 2 1	5 1 3 1 5 2 30 10 5 3	5 1 3 1 5 2 30 10 5 3
Lichen cover	5 2 5 5 5 1 1 1 1 1	- - - - + + + + +	- - - - + + + + +	- - - - + + + + +	3 - + + + + + + 5 - +	3 - + + + + + + 5 - +
Stone cover	75 85 20 70 80 90 80 60 90	60 90 80 50 95 50 95 80 90 50	60 90 80 50 95 50 95 80 90 50	60 90 80 50 95 50 95 80 90 50	90 99 95 99 95 95 70 50 90 95	90 99 95 99 95 95 70 50 90 95
Bare soil	0 0 10 + 0 0 0 0 0 0	20 0 0 40 0 10 0 10 0 50	20 0 0 40 0 10 0 10 0 50	20 0 0 40 0 10 0 10 0 50	0 0 0 0 0 0 0 0 30 0 0	0 0 0 0 0 0 0 0 30 0 0
Number of lichens	9 11 4 5 9 3 2 2 3 1	0 0 0 2 2 0 0 1 2 1	0 0 0 2 2 0 0 1 2 1	0 0 0 2 2 0 0 1 2 1	0 0 1 0 1 1 1 3 0 0 3	0 0 1 0 1 1 1 3 0 0 3
Number of bryophytes	9 12 10 6 6 19 4 13 11 10	2 1 3 3 1 1 0 3 3 6	2 1 3 3 1 1 0 3 3 6	2 1 3 3 1 1 0 3 3 6	2 0 4 3 3 3 1 0 4 1	2 0 4 3 3 3 1 0 4 1
Number of vasc.plants	28 19 27 24 27 28 16 29 14 21	17 5 12 6 13 15 15 7 9 9	17 5 12 6 13 15 15 7 9 9	17 5 12 6 13 15 15 7 9 9	11 8 12 10 14 7 6 8 11 15	11 8 12 10 14 7 6 8 11 15
<i>D.sp. Saxifragion sibiricae, Saxifragetum sibiricae</i>						
<i>Saxifraga sibirica</i>	+ 1 1 + + + + + 1 1	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Minuartia imbricata</i>	1 1 1 + + + 2 1 2 +	1 + + + + 2 1 2 +	1 + + + + 2 1 2 +	1 + + + + 2 1 2 +	1 + + + + + + + + +	1 + + + + + + + + +
<i>Matricaria caucasica</i>	+ + + +	+ + + + + 1 + + + +	+ + + + + 1 + + + +	+ + + + + 1 + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +
<i>Veronica telephifolia</i>	+ +	+ + + + + 1 + + + +	+ + + + + 1 + + + +	+ + + + + 1 + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +
<i>Murbeckiella huetii</i>	+ +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +
<i>Draba scabra</i>	+ 1 1 1 +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + + + +	+ + + + + + + + + + +
<i>D.sp. S.s. primuletosum amoena</i>						
<i>Primula amoena</i>	1 1 2 2 1 2 + 2 +	1 2 2 1 2 + 2 +	1 2 2 1 2 + 2 +	1 2 2 1 2 + 2 +	+ + + + + + + + +	+ + + + + + + + +
<i>Lloydia serotina</i>	+ + + + 1 1 + + +	+ + + + 1 1 + + +	+ + + + 1 1 + + +	+ + + + 1 1 + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Festuca ovina</i>	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Anemone speciosa</i>	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Polytrichastrum alpinum</i>	+ + + + + 1 + + +	+ + + + + 1 + + +	+ + + + + 1 + + +	+ + + + + 1 + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Cetraria islandica</i>	1 + + + 1 + + +	1 + + + 1 + + +	1 + + + 1 + + +	1 + + + 1 + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Myosotis alpestris</i>	r + + + r + + +	r + + + r + + +	r + + + r + + +	r + + + r + + +	+ + + + + + + + +	+ + + + + + + + +
<i>Luzula spicata</i>	+ r + + + + + +	+ r + + + + + +	+ r + + + + + +	+ r + + + + + +	+ + + + + + + + +	+ + + + + + + + +





For Table 10.3.

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

*Alchemilla sericea* (102/95, 113/95), *Alectoria echalybeiformis* (2/91), *Anastrophyllum minutum* (1/91, 43/89), *Anthemis marshalliana* (12/87), *Anthoxanthum odoratum* (150/90:1), *Aster alpinus* (138/90), *Astragalus levieri* (10/91), *Barbilophozia hatcheri* (52/89), *Blepharostoma trichophyllum* (102/95), *Blindia acuta* (52/89), *Brachythecium glaciale* (113/95), *Bryum capillare* (113/95), *Campanula saxifraga* (2/91), *Campylium stellatum* (43/89, 52/89), *Cephalozia pleniceps* (1/91, 3/91), *Cerastium purpurascens* (3/91, 10/91), *Cerastium undulatifolium* (18/86, 155/90), *Ceratodon purpureus* (56/95:1), *Cetraria ericetorum* (18/86, 38/89), *Cicerbita racemosa* (102/95), *Cirsium obvallatum* (113/95), *Cladonia gracilis* (43/89), *Comicularia muricata* (1/91, 2/91), *Cruciata laevipes* (12/86), *Cystopteris fragilis* (113/95), *Desmatodon latifolius* (75/95), *Dicranum spadiceum* (155/90), *Draba hispida* (43/89), *Draba rigida* (150/90, 156/90), *Draba sibirica* (27/81), *Dryopteris filix-mas* (156/90:r, 153/90:r), *Empetrum nigrum* (102/95, 138/90:3), *Encalypta alpina* (102/95), *Epilobium* sp. (151/90), *Erigeron alpinus* (156/90:r, 12/86), *Erigeron caucasicus* (15/86), *Eunomia rotundifolia* (38/89, 12/86), *Euphrasia ossica* (2/91), *Euphrasia petiolaris* (128/95), *Eurhynchium pulchellum* (102/95), *Gentiana pyrenaica* (102/95, 52/89), *Grimmia affinis* (18/86), *Grimmia elatior* (19/86), *Grimmia incurva* (3/91, 10/91), *Grimmia laevigata* (19/86), *Grimmia montana* (113/95), *Grimmia pulvinata* (2/91), *Gymnomitron concinatum* (1/91, 2/91), *Gymnomitron* sp. (102/95), *Hedysarum caucasicum* (128/95), *Helictotrichon versicolor* (128/95), *Hieracium macrolepis* (150/90), *Huperzia selago* (43/89, 2/91), *Hydrogymmia mollis* (128/95:1), *Hygrohypnum duriusculum* 128/95:1), *Hypnum cupressiforme* (2/91), *Hypnum revolutum* (2/91, 18/86), *Jungermannia* sp. (10/91), *Kobresia schoenoides* (12/91), *Koeleria eriostachya* (10/91), *Leontodon hispidus* (150/90:1, 27/81), *Lescurea saxicola* (102/95:1), *Lophozia excisa* (3/91), *Lophozia* sp. (102/95), *Minuartia aizoides* (43/89:1), *Minuartia circassica* (1/91, 2/91:r), *Minuartia recurva* (1/91, 12/86), *Mnium thomsonii* (102/95), *Myurella tenerima* (12/87), *Oxyria digyna* (153/90:1, 151/90), *Pedicularis condensata* (2/91:r), *Pedicularis nordmanniana* (150/90), *Peltigera aphthosa* (3/91), *Peltigera canina* (113/95), *Peltigera* sp. (128/95), *Philonotis fontana* (128/95:1), *Phleum alpinum* (113/95, 150/90), *Plagiochila porelloides* (52/89, 128/95), *Plagiothecium denticulatum* (113/95, 128/95), *Poa alpina* (43/89, 150/90), *Poa caucasica* (52/89), *Pogonatum umigerum* (102/95, 75/95), *Pohlia drummondii* (52/89), *Pohlia minor* (12/91), *Pohlia nutans* (102/95), *Pohlia obtusifolia* (16/91), *Polygonum viviparum* (10/91, 2/91), *Polytrichum juniperinum* (3/91, 43/89), *Potentilla divina* (2/91:r, 12/87), *Pseudoleskea incurvata* (113/95:1, 75/95), *Psora* sp. (1/91), *Radula lindbergiana* (128/95), *Ranunculus oreophilus* (102/95), *Rhizomnium punctatum* (128/95), *Sagina saginoides* (156/90:r), *Salix kazbekensis* (113/95), *Schistidium rivulare* (128/95:1), *Silene lychnidea* (12/86), *Solorina crocea* (3/91), *Sphenolobus minutus* (102/95), *Trifolium polyphyllum* (12/87), *Tritomania exsecta* (52/89), *Tritomania quinqueidentata* (1/91, 3/91), *Viola altaica* (1/91:r, 15/86).

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

1/91 - 29.07, 9, M.Khatipara; 3/91 - 29.07, 9, M.Khatipara; 43/89 - 01.09, 10, M.Khatipara; 10/91 - 04.08, 8, M.Khatipara; 2/91 - 29.07, 6, M.Khatipara; 102/95 - 19.08, 14, Azgek; 12/91 - 04.08, 6, M.Khatipara; 113/95 - 19.08, 24, M.Khatipara; 52/89 - 01.09, 25, M.Khatipara; 128/95 - 29.08, 30, Nazalykol; 150/90 - 18.08, 9, Baduk; 5/86 - 09.08, 10, M.Khatipara; 156/90 - 19.08, 25, Khuty; 16/91 - 04.08, 4, M.Khatipara; 32/91 - 17.08, 12, Nazalykol; 138/90 - 17.08, 9, Khadzhibey; 27/81 - 14.08, 10, Chuchkhur; 56/95 - 10.07, 25, Epchik; 153/90 - 19.08, 20, Baduk; 75/95 - 13.07, 9, Baduk; 15/86 - 13.08, 25, Goralykol; 17/86 - 13.08, 25, Kyshkadzher (A.Sennov); 18/86 - 13.08, 100, Kyshkadzher; 19/86 - 13.08, 25, Kyshkadzher; 12/87 - 17.08, 15, Alibek; 151/90 - 19.08, 25, Baduk; 38/89 - 18.08, 6, Kyshkadzher (N.Lubeznova); 36/89 - 18.08, 6, Kyshkadzher (N.Lubeznova); 155/90 - 19.08, 25, Baduk; 12/86 - 13.08, 50, Goralykol (I.Pavlova)

The role of bryophytes is very important. The ratio vascular plants / (bryophytes + lichens) is the lowest among all studied syntaxa of the reserve (0.9).

The nomenclature type, or *typus*, No. 10/91.

**S.s. *typicum*** combines alpine and subnival snowbed plant communities on screes. It does not have diagnostic species of its own, but typically lacks diagnostic species of other subassociations. The nomenclature type (*typus*) is releve No. 16/91.

**S.s. *saxifragetosum moschatae*** represents subnival snowbeds (2900-3750 m a.s.l.) on slopes of varying steepness (2° - 45°) and aspect. Floristic richness is relatively low. *Saxifraga moschata*, *Senecio karjaginii* and *Potentilla gelida* form the diagnostic set of the subassociation. The species indicate that the substrate is rather stable. The nomenclature type (*typus*) is releve No. 18/86.

Overall, we registered 93 vascular plant species, 64 bryophytes and 20 macrolichens in 30 relevés of the association. Mean number of species per releve was however rather low (15, 5 and 2 species correspondingly). More detailed study of floristic richness showed that average numbers were 4.6, 14.8 and 30.6 vascular plant species in 0.01, 1 and 100 sq.m - plots (ONIPCHENKO & SEMENOVA 1995). Vascular plant cover ranges from less than 1% to 40% (mean 10%), that of bryophytes - from less than 1% to 20% (mean 3%). The role of lichens is small.

### **Ecological features**

The communities are commonly found in the alpine and subnival zone within the elevation range of 2700 to 3750 m (mean 3110 m). They occupy slopes of various exposure and steepnesses (0-80°). Bare soil, rocks and boulders cover a significant portion of the community area (50-99%).

The considerable snow accumulation and high altitude position of this community shortens the vegetation season. On the other hand, there is no water shortage during the season and plants can develop quickly.

We detected about 8080 seeds/sq.m in the soil seed bank of the communities on Mt. M.Khatipara (SEMENOVA & ONIPCHENKO 1994). About half of the bank consists of *Saxifraga sibirica* seeds. *Carex pyrenaica*, *Cerastium cerastioides*, *Luzula multiflora*, *Murbeckiella huetii* and *Sedum tenellum* were other important components of the seed bank.

## 11. Subalpine meadows - **Mulgedio-Aconitetea**

Prodromus

*Mulgedio-Aconitetea* HADAC & KLIKA in KLIKA & HADAC 1944

*Calamagrostietalia villosae* PAWLOWSKI *et al.* 1928

*Calamagrostion arundinaceae* OBERD 1950

*Betonici macranthae-Calamagrostietum arundinaceae* ass.nov.

*B.m.-C.a. typicum* subass.nov

*B.m.-C.a. veronicetosum peduncularis* subass.nov.

*Rumicetalia alpini* MUCINA in KARNER & MUCINA 1993

*Rumicion alpini* RUBEL ex KLIKA in KLIKA & HADAC 1944

*Anthrisko sylvestris-Rumicetum alpini* ass.nov.

*A.s.-R.a. typicum* subass.nov.

*A.s.-R.a. senecionetosum platyphylloidis* subass.nov.

*Cephalario giganteae-Ligusticetum alani* ass.nov.

*Poetum longifoliae* ass.nov.

Subalpine meadows and tall herbaceous communities are well represented in the Teberda Reserve. Such diagnostic species of the class as *Millium effusum*, *Geranium sylvaticum*, *Campanula latifolia*, *Rumex alpestris* are common in the Caucasian communities (BUSLIK 1990, KARNER & MUCINA 1993). We consider the communities within two orders - *Calamagrostietalia villosae* and *Rumicetalia alpini* (Table. 11.1.)

### 11.1. *Betonici macranthae-Calamagrostietum arundinaceae*

The association comprises closed subalpine meadow with *Calamagrostis arundinacea* as one of the common dominants. Due to high frequency of this species and presence of some other diagnostic species (*Anthoxanthum odoratum*, *Silene vulgaris*, *Anemone narcissiflora*, *Deschampsia flexuosa* etc.), we consider the associations within *Calamagrostietalia villosae* and *Calamagrostion arundinaceae*

#### **Floristic features**

The set of diagnostic species includes many that are frequent in the subalpine zone (*Betonica macrantha*, *Bupleurum falcatum*, *Anthemis macroglossa*, *Trifolium canescens*, *Thesium alpinum*, *Tragopogon*

*reticulatus*). Some of the species are shared with *Viola altaicae-Festucetum variae* (*Leontodon hispidus*, *Myosotis alpestris*, *Festuca varia*, *Campanula collina*, *Polygala alpicola*), but these species distinguish the association from the communities of *Rumicion alpini*. (Tables 11.1., 11.2.). We subdivide the association into two subassociations.

**B.m.-C.a. typicum** includes communities with high frequency of *Pulsatilla aurea*, *Pedicularis condensata*, *Ranunculus oreophilus*, *Pyrethrum coccineum* etc. (Table 11.2.). They tend to occupy the upper part of the subalpine zone (2250-2650 m a.s.l., mean 2460 m). Typus, or nomenclature type, is releve No. 68/94).

**B.m.-C.a. veronicetosum peduncularis** is typical for the lower part of the subalpine zone within the elevation range 1950-2300 m a.s.l. (mean 2120 m). A considerable diagnostic set (*Veronica peduncularis*, *Polygonum alpinum*, *Seseli libanotis*, *Digitalis ciliata*, *Macrotomia echioides* etc.) distinguishes this syntaxon from the previous one. Typus, or nomenclature type, is releve No. 3/88.

In general, the communities of the association are floristically very rich. We registered 183 vascular plant species and 15 bryophytes in 20 relevés (Table 11.2.). The average species numbers per releve were 37 and 1 for vascular plants and bryophytes correspondingly. Lichens were completely absent. Ratio vascular plants / (bryophytes + lichens) is high (12.2). The role of bryophytes is also very low in term of plant cover. Vascular plant cover is high (50-100%, mean 84%).

### **Ecological features**

The communities are typical of the subalpine zone within the altitude range of 1950 to 2650 m. They occupy mainly steep slopes (7°-35°, mean 26°) of near southern exposure. Stone and bare soil cover is low. The communities are rather productive, but due to their position in the landscape they may sometimes lack sufficient water supply. The communities can easily degrade if overgrazed. Due to their rich floristic composition, which includes a number of attractive wildflowers (*Lilium monadelphum*, *Pulsatilla aurea*, *Pyrethrum coccineum*, *Aetheopappus vvedenskii*), the communities must be placed under especially strong protection in the reserve area.

**Table 11.1.**  
Diagnostic table of *Mulgedio-Aconitetea*

	1	2	3	4	5	6
<i>D.sp. B.m.-C.a. typicum</i>						
<i>Pulsatilla aurea</i>	IV	-	-	-	-	-
<i>Pedicularis condensata</i>	IV	-	-	-	I	-
<i>Ranunculus oreophilus</i>	IV	I	-	-	-	-
<i>Gentiana biebersteinii</i>	III	-	-	-	-	-
<i>Pyrethrum coccineum</i>	III	-	-	-	-	-
<i>Erigeron caucasicus</i>	III	-	-	-	-	-
<i>Daphne glomerata</i>	III	I	-	I	-	-
<i>Pedicularis comosa</i>	II	-	-	-	-	-
<i>Senecio caucasicus</i>	II	-	-	-	-	-
<i>Aetheopappus vvedenskii</i>	II	-	-	-	-	-
<i>Helictotrichon versicolor</i>	II	-	-	-	-	-
<i>D.sp. B.m.-C.a. veronicetosum peduncularis</i>						
<i>Veronica peduncularis</i>	-	V	-	-	-	I
<i>Polygonum alpinum</i>	-	V	-	-	I	-
<i>Seseli libanotis</i>	-	IV	-	-	-	-
<i>Digitalis ciliata</i>	I	IV	-	-	I	-
<i>Macrotomia echioides</i>	-	III	-	-	-	-
<i>Clinopodium vulgare</i>	-	III	-	-	-	-
<i>Cirsium chlorocomos</i>	-	III	-	-	-	-
<i>Asyneuma campanuloides</i>	-	III	-	-	I	-
<i>Stachys germanica</i>	I	III	-	-	-	-
<i>Pimpinella rhodantha</i>	I	III	-	-	II	-
<i>Geranium platypetalum</i>	-	II	-	-	-	-
<i>Heracleum freynianum</i>	-	II	-	-	-	-
<i>Pastinaca pimpinellifolia</i>	-	II	-	-	-	-
<i>Origanum vulgare</i>	-	II	-	-	-	-
<i>Lilium monadelphum</i>	-	II	-	-	I	-
<i>D.sp. Betonici macranthae-Calamagrostietum arundinaceae</i>						
<i>Betonica macrantha</i>	V	V	-	-	IV	I
<i>Bupleurum falcatum</i>	IV	IV	-	-	-	-
<i>Leontodon hispidus</i>	IV	II	-	-	-	-
<i>Myosotis alpestris</i>	IV	III	-	-	I	I
<i>Campanula collina</i>	V	III	-	-	-	-
<i>Anthemis macroglossa</i>	III	III	-	-	-	-
<i>Hedysarum caucasicum</i>	IV	II	-	-	I	-
<i>Festuca varia</i>	IV	II	-	-	-	-
<i>Trifolium canescens</i>	IV	II	-	-	-	-
<i>Geranium renardii</i>	III	II	-	-	-	-
<i>Thesium alpinum</i>	III	II	-	-	-	-
<i>Tragopogon reticulatus</i>	III	II	-	-	-	-
<i>Polygala alpicola</i>	III	II	-	-	-	-
<i>Rhinanthus minor</i>	II	III	-	-	-	-
<i>Primula veris</i>	II	II	-	-	-	-
<i>Festuca djimilensis</i>	II	IV	-	I	II	-
<i>Gentiana septemfida</i>	V	II	-	-	I	I

Table 11.1. (continued)

	1	2	3	4	5	6
<i>D.sp. Calamagrostion arundinaceae, Calamagrostietalia villosae</i>						
<i>Calamagrostis arundinacea</i>	IV	V	-	-	III	-
<i>Anthoxanthum odoratum</i>	V	-	-	-	-	I
<i>Silene vulgaris</i>	IV	IV	I	I	III	-
<i>Anemone narcissiflora</i>	III	-	-	-	-	-
<i>Deschampsia flexuosa</i>	III	-	-	-	-	-
<i>Hieracium prenanthoides</i> gr.	II	I	-	-	I	-
<i>Solidago virgaurea</i>	I	-	-	-	-	-
<i>D.sp. A.s.-R.a. typicum</i>						
<i>Galeopsis bifida</i>	-	-	III	-	I	II
<i>Symphytum asperum</i>	-	-	III	I	-	I
<i>D.sp. A.s.-R.a. senecionetosum platyphylloides</i>						
<i>Senecio platyphylloides</i>	-	-	-	V	I	-
<i>D.sp. Anthrisco sylvestris-Rumicetum alpini</i>						
<i>Urtica dioica</i>	-	-	V	II	I	III
<i>Anthriscus sylvestris</i>	-	I	III	IV	II	II
<i>D.sp. Cephalario giganteae-Ligusticetum alani</i>						
<i>Ligusticum alatum</i>	-	-	-	-	IV	-
<i>Aconitum orientale</i>	-	-	II	II	IV	I
<i>Vicia cracca</i>	I	II	I	-	IV	II
<i>Dactylis glomerata</i>	-	II	II	-	IV	I
<i>Cephalaria gigantea</i>	II	V	I	-	V	-
<i>Lapsana communis</i>	-	I	-	I	II	-
<i>D.sp. Poetum longifoliae</i>						
<i>Alopecurus pratensis</i>	-	-	I	-	I	IV
<i>Poa longifolia</i>	III	III	I	-	III	V
<i>Senecio subflocosus</i>	-	-	-	-	-	II
<i>D.sp. Rumicion alpini, Rumicetalia alpini</i>						
<i>Rumex alpinus</i>	-	I	V	V	II	II
<i>Lamium album</i>	-	I	II	-	III	II
<i>Veratrum album</i>	I	-	I	I	III	-
<i>Heracleum asperum</i>	-	-	I	III	I	III
<i>Veronica filiformis</i>	-	I	I	II	II	II
<i>Cerastium davuricum</i>	-	-	I	-	I	II
<i>D.sp. Mulgedio-Aconitetea</i>						
<i>Millium effusum</i>	-	-	V	V	V	II
<i>Geranium sylvaticum</i>	II	IV	I	III	V	IV
<i>Rumex alpestris</i>	III	III	-	I	V	-
<i>Campanula latifolia</i>	-	I	I	II	III	-
<i>Aconitum nasutum</i>	I	I	-	-	I	-
<i>Achillea millefolium</i>	-	III	-	-	I	IV
<i>Athyrium distentifolium</i>	-	-	-	I	-	-
<i>Astrantia maxima</i>	IV	V	-	I	IV	I

Syntaxa:

1 - *Betonici macranthae-Calamagrostietum arundinaceae typicum*, 2 - *B.m.-C.a. veronicetosum peduncularis*, 3 - *Anthrisco sylvestris-Rumicetum alpini typicum*, 4 - *A.s.-R.a. senecionetosum platyphylloides*, 5 - *Cephalario giganteae-Ligusticetum alani*, 6 - *Poetum longifoliae*

**Table 11.2.**

*Betonici macranthae-Calamagrostietum arundinaceae*

Releve No.	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0		
	69	49	68	14	12	13	86	67	9	65	57	3	48	94	7	5	6	2	25	
Year	94	93	94	88	88	95	94	95	84	95	93	88	93	94	93	93	93	93	93	94
Altitude (* 10)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
	50	50	50	30	30	50	65	60	40	55	20	20	30	20	05	05	05	10	95	
Steepness	30	30	30	35	35	10	30	30	20	25	30	35	25	20	30	30	30	7	10	
Exposition	se	se	sw	sw	sw	sw	sw	sw	ne	ne	se	sw	e	se	sw	sw	se	se	se	
Vascular plant cover	50	80	80	90	95	85	80	90	95	95	99	90	90	70	65	75	90	85	95	
Bryophyte cover	0	0	0	+	5	0	+	+	10	0	0	0	0	0	0	0	0	+	0	
Lichen cover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stone cover	0	5	0	+	+	0	0	+	0	0	+	+	+	15	0	1	0	+	+	
Bare soil	+	0	30	0	0	15	5	5	0	5	0	0	0	2	0	0	0	0	1	
<i>D.sp. B.m.-C.a. typicum</i>																				
<i>Pulsatilla aurea</i>				1	1	1	1	1	2	1										
<i>Pedicularis condensata</i>	+		+	1	1	+		+	1											
<i>Ranunculus oreophilus</i>	1	+	1	1	1		1	+	1		+									
<i>Gentiana biebersteinii</i>	+	+			+		+		+											
<i>Pyrethrum coccineum</i>	+	+	+	1	1					+										
<i>Erigeron caucasicus</i>	+		+	+			+	+												
<i>Daphne glomerata</i>		+	+	+		+	+	+						+						
<i>Pedicularis comosa</i>	+	+		1			+													
<i>Senecio caucasicus</i>							+	2		1										
<i>Aetheopappus vvedenskii</i>			+	+	+		2													
<i>Helictotrichon versicolor</i>	+	+					+													
<i>D.sp. B.m.-C.a. veronicetosum peduncularis</i>																				
<i>Veronica peduncularis</i>																				
<i>Polygonum alpinum</i>																				
<i>Seseli libanotis</i>																				
<i>Digitalis ciliata</i>		1																		
<i>Macrotomia echioides</i>																				
<i>Clinopodium vulgare</i>																				
<i>Cirsium chlorocomos</i>																				
<i>Asyneuma campanuloides</i>																				
<i>Stachys germanica</i>							+													
<i>Pimpinella rhodantha</i>		+																		
<i>Geranium platypetalum</i>																				
<i>Heracleum freynianum</i>																				
<i>Pastinaca pimpinellifolia</i>																				
<i>Origanum vulgare</i>																				
<i>Lilium monadelphum</i>																				
<i>D.sp. Betonici macranthae-Calamagrostietum arundinaceae</i>																				
<i>Betonica macrantha</i>	1	1	+	2	2	+	2	2	1	+	1	1	1	1	1	2	1	1	2	
<i>Bupleurum falcatum</i>	1	1	+	1	1	1	+		1		1	1	2	1	r	1	+			
<i>Leontodon hispidus</i>	1	1	1	+	1	+		+	1			1	+	+						
<i>Myosotis alpestris</i>	+		+	+	+	+	+	+							r		+	+	+	
<i>Campanula collina</i>	+	1	1	1	1	+	+	+	+		+	+	+	+						
<i>Anthemis macroglossa</i>	+	1	+			+	1		1		+	+	1	+						+
<i>Hedysarum caucasicum</i>		1	3	2	1		2	1	2	1	1	2			+					
<i>Festuca varia</i>	2	2	2	2			2	1	2		1			1						
<i>Trifolium canescens</i>	1	1	+	1	1	+			+					1						+

Table 11.2. (continued)

Releve No.	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
	69	49	68	14	12	13	86	67	9	65	57	3	48	94	7	5	6	2	25
Year	94	93	94	88	88	95	94	95	84	95	93	88	93	94	93	93	93	93	94
<i>Geranium renardii</i>	2	2	2	2	1		1				1	1	2						
<i>Thesium alpinum</i>	+	r	+				+		+		+	1	+						
<i>Tragopogon reticulatus</i>	1		+		+	+	+				+								+
<i>Polygala alpicola</i>		+	+	+		+			+		+			+					
<i>Rhinanthus minor</i>			+	+	+						+	+	+						+
<i>Primula veris</i>							+	1		+					+	+			
<i>Festuca djimilensis</i>				2	3	2				2	2	2	3		1	2	+		
<i>Gentiana septemfida</i>	+	+		+	+	+	1	+	+	+							+	+	
D.sp. <i>Calamagrostion arundinaceae</i> , <i>Calamagrostietalia villosae</i>																			
<i>Calamagrostis arundinacea</i>	3	3	2	1		2	3		1	1	3	3	1	4	2	2	1		2
<i>Anthoxanthum odoratum</i>	+	+	1		+	1	+	+	1	+									
<i>Silene vulgaris</i>	1		1		1	+		+	1	+	1	1			+		+	+	1
<i>Anemone narcissiflora</i>						2	+	2	1	3									
<i>Deschampsia flexuosa</i>	1	1		1			1		1										
<i>Hieracium prenanthoides</i>	+		+		1	+													+
<i>Solidago virgaurea</i>			+						1										
D.sp. <i>Mulgedio-Aconitetea</i>																			
<i>Geranium sylvaticum</i>					1	1		1		1	+	1			2	1		2	1
<i>Rumex alpestris</i>	+		+				+	+	1	+	1		+					1	1
<i>Campanula latifolia</i>																			+
<i>Aconitum nasutum</i>								+									+		
<i>Achillea millefolium</i>																+	+	1	+
<i>Astrantia maxima</i>		+		2	1	+	1	1	1	1	+	1	1	+	+	1		1	+
Other species																			
<i>Agrostis vinealis</i>					1		+	+	+				1	+				+	+
<i>Alchemilla vulgaris aggr.</i>					+	+	1				+			1	+			1	+
<i>Botrychium lunaria</i>		r			+														+
<i>Bromopsis variegata</i>	1	1									1				+	+	2		+
<i>Carduus adpressus</i>				+							+	1			+	+	+	r	+
<i>Carex atrata</i>			+				+	+											
<i>Carex umbrosa</i>		+													r	+	+		
<i>Cephalaria gigantea</i>		1	+		1	+					1	1	1		1	2	+	1	1
<i>Chaerophyllum aureum</i>											+				+	1	+	+	+
<i>Cicerbita racemosa</i>													+		+	+			
<i>Cirsium munitum</i>			+	1	1	+		+											
<i>Cruciata laevipes</i>	+	+			1	+	+			+	+		+	+	+	+	+	+	+
<i>Dactylis glomerata</i>											1							2	+
<i>Dianthus cretaceus</i>			+	+							+								
<i>Euphrasia ossica</i>		+			+				+										
<i>Festuca brunnescens</i>			+				+	+											+
<i>Fritillaria lutea</i>	+								+						+			+	
<i>Galium verum</i>	+												+	+				+	
<i>Gentiana verna</i>	+						+	+											
<i>Geranium gymnocaulon</i>								1	2	+									
<i>Hieracium macrolepis</i>	+	+	+																
<i>Luzula multiflora</i>		+						+	+										
<i>Nardus stricta</i>	+	+	1						1										
<i>Poa longifolia</i>						+	+	+	+	+			1			+	2	1	1

Table 11.2. (continued)

Releve No.	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
	69	49	68	14	12	13	86	67	9	65	57	3	48	94	7	5	6	2	25
Year	94	93	94	88	88	95	94	95	84	95	93	88	93	94	93	93	93	93	94
<i>Polygonum bistorta</i>	+	+	+	1	1	1												1	2
<i>Primula ruprechtii</i>				1	+				+										
<i>Scabiosa caucasica</i>	+	2	1								1								
<i>Senecio kolenatianus</i>				+				+				+							
<i>Thalictrum foetidum</i>														+	+	+			
<i>Trifolium ambiguum</i>	1		1		1				1		+	1							+
<i>Trifolium medium</i>														1	1	1			
<i>Trisetum flavescens</i>					+				+		+	+			+			+	+
<i>Vaccinium myrtillus</i>							+	1					+						
<i>Valeriana cardamines</i>														+	+	+			
<i>Veronica gentianoides</i>	+	+	1	1	+	1	+	1	+									+	
<i>Vicia cracca</i>		+											1	1					+

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

*Achyrophorus maculatus* (3/83:1), *Alchemilla caucasica* (69/94, 49/93), *Alyssum murale* (69/94), *Anthemis marshalliana* (69/94, 68/94), *Anthriscus sylvestris* (6/93), *Anthyllis vulneraria* (49/93), *Arenaria rotundifolia* (67/95, 2/93), *Astragalus oreades* (68/94, 194/94), *Astragalus* sp. (57/93, 6/93), *Bartramia ithyphylla* (14/88), *Brachythecium erythrorhizon* (186/94, 2/93), *Brachythecium reflexum* (67/95), *Brachythecium velutinum* (14/88, 12/88:1), *Briza media* (49/93), *Bromopsis riparia* (25/94), *Bryum capillare* (12/88:1), *Carex brevicollis* (25/94), *Carex caryophylla* (69/94, 68/94), *Carex caucasica* (48/93:1), *Carex mingrelica* (13/95, 5/93), *Carex pallescens* (2/93), *Carex panicea* (194/94), *Carex sempervirens* (186/94), *Carlina vulgaris* (3/88), *Carum meifolium* (68/94, 9/84:1), *Centaurea cheiranthifolia* (69/94:1, 49/93), *Centaurea leucophylla* (3/88), *Centaurea nigrifimbria* (13/95), *Centaurea salicifolia* (49/93, 2/93), *Centaurea salviifolia* (194/94), *Cerastium arvense* (69/94, 6/93), *Cirsium obvallatum* (7/93, 5/93:1), *Coeloglossum viride* (68/94), *Coronilla orientalis* (186/94), *Cotoneaster integerimus* (194/94), *Crocus reticulatus* (13/95), *Draba hispida* (67/95), *Draba sibirica* (49/93, 6/93), *Dracocephalum ruyschiana* (3/88:1), *Euphorbia iberica* (25/94), *Euphorbia macroceras* (194/94), *Eurhynchium pulchellum* (186/94), *Festuca ovina* (25/94), *Gymnadenia conopsea* (49/93), *Helianthemum nummularium* (49/93:1, 3/88:1), *Hypericum linarioides* (69/94), *Inula orientalis* (9/84:1), *Juniperus communis* (49/93, 3/88), *Kemulariella caucasica* (9/84:1, 65/95), *Lamium album* (2/93), *Lapsana communis* (25/94), *Lathyrus cyaneus* (25/94), *Lathyrus pratensis* (14/88:1), *Lophocolea minor* (14/88), *Lotus comiculatus* (49/93:1, 3/88:1), *Minuartia recurva* (68/94), *Nonea intermedia* (5/93:1), *Orobanche grossheimii* (14/88), *Orobanche purpurea* (2/93), *Orobanche* sp. (57/93), *Pedicularis wilhelmsiana* (2/93), *Phleum alpinum* (9/84), *Phleum phleoides* (49/93), *Plagiomnium affine* (9/84:1), *Plantago atrata* (69/94, 68/94), *Poa palustris* (5/93:1, 6/93:1), *Poa pratensis* (7/93), *Polygala anatolica* (69/94), *Polygonatum verticillatum* (3/88), *Polytrichum juniperinum* (186/94), *Populus tremula* (3/88), *Primula meyeri* (67/95:1), *Pseudoleskea incurvata* (67/95), *Rhodobryum roseum* (14/88), *Rhododendron caucasicum* (9/84:1), *Rhynchocorys elephas* (13/95), *Rosa* sp. (3/88, 7/93), *Rosa villosa* (194/94), *Rumex alpinus* (48/93), *Scabiosa ochroleuca* (69/94, 194/94), *Sedum spurium* (194/94), *Sempervivum caucasicum* (69/94, 194/94), *Senecio aurantiacus* (67/95), *Seseli alpinum* (49/93, 6/93), *Silene italica* (194/94), *Taraxacum confusum* (69/94), *Taraxacum stevenii* (49/93), *Tayloria serrata* (9/84:1), *Thalictrum minus* (25/94:1), *Thymus nummularius* (14/88, 194/94), *Tortella tortuosa* (14/88), *Tortula subulata* (12/88), *Traunsteinera sphaerica* (68/94, 3/88), *Trifolium alpestre* (2/93), *Trifolium hybridum* (49/93), *Trifolium pratense* (12/88:1), *Trollius ranunculinus* (12/88), *Valeriana alpestris* (7/93, 5/93:1), *Veratrum album* (65/95), *Verbascum pyramidatum* (194/94), *Veronica chamaedrys* (6/93, 2/93), *Veronica filiformis* (2/93), *Vicia cassubica* (2/93), *Vicia sepium* (2/93), *Viola canina* (6/93:r), *Weissia controversa* (14/88, 12/88).

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

69/94 - 16.07, 25, Bol.Khatipara; 49/93 - 10.08, 16, M.Khatipara; 68/94 - 16.08, 25, Bol.Khatipara; 14/88 - 16.08, 64, Musat-Cheri; 12/88 - 16.08, 64, Musat-Cheri; 13/95 - 03.07, 25, Alibek; 186/94 - 09.09, 25, Kichi-Murudzhu; 67/95 - 13.07, 25, Baduk; 9/84 - 26.08, 25, M.Khatipara; 65/95 - 13.07, 25, Baduk (A.Egorov); 57/93 - 16.08, 16, Baduk; 3/88 - 30.07, 25, Ullu-Murudzhu; 48/93 - 10.08, 16, M.Khatipara; 194/94 - 10.09, 25, Kichi-Murudzhu; 7/93 - 08.07, 25, Ullu-Murudzhu (N.Drenova); 5/93 - 07.07, 25, Ullu-Murudzhu (E.Kuraeva); 6/93 - 07.07, 25, Ullu-Murudzhu (D.Sukhova); 2/93 - 04.07, 25, M.Khatipara (A.Egorov); 25/94 - 09.07, 25, Dombay-Ulgen (A.Egorov).

## 11.2. *Rumicetalia alpini*, *Rumicion alpini*

These syntaxa comprise subalpine tall herbaceous communities. Their development is often connected with existing or recent anthropogenic influence. We propose three new associations within the alliance.

### 11.2.1. *Anthriscus sylvestris*-*Rumicetum alpini*

#### Floristic features

The ruderal tall herbaceous communities form this association. *Rumex alpinus* is the main dominant, but diagnostic species (*Urtica dioica*, *Anthriscus sylvestris*) are also very common components of the communities. We distinguish two subassociations within the syntaxon (Table 11.3.).

***A.s.-R.a. typicum*** (Typus, or nomenclature type, No. 56/93) combines communities with high frequency of *Urtica dioica*, *Galeopsis bifida*, *Symphytum asperum*.

***A.s.-R.a. senecionetosum platyphylloidis*** (Typus, or nomenclature type, No. 31/95) includes communities with *Senecio platyphylloides*.

As a whole this community has low floristic richness. We registered only 69 vascular plant species and 3 bryophytes in 20 relevés. Lichens are completely absent and the role of bryophytes is negligible. Mean floristic richness was 10 species per releve (Table 11.3.). Tall (1.5-2.5 m) and dense (80-100%, mean 95%) vascular plant cover prevents establishment of other plants in this community.

#### Ecological features

The community occupies gentle (2°-20°, mean 6°) slopes of various exposures. It occurs at the sites of former livestock enclosures and sheepfolds, where plant cover has been drastically changed and soil has been manured. A few tall and highly productive species have established at such sites, since grazing was stopped. The community is very stable due to the high competitive ability of the dominants.

The community is typical of the subalpine zone in the altitude range of 1850 to 2600 m (mean 2300 m). It occupies the lower portions of slopes, valley bottoms and depressions on slopes with significant winter snowpack

accumulation. Stable water supply from the upper part of slopes is an important factor increasing its productivity.

Wild ungulates use the community as a pasture very seldom, if at all. Among large mammals only bear often feed on some plants (*Millium effusum*, *Heracleum asperum*, *Anthriscus sylvestris*), especially in the spring (BOBYR, personal communication).

### **11.2.2. *Cephalario giganteae-Ligusticetum alani***

#### **Floristic features**

The association combines multispecific tall herbaceous communities. *Ligusticum alatum*, *Aconitum orientale*, *Cephalaria gigantea*, *Lapsana communis*, *Dactylis glomerata*, *Vicia cracca* (Table 11.4.), represent diagnostic species. All species typically occur on rich soils.

Floristic richness is the highest among other communities of the alliance. We registered 77 vascular plant species and 4 bryophytes in 10 relevés. Average numbers were 25 vascular plant species and 1 bryophyte per relevé. As in other associations of the class, lichens were completely absent. Plant cover is tall (1.5-2 m) and dense (90-100%, mean 97%). Typus, or nomenclature type, is relevé No. 79/95.

#### **Ecological features**

The communities occupy bottoms of U-shaped valleys, alluvial fans and gentle (2°-20°, mean 8°) slopes of various but mainly southern exposure within the subalpine zone (1900-2600 m, mean 2170 m). Their high production is supported by ample water and nutrient supply brought from the upper slopes by snow avalanches and meltwater flows.

**Table 11.3.**

*Anthrisco sylvestris-Rumicetum alpini*

Releve No.	0 0 0 0 0 0 0 0 1 0	0 0 0 0 0 0 0 1 2
	15 16 80 93 55 56 3 49 93 58	73 28 45 14 31 99 65 76 02
Year	93 93 93 94 93 93 95 95 94 83	93 94 93 95 95 95 94 94 94
Altitude (* 10)	2 2 2 2 2 2 2 2 2 1	2 2 2 2 2 2 2 2 2
	25 25 35 35 15 15 00 35 35 85	45 00 60 50 45 35 40 38 38
Steepness	5 5 5 3 5 5 5 20 2 15	3 3 2 5 5 5 7 5 20
Exposition	w sw so nw sw e s w sw s	se s e sw sw se e nw ne
Vascular plant cover	99 99 99 80 99 99 99 95 90 90	98 98 99 99 99 99 90 90 90
Bryophyte cover	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 + 0 2
Stone cover	+ 0 0 + + 5 0 + 0 0	+ 0 0 0 0 0 2 10 10
Bare soil	0 0 0 + 0 0 0 5 0 0	0 0 0 0 0 0 + 0 0
<i>D.sp. A.s.-R.a. typicum</i>		
<i>Galeopsis bifida</i>	r + + + +	
<i>Symphytum asperum</i>	+ 1 + 1 1	1
<i>D.sp. A.s.-R.a. senecionetosum platyphylloides</i>		
<i>Senecio platyphylloides</i>		+ + 1 2 1 1 2 1 1
<i>D.sp. Anthrisco sylvestris-Rumicetum alpini</i>		
<i>Urtica dioica</i>	2 1 2 + 1 + 1 4 1 3	2 1
<i>Anthriscus sylvestris</i>	3 3 3 2 3 1	3 3 3 3 3 2 2
<i>D.sp. Rumicion alpini, Rumicetalia alpini</i>		
<i>Rumex alpinus</i>	4 5 3 4 3 2 4 2 3 2	4 4 3 4 4 4 3 3 1
<i>Lamium album</i>	1 1 1	
<i>Veratrum album</i>	1 +	1
<i>Heracleum asperum</i>	+ 1	1 + 1 2
<i>Veronica filiformis</i>	1 +	+ +
<i>Cerastium davuricum</i>	+ +	
<i>D.sp. Mulgedio-Aconitetea</i>		
<i>Millium effusum</i>	4 5 3 2 3 2 2 2 3	3 3 3 2 2 1 2 4 4
<i>Geranium sylvaticum</i>	1 r	+ + + + +
<i>Rumex alpestris</i>		
<i>Campanula latifolia</i>	2	1 1
<i>Aconitum nasutum</i>		
<i>Achillea millefolium</i>		
<i>Athyrium distentifolium</i>		1
<i>Astrantia maxima</i>		+
Other species		
<i>Aconitum orientale</i>	+ 3 3	1 1
<i>Carduus adpressus</i>	+ r 1	+ +
<i>Cirsium munitum</i>		+ + +
<i>Dactylis glomerata</i>	+ + + 1	

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

*Agropyron caninum* (58/83), *Alchemilla vulgaris* aggr. (73/93, 202/94:1), *Alopecurus pratensis* (49/95:1, 58/83:1), *Angelica tatiana* (55/93:2), *Arctium tomentosum* (49/95), *Asperugo procumbens* (49/95:1), *Brachythecium reflexum* (202/94:1), *Bromopsis benekenii* (58/83:1), *Campanula glomerata* (14/95:1), *Capsella bursa-pastoris* (49/95:1), *Cardamine uliginosa* (93/94), *Cephalaria gigantea* (80/93:2, 55/93), *Chaerophyllum aureum* (80/93:1, 58/83:1), *Chaerophyllum confusum* (49/95), *Chamerion angustifolium* (73/93), *Cicerbita racemosa* (202/94), *Cuscuta europaea* (58/83), *Daphne glomerata* (14/95), *Descurainia sophia* (49/95:2), *Euphorbia macroceras* (176/94), *Festuca djimilensis* (202/94), *Fritillaria latifolia* (14/95), *Fritillaria lutea* (176/94:r), *Galium aparine* (58/83:1), *Geranium gymnocaulon* (202/94:2), *Geranium pusillum* (58/83), *Geum rivale* (14/95), *Hesperis matronalis* (49/95), *Inula orientalis* (99/95, 202/94:1), *Lapsana communis* (202/94), *Myosotis amoena* (3/95, 193/94:1), *Myosotis caespitosa* (56/93:1),

*Myosotis sparsiflora* (49/95), *Pedicularis atropurpurea* (202/94), *Poa annua* (49/95), *Poa longifolia* (93/94, 49/95), *Poa pratensis* (49/95), *Polygonum aviculare* (49/95:1), *Potentilla elatior* (202/94), *Pseudoleskea incurvata* (65/94), *Pseudoleskea radicata* (202/94:1), *Rubus idaeus* (16/93, 58/83:1), *Scrophularia scopolii* (14/95), *Silene vulgaris* (58/83:1, 202/94:1), *Stellaria media* (49/95), *Stellaria nemorum* (56/93), *Thlaspi arvense* (49/95), *Trisetum flavescens* (73/93), *Valeriana officinalis* (14/95), *Vicia cracca* (80/93, 58/83), *Vicia sepium* (28/94).

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

15/93 - 08.07, 25, Ullu-Murudzhu (N.Illarionova); 16/93 - 08.07, 25, Ullu-Murudzhu (E.Kuraeva); 80/93 - 22.08, 25, M.Khatipara; 93/94 - 20.07, 25, Goralykol (D.Sukhova); 55/93 - 16.08, 25, Baduk; 56/93 - 16.08, 25, Baduk; 3/95 - 01.07, 25, Alibek; 49/95 - 09.07, 25, Epchik; 193/94 - 10.09, 25, Kichi-Murudzhu; 58/83 - 14.09, 100, M.Khatipara; 73/93 - 17.08, 25, Baduk; 28/94 - 09.07, 25, Dombay-Ulgen; 45/93 - 10.08, 25, M.Khatipara; 14/95 - 03.07, 25, Alibek; 31/95 - 06.07, 100, Chuchkhur; 99/95 - 25.07, 25, Khadzhibey (O.Cherednichenko); 65/94 - 15.07, 25, Bol.Khatipara; 176/94 - 08.09, 25, Klukhor; 202/94 - 11.09, 25, Klukhor.

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### 11.2.3. *Poetum longifoliae*

#### Floristic features

The association comprises subalpine grasslands with a tall grass - *Poa longifolia* - as a main dominant. The diagnostic species set includes *Alopecurus pratensis* and *Senecio subfloccosus* as well. Floristic richness here is intermediate between the two previous associations.

We registered 52 vascular plant species and 7 bryophytes in 8 releves. Mean numbers per releve were 15 and 1 species respectively. Vascular plant cover is high (10-90%, mean 67%), role of bryophytes is low.

Typus, or nomenclature type, is releve No. 146/94.

#### Ecological features

The community forms on recently or currently grazed sites. The impact of grazing is obvious: high frequency of non-palatable plants (*Alchemilla vulgaris* aggr., *Achillea millefolium*, *Lamium album*, *Urtica dioica* etc.), presence of a dense network of cattle paths, and cattle dung. This association is an example of human-altered vegetation within the preserve.

The grasslands occupy gentle (2°-10°, mean 5°) slopes of various (mainly northwestern) exposure within the subalpine zone near the timberline (altitude range 2150-2420 m, mean 2320 m). Significant snowpack accumulation and abundant water supplies from the upper portion of the ridge create a favourable water regime.

**Table 11.4.**

*Cephalario giganteae-Ligusticetum alani* and *Poetum longifoliae*

Releve No.	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1
	59	79	38	60	77	78	98	45	15	44	18	21	22	90	97	46	19	45
Year	83	95	95	95	95	95	95	83	95	93	95	91	91	94	94	94	95	94
Altitude (* 10)	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	90	15	90	20	15	20	35	10	15	60	30	30	30	15	40	42	30	42
Steepness	20	10	2	5	3	10	5	15	10	2	5	3	2	10	2	5	5	5
Exposition	ne	s	w	se	e	se	se	se	se	se	nw	n	nw	ws	n	e	nw	ws
Vascular plant cover	95	99	90	99	95	98	99	90	99	98	90	80	75	40	10	60	90	90
Bryophyte cover	0	0	15	0	+	0	0	0	0	0	7	0	0	0	1	2	5	0
Lichen cover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stone cover	+	+	2	0	3	2	0	0	0	+	0	0	0	1	90	2	0	1
Bare soil	0	0	0	0	5	0	+	0	0	0	0	0	0	1	+	0	0	0
D.sp. <i>Cephalario giganteae-Ligusticetum alani</i>																		
<i>Ligusticum alatum</i>	2	2	2	2	2	+	1											
<i>Aconitum orientale</i>	2	2	2	1	+	1		1										+
<i>Vicia cracca</i>	1	1	1	+	+	2		1	1				1			+		
<i>Dactylis glomerata</i>	2		1	+	+	1		1	1				1					
<i>Cephalaria gigantea</i>	2	+	2	1	+	2	+	2	3	+								
<i>Lapsana communis</i>	+	+	+							+								
D.sp. <i>Poetum longifoliae</i>																		
<i>Alopecurus pratensis</i>				+	+							r	1		+	1	+	+
<i>Poa longifolia</i>			2		+	+	+			2	1	3	3	2	3	4	4	2
<i>Senecio subflocossus</i>														+	+			
D.sp. <i>Rumicion alpini, Rumicetalia alpini</i>																		
<i>Rumex alpinus</i>	+	1		+						1	1			+				
<i>Lamium album</i>	1	+	+	+				1	+					1	+	+		
<i>Veratrum album</i>		1		1	1	+		1		2								
<i>Heracleum asperum</i>	2		1								+			+	+			+
<i>Veronica filiformis</i>		1	+	+							1	r						
<i>Cerastium davuricum</i>	1								+					1		1		1
D.sp. <i>Mulgedio-Aconitetea</i>																		
<i>Millium effusum</i>	2	2	2	2	+	1	+	2	2	2	1			1				1
<i>Geranium sylvaticum</i>	1	+	1	+	+	2	2	2	2	2	+		1	1			+	+
<i>Rumex alpestris</i>	+	+		+	1	1	1	1	+	1								
<i>Campanula latifolia</i>		2		3	1	+	1			1								
<i>Aconitum nasutum</i>										+								
<i>Achillea millefolium</i>	+							+				1	1		1	+	1	
<i>Astrantia maxima</i>		+	+		+	1	+	+	1	1	+							
Other species																		
<i>Alchemilla vulgaris aggr.</i>	1	+	1		+	1	+	+	1	2	1	2	2	2	2			3
<i>Anthriscus sylvestris</i>	1							2	1	2				1	+			
<i>Betonica macrantha</i>	1				+	2	+	1	2	1						+		
<i>Brachythecium salebrosum</i>			1		+						1							1
<i>Bromopsis variegata</i>											+		1		+			
<i>Calamagrostis arundinacea</i>	1		1			2	+	1	+									
<i>Carduus adpressus</i>	1	+	1	+					1									
<i>Chaerophyllum aureum</i>		1	1	+	+	1												
<i>Chamerion angustifolium</i>	1		1								5						2	4
<i>Cirsium munitum</i>					+	1	+			2								
<i>Cirsium obvallatum</i>	1		1												+			1
<i>Cruciata laevipes</i>	+		+						+	+			+	+	+			

Table 11.4. (continued)

Releve No.	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1
	59	79	38	60	77	78	98	45	15	44	18	21	22	90	97	46	19	45
Year	83	95	95	95	95	95	95	83	95	93	95	91	91	94	94	94	95	94
<i>Deschampsia caespitosa</i>											+	1						+
<i>Festuca djimilensis</i>						1	1		1									
<i>Galeopsis bifida</i>										+	+	r						
<i>Inula orientalis</i>	1				3	4												
<i>Myosotis amoena</i>		1	1							+								
<i>Phleum alpinum</i>										+	+	+						
<i>Pimpinella rhodantha</i>	+								1	+								
<i>Polygonum bistorta</i>				+	+	2				+	1			+	2			+
<i>Ranunculus caucasicus</i>						1				1		1						
<i>Rubus idaeus</i>	1		1						2			1						+
<i>Silene vulgaris</i>					+	2	+	1	1	1								
<i>Trisetum flavescens</i>							+	+	1				1		1	+		
<i>Trollius ranunculinus</i>					+	1	1											
<i>Urtica dioica</i>			+						1		1					1	1	1
<i>Vicia sepium</i>			+						1	+			1					

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

*Agropyron caninum* (59/83), *Agrostis stolonifera* (98/95, 118/95:2), *Agrostis vinealis* (21/91:1, 22/91:2), *Angelica tatiana* (79/95:3, 60/95:1), *Anthoxanthum odoratum* (22/91), *Aquilegia olympica* (59/83:1, 78/95:1), *Asyneuma campanuloides* (138/95), *Betula litwinowii* (45/83), *Brachythecium reflexum* (138/95:1, 77/95), *Brachythecium starkei* (118/95:1, 119/95:1), *Bryum subelegans* (146/94), *Campanula rapunculoides* (59/83:1, 45/83), *Cardamine impatiens* (79/95), *Cardamine uliginosa* (59/83), *Carduus nutans* (115/95), *Carex atrata* (44/93, 90/94), *Carex mingrellica* (79/95), *Carex umbrosa* (22/91), *Carum meifolium* (44/93), *Colchicum speciosum* (45/83), *Digitalis ciliata* (59/83), *Draba sibirica* (22/91, 97/94), *Dryopteris filix-mas* (59/83:1, 45/83), *Euphrasia ossica* (22/91:r), *Festuca ovina* (22/91), *Fragaria vesca* (59/83), *Fritillaria lutea* (22/91:r), *Galium verum* (119/95), *Gentiana septemfida* (115/95, 22/91:r), *Geranium gymnocaulon* (44/93:2), *Hedysarum caucasicum* (78/95), *Hieracium prenanthoides* gr. (77/95, 78/95:1), *Juniperus communis* (138/95), *Lathyrus pratensis* (115/95:1), *Leskeella nervosa* (97/94), *Lilium monadelphum* (78/95), *Linum hypericifolium* (45/83), *Luzula multiflora* (22/91), *Myosotis alpestris* (59/83, 22/91), *Nardus stricta* (22/91), *Orobanche grossheimii* (45/83), *Pedicularis condensata* (44/93), *Poa nemoralis* (118/95:1, 146/94), *Polygonum alpinum* (115/95), *Pulmonaria mollissima* (59/83:1), *Radula complanata* (97/94), *Rhodobryum roseum* (138/95), *Rumex longifolius* (146/94), *Sanionia uncinata* (97/94, 146/94:1), *Senecio platyphylloides* (59/83:1, 98/95), *Silene saxatilis* (22/91:1), *Symphytum asperum* (90/94), *Tortula ruralis* (138/95, 146/94), *Trifolium ambiguum* (44/93:1, 22/91:1), *Veronica gentianoides* (21/91:r, 22/91), *Veronica peduncularis* (22/91).

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

59/83 - 10.09, 25, Mukhu; 79/95 - 14.07, 25, Baduk; 138/95 - 31.08, 25, Ullu-Murudzhu; 60/95 - 12.07, 25, Baduk; 77/95 - 14.07, 25, Baduk (A.Egorov); 78/95 - 14.07, 25, Baduk; 98/95 - 25.07, 25, Khadzhibey (O.Cherednichenko); 45/83 - 08.09, 25, Bol.Khatipara; 115/95 - 19.08, 25, M.Khatipara; 44/93 - 10.08, 25, M.Khatipara; 118/95 - 29.08, 25, Nazalykol; 21/91 - 16.08, 25, Nazalykol; 22/91 - 16.08, 25, Nazalykol; 90/94 - 20.07, 25, Goralykol; 97/94 - 20.07, 25, Goralykol; 146/94 - 04.09, 25, Oriuchat; 119/95 - 29.08, 25, Nazalykol; 145/94 - 04.09, 25, Oriuchat.

## 12. Elfin - *Loiseleurio-Vaccinietea*

Prodromus

*Loiseleurio-Vaccinietea* EGGLER 1952

*Rhododendro-Vaccinietalia* BRAUN-BLANQUET in BRAUN-BLANQUET & JENNY  
1926

*Rhododendron caucasici* all.nov.

*Lerchenfeldio-Rhododenretum caucasici* ONIPCHENKO & SENNOV 1992

*L.-R.c. oxalidetosum* ONIPCHENKO & SENNOV 1992

*L.-R.c. typicum* ONIPCHENKO & SENNOV 1992

*L.-R.c. pleurozietosum* subass.nov.

*Aconito nasuti-Juniperion* all.nov.

*Aconito nasuti-Juniperetum* ass.nov.

*A.n.-J. typicum* subass.nov.

*A.n.-J. chaerophylletosum rosei* subass.nov.

*Salici kazbekensis-Empetrion nigrae* all.nov.

*Polygono viviparum-Salicetum kazbekensis* ass.nov.

*Loiseleurio-Vaccinietea, Rhododendro-Vaccinietalia*

The class and order combine Arctic and alpine dwarf scrub communities on poor acidic soils (GRABHERR 1993c). Physiognomic features (i.e., dwarf shrub dominance) are important for diagnosis of this community, since the diagnostic species set is represented by a few species with wide ecological ranges. There are two such species in the study area, *Vaccinium vitis-idaea* and *Empetrum nigrum*. We suggest three new alliances within the order (Table 12.1.).

### 12.1. *Rhododendron caucasici*

*Rhododendron causicum* scrub communities are widespread in the Caucasus (BUSH 1935, GROSSGEIM 1948, GULISASHVILI *et al.* 1975, BORLAKOV & SABLINA 1985, GADZHIEH *et al.* 1986, IVANOV 1988). Due to many common species we consider this community within the same association (ONIPCHENKO & SENNOV 1992) as *Lerchenfeldio-Rhododenretum caucasici*.

**Table 12.1.**  
Diagnostic table of *Loiseleurio-Vaccinietea*

	1	2	3	4	5	6
D.sp. <i>L.-R.c. oxalidetosum</i>						
<i>Oxalis acetosella</i>	V	-	II	-	-	-
<i>Millium effusum</i>	V	-	-	-	-	-
<i>Athyrium distentifolium</i>	V	-	-	-	-	-
<i>Gymnocarpium dryopteris</i>	III	-	-	-	-	-
<i>Brachythecium graciale</i>	II	-	-	-	-	-
<i>Calamagrostis arundinacea</i>	IV	-	I	IV	III	-
D.sp. <i>L.-R.c. typicum</i>						
<i>Sibbaldia procumbens</i>	I	V	I	-	-	I
<i>Gnaphalium supinum</i>	-	IV	I	-	-	I
<i>Sedum tenellum</i>	I	IV	-	-	-	I
<i>Leontodon hispidus</i>	-	II	-	I	I	-
D.sp. <i>L.-R.c. pleurozietosum</i>						
<i>Pleurozium schreberi</i>	-	I	V	II	I	I
<i>Hylocomium splendens</i>	-	I	V	III	II	I
<i>Dicranoweisia crispula</i>	I	II	IV	-	-	-
<i>Dicranum congestum</i>	-	-	III	-	-	I
<i>Peltigera aphthosa</i>	-	-	III	I	I	II
D.sp. <i>Lerchenfeldio-Rhododenretum caucasici</i>						
<i>Rhododendron caucasicum</i>	V	V	V	I	I	II
<i>Vaccinium myrtillus</i>	V	IV	V	III	-	I
<i>Solidago virgaurea</i>	V	IV	II	I	-	-
<i>Senecio taraxacifolius</i>	II	III	II	-	-	-
<i>Chamerion angustifolium</i>	IV	III	II	I	-	-
<i>Dicranum scoparium</i>	IV	V	V	III	I	IV
<i>Deschampsia flexuosa</i>	V	V	V	IV	IV	-
<i>Anthoxanthum odoratum</i>	II	V	V	II	III	-
D.sp. <i>A.n.-J. typicum</i>						
<i>Cladonia pyxidata</i>	III	V	III	III	-	V
<i>Hypericum linarioides</i>	-	-	-	III	I	-
<i>Sedum spurium</i>	-	-	-	III	-	-
D.sp. <i>A.n.-J. chaerophylletosum rosei</i>						
<i>Chaerophyllum roseum</i>	-	II	I	-	IV	-
<i>Galium verum</i>	-	-	-	I	IV	-
<i>Primula ruprechtii</i>	-	-	-	I	IV	-
<i>Gentiana septemfida</i>	-	-	-	I	IV	I
<i>Poa longifolia</i>	II	I	I	I	IV	-
<i>Ranunculus oreophilus</i>	I	II	III	I	IV	I
<i>Pedicularis comosa</i>	-	-	-	I	III	II
<i>Geranium sylvaticum</i>	II	II	II	I	III	-
D.sp. <i>Aconito nasuti-Juniperion, Aconito nasuti-Juniperetum</i>						
<i>Seseli alpinum</i>	-	II	III	IV	V	I
<i>Aconitum nasutum</i>	-	-	-	IV	IV	-
<i>Juniperus communis</i>	II	-	II	V	V	-
<i>Abietinella abietina</i>	-	-	-	II	III	-
<i>Betonica macrantha</i>	-	-	-	II	IV	-

Table 12.1. (continued)

	1	2	3	4	5	6
<i>Bromopsis variegata</i>	-	-	-	II	IV	I
<i>Tortula ruralis</i>	-	-	-	IV	II	-
<i>Cotoneaster integerrimus</i>	I	-	-	III	I	-
<i>Festuca varia</i>	I	II	I	IV	V	-
<i>Rhytidium rugosum</i>	-	-	-	III	IV	III
<i>Senecio aurantiacus</i>	-	I	-	II	IV	I
<i>Campanula collina</i>	-	II	II	V	V	I
D.sp. <i>Salici kazbekensis</i> - <i>Empetrium nigrae</i> , <i>Polygono viviparum</i> - <i>Salicetum kazbekensis</i>						
<i>Polygonum viviparum</i>	-	-	-	-	-	V
<i>Salix kazbekensis</i>	-	-	II	-	-	V
<i>Lloidia serotina</i>	-	I	-	-	-	IV
<i>Helictotrichon versicolor</i>	-	-	I	II	IV	V
<i>Carex umbrosa</i>	-	I	-	I	III	V
<i>Carex sempervirens</i>	-	-	-	-	-	IV
<i>Comicularia muricata</i>	-	-	-	-	-	III
<i>Eritrichium caucasicum</i>	-	-	-	-	-	III
<i>Tortella tortuosa</i>	-	I	-	-	-	III
<i>Anemone speciosa</i>	-	IV	II	-	II	V
<i>Campanula tridentata</i>	-	III	II	-	I	V
<i>Carum caucasicum</i>	-	IV	II	-	II	V
<i>Cetraria cucullata</i>	-	-	-	I	I	V
<i>Thamnolia vermicularis</i>	-	-	-	-	I	V
<i>Cetraria nivalis</i>	-	-	-	I	I	V
<i>Cladonia gracilis</i>	-	I	II	-	I	V
<i>Luzula spicata</i>	-	I	-	-	I	IV
<i>Arenaria lychnidea</i>	-	-	-	I	-	IV
<i>Fissidens osmundoides</i>	-	-	-	-	-	II
<i>Minuartia circassica</i>	-	II	I	II	II	IV
<i>Cladonia mitis</i>	-	III	V	I	I	V
D.sp. <i>Rhododendro-Vaccinietalia</i> , <i>Loiseleurio-Vaccinietea</i>						
<i>Empetrum nigrum</i>	-	IV	V	I	I	V
<i>Vaccinium vitis-idaea</i>	-	III	V	IV	IV	V
Other species						
<i>Alchemilla vulgaris</i> aggr.	II	I	IV	I	II	-
<i>Anthemis cretica</i>	-	IV	IV	-	I	I
<i>Carex atrata</i>	II	IV	-	-	I	I
<i>Cetraria islandica</i>	II	V	V	IV	V	V
<i>Festuca ovina</i>	-	IV	IV	III	V	V
<i>Geranium gymnocaulon</i>	IV	II	I	-	-	-
<i>Myosotis alpestris</i>	-	II	II	III	IV	II
<i>Polygonum bistorta</i>	-	-	II	III	IV	II
<i>Rumex alpestris</i>	IV	II	-	I	-	-
<i>Sanionia uncinata</i>	II	IV	III	IV	IV	I

Syntaxa:

1 - *Lerchenfeldio-Rhododendretum caucasicum oxalidetosum*; 2 - *L.-R.c. typicum*; 3 - *L.-R.c. pleurozietosum*; 4 - *Aconito nasuti-Juniperetum typicum*; 5 - *A.n.-J. chaerophylletosum rosei*; 6 - *Polygono viviparum-Salicetum kazbekensis*

## Floristic features

Except for *Rhododendron caucasicum* and *Senecio taraxacifolium*, other diagnostic species of the association are common boreal species (*Vaccinium*

*myrtillus*, *Solidago virgaurea*, *Chamaenerion angustifolium*, *Dicranum scoparium*, *Deschampsia flexuosa*, *Anthoxanthum odoratum*). As a rule, *Rhododendron caucasicum* is the main dominant, covering more than 50% of the community area.

The communities are floristically rich (IVANOV 1988). We registered 107 vascular plant species, 53 bryophytes and 12 lichens in 22 relevés of the association. The mean species numbers per relevé were 22, 7 and 3 respectively. The ratio vascular plants/(bryophytes+lichens) was relatively low (1.6). Vascular plant cover ranged between 30 and 95% (mean 76%), the same values for bryophytes and lichens were 2-90%(27%) and 0-30%(6%) respectively. So the role of bryophytes is considerable in terms of species number and plant cover.

The mean number of vascular plant species was estimated as 3.5, 12.5 and 40.4 for 0.01, 1 and 100 sq.m- plots respectively (ONIPCHENKO & SEMENOVA 1995). Three subassociations can be distinguished within the association (Table 12.2.).

**L.-R.c. oxalidetosum** includes communities of the subalpine zone (2150-2550 m, mean 2410 m), where forest species are well represented (*Oxalis acetosella*, *Athyrium distentifolium*, *Gymnocarpium dryopteris* etc.). The role of lichens is negligible. Typus, or nomenclature type, No. 161/90.

**L.-R.c. typicum** (= *L.-R.c. cetrarietosum islandicae* ONIPCHENKO & SENNOV 1992) includes the communities of the alpine zone (2400-2700 m a.s.l., mean 2630 m). Alpine snowbed and grassland species form the diagnostic set of the subassociation (*Sibbaldia procumbens*, *Gnaphalium supinum*, *Sedum tenellum*, *Leontodon hispidus*). Typus, or nomenclature type, No. 4/89.

**L.-R.c. pleurozietosum** combines communities where moss cover is well-developed (5-90%, mean 39%). Boreal mosses (*Pleurozium schreberi*, *Hylocomium splendens*, *Dicranoweisia crispula*, *Dicranum congestum*) and *Peltigera aphthosa* form the diagnostic set of the subassociation.

Typus, or nomenclature type, No. 168/94.

The association can be considered as a geographical vicarious syntaxon of the *Rhododendretum ferruginei* RÜBEL 1911 of the Alps (*Rhododendro* -

*Vaccinietum* BRAUN-BLANQUET in BRAUN-BLANQUET & JENNY 1926) (HEISELMAYER 1982, ISDA 1985, PIGNATTI *et al.* 1990, GRABHERR 1993c). There are several common species in both associations (*Vaccinium myrtillus*, *Deschampsia flexuosa*, *Hylocomium splendens*, *Peltigera aphthosa*).

### Ecological features

*Rhododendron caucasicum* scrub communities develop within alpine and subalpine zones at altitudes of 2150 to 2700 m a.s.l., mean 2530 m) mainly on steep northern leeward (10-45°, mean 29°) slopes with significant winter snow accumulation. Amount of boulders at the surface varies (0-40%). Soils are acid and humus-rich. We detected from 750 to 2480 viable seeds per sq.m in the soils under the community (SEMENOVA & ONIPCHENKO 1994). *Rhododendron* seeds were rare, while the most common species in the seed bank were *Luzula multiflora*, *Sedum tenellum*, *Phleum alpinum*, *Carex atrata* and *Carex pyrenaica*.

## 12.2. *Aconito nasuti-Juniperion*

The alliance comprises communities where the dwarf form of *Juniperus communis* is the main dominant. It can be considered as the Caucasian vicarious syntaxon of *Juniperion nanae* BRAUN-BLANQUET *et al.* 1939. Only few species (*Cotoneaster integerrimus*, *Carex sempervirens*) are shared by both syntaxa (GRABHERR 1993). We propose one association within the alliance.

### *Aconito nasuti-Juniperetum*

#### Floristic features

The diagnostic set includes *Juniperus communis* and several accompanying species (*Seseli alpinum*, *Aconitum nasutum*, *Abietinella abietina*, *Senecio aurantiacus*), including some common alpine species (*Campanula collina*, *Festuca varia*, *Betonica macrantha*, *Bromopsis variegata*) (Table 12.3.). Two subassociations may be distinguished according to differences in floristic composition.

**A.n.-J. typicum** combines more "warm" communities occupying mainly south slopes. *Sedum spurium*, *Hypericum linarioides*, *Cladonia pyxidata*

are more frequent in the communities. Typus, or nomenclature type, No. 81/93.

**A.n.-J. *chaerophylletosum rosei*** represents communities developing mainly on west or east slopes. Several species prefer the habitats and can be considered as diagnostic (*Chaerophyllum roseum*, *Galium verum*, *Primula ruprechtii*, *Gentiana septemfida* etc.). Typus, or nomenclature type, No. 95/94.

The communities of the association are floristically rich. We registered 129 vascular plant species, 46 bryophytes and 13 lichens in 20 releves. Average species numbers per releve were 23, 7 and 8 species correspondingly. Cover of vascular plants (mainly *Juniperus*) ranges within 70-100% (mean 88%), the same values for bryophyte and lichen cover are 1-70%(24%) and 0-30%(6%) respectively.

### **Ecological features**

The communities are commonly found in the alpine and subalpine zones at an altitude between 2300 and 2840 m (mean 2510 m), but as a rule they occupy only small areas within these zones. They occur on slopes with various aspects (but never on the northern slopes!) and steepness (2°-35°, mean 16°). As a rule, the communities develop as stripes along the ridge tops, slope bends and transition zones between lee and windward slopes. Snow depth often corresponds to the height of *Juniperus communis* shrubs (20-40 cm), because frost and winds kill exposed branches in winter.

### **12.3. *Salici kazbekensis-Empetrion nigrae***

The alliance combines so-called "dwarf shrub heaths" (SHIFFERS 1953). Their position in the floristic classification is not obvious. Species of *Carici rupestris-Kobresietea bellardii* and *Juncetea trifidi* are very well represented in the communities, so it is possible to consider the alliance within these classes (LSBIRDIN, personal communication). However, in our work we describe it within *Loiseleurio-Vaccinietea* due to the physiognomic features (dwarf shrub dominance) and high frequency of *Empetrum nigrum* and *Vaccinium vitis-idaea* (Table 12.1., 12.3.). We propose one association within the alliance.

**Table 12.2.**

*Lerchenfeldio-Rhododenretum caucasici*

Releve No.	0 0 1 1 0 1 1 1	0 0 0 0 0 0 0 1	0 0 0 0 1 0
	54 55 61 60 41 90 77 99	26 37 38 4 3 45 30 34	75 47 96 99 68 66
Year	91 91 90 90 91 94 94 94	91 83 83 89 89 89 91 95	94 94 94 94 94 95
Altitude (* 10)	2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2	2 2 2 2 2 2 2
	15 20 55 55 55 50 38 41	40 65 70 70 60 68 60 70	45 63 45 55 68 52
Steepness	15 20 35 35 30 30 10 30	35 45 45 30 35 35 25 30	25 30 30 30 30 15
Exposition	n ne ne ne ne ne n n	nw ne n ne n w w n	nw ne nw nw n ne
Vascular plant cover	85 90 85 90 90 85 80 80	60 70 30 60 60 65 55 70	95 90 75 85 75 85
Bryophyte cover	10 2 40 20 5 10 20 30	5 20 40 40 50 20 10 10	40 5 30 90 40 30
Lichen cover	+ + + 0 0 + + +	5 8 8 5 5 10 + 10	0 15 30 3 15 10
Stone cover	0 + 0 0 + 5 + +	+ 5 40 10 5 + + 2	+ 5 + 5 5 5
<i>D.sp. L.-R.c. oxalidetosum</i>			
<i>Oxalis acetosella</i>	1 1 1 1 1 1 + +		1 +
<i>Millium effusum</i>	r r + 1 1 + + +		
<i>Athyrium distentifolium</i>	+ + + 2 + + +		
<i>Gymnocarpium dryopteris</i>	1 1 + 1		
<i>Brachythecium graciale</i>	2 1		
<i>Calamagrostis arundinacea</i>	+ 1 + + 1		+
<i>D.sp. L.-R.c. typicum</i>			
<i>Sibbaldia procumbens</i>	+	2 + 2 + 1 + + 2	+
<i>Gnaphalium supinum</i>		+ + + 1 + +	+
<i>Sedum tenellum</i>	r	r + + + + +	
<i>Leontodon hispidus</i>		+ + + +	
<i>D.sp. L.-R.c. pleurozietosum</i>			
<i>Pleurozium schreberi</i>		+ +	1 + 1 3 3 1
<i>Hylocomium splendens</i>		+ +	+ 1 3 1 1
<i>Dicranoweisia crispula</i>	+	+ +	+ + + +
<i>Dicranum congestum</i>			1 1 1
<i>Peltigera aphthosa</i>			1 + +
<i>D.sp. Lerchenfeldio-Rhododenretum caucasici, Rhododendron caucasici</i>			
<i>Rhododendron caucasicum</i>	5 5 4 4 5 4 4 4	3 3 1 3 3 4 3 3	4 4 3 4 3 3
<i>Vaccinium myrtillus</i>	+ 1 3 1 1 3 2	2 2 1 2 1 2	+ 2 1 1 2
<i>Solidago virgaurea</i>	+ 1 + 1 1 2 +	+ + 1 1 +	+ 1
<i>Senecio taraxacifolius</i>	r r +	1 1 + 1	+ +
<i>Chamerion angustifolium</i>	+ + 1 r +	r + + +	+ +
<i>Dicranum scoparium</i>	2 1 1 1 2	+ + + + + +	1 + 2 1 2
<i>Deschampsia flexuosa</i>	+ r 1 1 1 + 1 1	2 2 + + 2 1 2 2	1 1 2 1 2 1
<i>Anthoxanthum odoratum</i>	+ + +	1 + + 1 + 1 1	+ + 1 + +
<i>D.sp. Rhododendro-Vaccinietales, Loiseleurio-Vaccinietales</i>			
<i>Empetrum nigrum</i>		+ 2 + 2 1 1	1 1 + 2 2
<i>Vaccinium vitis-idaea</i>		1 + 1 +	+ 2 + + +
Other species			
<i>Agrostis vinealis</i>	+ +	1 + +	+ +
<i>Alchemilla vulgaris aggr.</i>	r +	1	+ + + +
<i>Anemone speciosa</i>		+ + 1 + r	+ +
<i>Anthemis cretica</i>		+ + 1 + 1	+ + + +
<i>Astrantia maxima</i>	+		1 +

Table 12.2. (continued)

Releve No.	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0		
	54	55	61	60	41	90	77	99	26	37	38	4	3	45	30	34	75	47	96	99	68	66		
Year	91	91	90	90	91	94	94	94	91	83	83	89	89	89	91	95	94	94	94	94	94	94	95	
<i>Barbilophozia barbata</i>			+	+											+									
<i>Brachythecium reflexum</i>	1	+					+								+		+					+	+	
<i>Brachythecium starkei</i>							+			+		+											+	
<i>Campanula collina</i>									r						1	+	+	+						
<i>Campanula tridentata</i>										1	1	1				+		+					+	
<i>Carex atrata</i>	r				r				+		+		+		+	+								
<i>Carex pyrenaica</i>								+			+	+				+								
<i>Carum caucasicum</i>									+	+	1	1	1					+	+					
<i>Carum meifolium</i>							+						1			+	+							
<i>Cetraria islandica</i>						+	+	+	1	1	1	2	1	2	+	2		2	2	2	2	2	2	
<i>Chaerophyllum roseum</i>														+	+						+			
<i>Cladonia furcata</i>															+				+			+		
<i>Cladonia gracilis</i>													+						+				+	
<i>Cladonia mitis</i>									1	1	+	+					2	2	+	2	2	+		
<i>Cladonia pyxidata</i>		+	+			+		+	1	1	+	+	+	1	+	+		1			+	1		
<i>Cladonia rangiferina</i>																	1	+				+		
<i>Crepis glabra</i>				+				+					+											
<i>Draba hispida</i>					r										+		+							
<i>Dryopteris carthusiana</i>	+		+			+																		
<i>Festuca brunnescens</i>					+					1	+													
<i>Festuca ovina</i>									1	+	+	+	+			+		+	+	+	+	+		
<i>Festuca varia</i>		r													+	+								
<i>Geranium gymnocaulon</i>				r	+	+	1	+					1			+	3							
<i>Geranium sylvaticum</i>	+					+			r					+				+		1				
<i>Hedysarum caucasicum</i>													1		1		+						2	
<i>Hieracium macrolepis</i>			+									+	+	1	1							+	+	
<i>Huperzia selago</i>			+					+			+	+	+					1						
<i>Juniperus communis</i>	1	1													+		1						2	
<i>Kemulariella caucasica</i>						+	+										+							
<i>Lescurea incurvata</i>					1				+				+											
<i>Lescurea saxicola</i>	+									+					+						+	+	+	
<i>Lophozia sp.</i>						+	+									+						+		
<i>Luzula multiflora</i>										+			1		+	1	+							
<i>Minuartia circassica</i>										+					r			+						
<i>Myosotis alpestris</i>												+	+		+		+				+			
<i>Nardus stricta</i>				+	+				1	1		1	1			1	+	+						
<i>Pedicularis condensata</i>													+		r	+		+						
<i>Pedicularis nordmanniana</i>											+	+	+			+					+			
<i>Phleum alpinum</i>						+	+	+					1				+							
<i>Plagiothecium denticulatum</i>	1	+			1					+		+										+		
<i>Poa longifolia</i>					+	+	+		r								+							
<i>Polytrichastrum alpinum</i>				+							+											+		
<i>Polytrichum juniperinum</i>					+					1		+	+	+								+		
<i>Primula meyeri</i>										+	2	+												
<i>Pulsatilla aurea</i>				+	+	+								+			1							
<i>Ranunculus oreophilus</i>								+					+		+							+	+	+

Table 12.2. (continued)

Releve No.	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Year	54	55	61	60	41	90	77	99	26	37	38	4	3	45	30	34	75	47	96	99	68	66
	91	91	90	90	91	94	94	94	91	83	83	89	89	89	91	95	94	94	94	94	94	95
<i>Rhytidadelphus triquetrus</i>						+						+		+			2				3	
<i>Rumex alpestris</i>				+	+	+	+	+						+	+	+						
<i>Sanionia uncinata</i>		+					+		1		+	+	+			1	+	1	2			
<i>Senecio caucasicus</i>						+								1	+		+				1	
<i>Senecio platyphylloides</i>	+	+	r				+															
<i>Seseli alpinum</i>											+		+	+				+	+			+
<i>Silene vulgaris</i>			r	+	+	+								1	1							
<i>Stereocaulon alpinum</i>									+	+						+						
<i>Taraxacum officinale</i> agg.											+	+	1									
<i>Trisetum flavescens</i>				r		+											+					
<i>Valeriana alpestris</i>																		+	+	+		
<i>Veratrum album</i>					+	+	1						+	+			+	r				
<i>Veronica gentianoides</i>						+			+		+			+	+		+					
<i>Viola altaica</i>									+	+							+	+				+

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

*Alopecurus ponticus* (190/94), *Anemone narcissiflora* (75/94), *Antennaria dioica* (37/83), *Barbilophozia hatcheri* (96/94, 99/94), *Barbilophozia lycopodioides* (190/94, 66/95), *Bartramia ithyphylla* (37/83, 96/94), *Brachythecium erythrorrhizon* (177/94:2), *Brachythecium latifolium* (75/94), *Brachythecium rivulare* (199/94), *Brachythecium salebrosum* (75/94), *Brachythecium velutinum* (45/89), *Briza marcowiczii* (3/89, 134/95:1), *Carex caryophyllea* (47/94, 96/94), *Carex umbrosa* (26/91), *Catabrosella variegata* (134/95:1), *Cephalozia lunulifolia* (190/94), *Cephalozia* sp. (199/94, 134/95), *Cerastium purpurascens* (75/94, 47/94), *Cetraria pinastri* (96/94, 168/94), *Cirsium munitum* (75/94), *Cotoneaster integerrimus* (55/91), *Daphne glomerata* (30/91:r, 75/94), *Desmatodon latifolius* (3/89, 45/89), *Dicranum muehlenbeckii* (96/94), *Diplophyllum taxifolium* (177/94, 134/95:1), *Dryopteris filix-mas* (190/94), *Euphorbia macroceras* (190/94), *Eurhynchium pulchellum* (37/83), *Festuca djimilensis* (190/94), *Gentiana pyrenaica* (26/91:r, 38/83), *Grimmia elatior* (190/94), *Helictotrichon versicolor* (96/94), *Hieracium lactucella* agg. (168/94), *Hieracium murorum* agg. (54/91, 66/95), *Homalothecium sericeum* (37/83), *Hyalopoa pontica* (38/83), *Hylocomiastrum pyrenaicum* (75/94), *Hypnum callichroum* (199/94:1), *Kiaeria starkei* (134/95:1), *Ligusticum caucasicum* (41/91:r, 199/94), *Lloidia serotina* (38/83), *Lophocolea heterophylla* (190/94, 199/94), *Lophozia longiflora* (161/90:1, 41/91:1), *Lophozia sudetica* (3/89), *Luzula spicata* (38/83), *Minuartia aizoides* (37/83, 4/89), *Minuartia imbricata* (38/83), *Minuartia recurva* (37/83), *Mnium spinosum* (190/94, 75/94:1), *Orthodicranum montanum* (54/91:1), *Paraleucobryum enerve* (37/83), *Paraleucobryum longifolium* (54/91, 38/83), *Peltigera rufescens* (37/83, 38/83:1), *Plagiothecium cavifolium* (190/94, 134/95), *Plantago atrata* (37/83), *Poa caucasica* (55/91:r, 45/89), *Pohlia cruda* (96/94), *Pohlia filum* (134/95), *Pohlia proligera* (96/94), *Polygonum bistorta* (47/94, 168/94), *Polytrichum commune* (26/91), *Polytrichum piliferum* (37/83:2, 47/94), *Potentilla crantzii* (41/91:1, 4/89), *Pseudoleskea incurvata* (190/94, 199/94), *Psora* sp. (30/91), *Pterigynandrum filiforme* (96/94), *Racomitrium canescens* (66/95), *Ranunculus brachylobus* (134/95:2), *Ranunculus caucasicus* (75/94), *Rubus idaeus* (54/91), *Salix kazbekensis* (96/94:1, 99/94:1), *Saxifraga sibirica* (38/83, 3/89), *Scorzonera cana* (37/83), *Senecio aurantiacus* (45/89), *Senecio kolenatianus* (161/90:r, 190/94), *Silene saxatilis* (177/94, 168/94), *Solorina crocea* (38/83, 96/94), *Taraxacum confusum* (47/94), *Taraxacum stevenii* (134/95:1, 47/94), *Thesium alpinum* (54/91:r), *Tortella tortuosa* (37/83), *Trollius ranunculinus* (190/94, 75/94).

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

54/91 - 31.08, 25, Sev.Ptysh; 55/91 - 31.08, 25, Sev.Ptysh; 161/90 - 19.08, 16, Khuty; 160/90 - 19.08, 16, Khuty; 41/91 - 18.08, 25, Ullu-Murudzhu; 190/94 - 10.09, 25, Kichi-Murudzhu; 177/94 - 08.09, 25, Klukhor; 199/94 - 11.09, 25, Klukhor; 26/91 - 16.08, 25, Nazalykol; 37/83 - 31.08, 16, M.Khatipara; 38/83 - 31.08, 25, M.Khatipara; 4/89 - 07.08, 25, M.Khatipara; 3/89 - 07.08, 100, M.Khatipara; 45/89 - 01.09, 25, M.Khatipara; 30/91 - 16.08, 25, Nazalykol; 134/95 - 30.08, 25, Ullu-Murudzhu; 75/94 - 16.07, 25, Bol.Khatipara; 47/94 - 12.07, 12, Kyshkadzher; 96/94 - 20.07, 25, Goralykol; 99/94 - 21.07, 25, Goralykol; 168/94 - 06.09, 25, Nazalykol; 66/95 - 13.07, 25, Baduk.

*Polygono viviparum-Salicetum kazbekensis*

**Floristic features**

The diagnostic set of the association includes several groups of species. First, *Salix kazbekensis* (dominant). Second, such common alpine species as *Campanula tridentata*, *Carum caucasicum*, *Carex umbrosa*. Third, a good deal of *Carici rupestris- Kobresietea bellardii* (*Polygonum viviparum*, *Lloydia serotina*) and *Juncetea trifidi* (*Helictotrichon versicolor*, *Luzula spicata*, *Eritrichium caucasicum*, *Anemone speciosa* etc.) among the vascular plant species as well as fruticose lichens (*Cetraria cucullata*, *C.nivalis*, *Cladonia gracilis*, *C.mitis*, *Thamnolia vermicularis*).

Floristic richness of the communities is moderate. We registered 71 vascular plant species, 39 bryophytes and 14 lichens in 11 relevés (Table 12.4.). The mean values per relevé were 23, 7 and 8 species correspondingly. Vascular plant cover ranges between 35% and 75% (mean 50%), the same values for bryophytes and lichens were 1-30%(7%) and 15-50%(35%) respectively. So the role of lichens is very important in term of plant cover as well as species number. Typus, or nomenclature type, No. 108/95

**Ecological features**

The community occupies mainly steep (5°-30°, mean 23°) northern slopes within the alpine zone (altitude range 2600-2860 m, mean 2710 m). It occurs on ridge tops and windward slopes where thin winter snow cover does not provide adequate protection from deep freezing to the soil. On the other hand, northern exposure leads to low solar radiation. Due to such a stressful environment, the communities have low production. Stones cover up to 30% (mean 10%) of the soil surface.

**Table 12.3.**

*Aconito nasuti-Juniperetum*

Releve No.	0 0 1 0 0 1 1 0 0 0	0 0 0 0 0 1 1 0 0 0
	81 77 23 62 64 33 53 20 88 33	14 11 50 91 95 69 47 71 82 32
Year	93 94 95 94 95 94 94 95 93 95	94 94 94 94 94 94 94 94 93 94
Altitude (* 10)	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2
	35 45 40 30 40 55 84 50 50 60	41 55 65 35 40 68 42 55 75 50
Steepness	25 15 3 30 10 30 2 20 3 30	10 30 2 5 3 30 10 35 20 10
Sxposition	se se s se rw e s s e sw	sw w w nw w se sw ne se w
V.p. cover	95 90 90 90 90 90 85 95 70 90	85 70 95 # 90 95 90 90 80 85
Bryophyte cover	5 40 40 + 40 10 4 5 40 30	70 50 20 30 30 30 5 10 10 15
Lichen cover	3 2 5 0 + 1 20 + 5 30	3 20 5 5 0 5 2 3 20 +
Stone cover	20 30 3 + 2 + 0 3 40 +	+ + 5 + 1 0 2 + 20 +
<i>D.sp. A.n.-J. typicum</i>		
<i>Cladonia pyxidata</i>	1 + + + +	
<i>Hypericum linarioides</i>	+ + + +	+
<i>Sedum spurium</i>	2 + + 1 1 +	
<i>D.sp. A.n.-J. chaerophylletosum rosei</i>		
<i>Chaerophyllum roseum</i>		+ + + + + + +
<i>Galium verum</i>		+ + + + 1 + + 1
<i>Primula ruprechtii</i>	+ 1	+ + + + + + +
<i>Gentiana septemfida</i>		+ + + + + + +
<i>Poa longifolia</i>	1	1 + 1 + 1 1 1
<i>Ranunculus oreophilus</i>		+ + + + + + 1
<i>Pedicularis comosa</i>		+ + + + + + +
<i>Geranium sylvaticum</i>	+ +	+ + + 1 + +
<i>D.sp. Aconito nasuti-Juniperion, Aconito nasuti-Juniperetum</i>		
<i>Seseli alpinum</i>	+ + + + + + 1 +	+ + + + + + + 1 1
<i>Aconitum nasutum</i>	+ + 1 + + + +	1 + + 1 1 1 + +
<i>Juniperus communis</i>	5 4 5 5 4 4 4 5 4 4	4 3 5 5 4 4 4 4 4 4
<i>Abietinella abietina</i>		+ 1 2 + 1 1
<i>Betonica macrantha</i>	+ 1 + +	1 1 1 1 + 1 + +
<i>Bromopsis variegata</i>	+ + + + +	+ + + + 3 + +
<i>Tortula ruralis</i>	1 + + + 1 + 3	1 + + 1
<i>Cotoneaster integerrimus</i>	1 + 1 1 1	+ + + + + + +
<i>Festuca varia</i>	+ + + + + + 1	+ 1 + 1 + + 1 + + +
<i>Rhytidium rugosum</i>	1 1 + + +	1 + 2 + + 1 1
<i>Senecio aurantiacus</i>	+ + + + +	+ + + + + + +
<i>Campanula collina</i>	+ + + + + + + 1	+ 2 + + + + 1 1 +
<i>D.sp. Rhododendro-Vaccinietales, Loiseleurio-Vaccinietales</i>		
<i>Empetrum nigrum</i>	2 2	2 2 3 2 2 +
<i>Vaccinium vitis-idaea</i>	2 2 2 1 + 2 2 2	2 2 2 2 3 2 2 +
Other species		
<i>Agrostis vinealis</i>	+ + + +	+ + + + 1
<i>Alchemilla caucasica</i>	+ + + +	+ 1 + + + +
<i>Alchemilla vulgaris aggr.</i>	+ + + +	+ 1 + + + +
<i>Anemone speciosa</i>	+ + + +	+ + + + + +
<i>Antennaria dioica</i>	+ + + +	+ + + + + +
<i>Anthemis marshalliana</i>	+ + + +	+ + + + + +
<i>Anthoxanthum odoratum</i>	+ + + +	+ 1 + + + +

**Table 12.3.** (continued)

Releve No.	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0		
Year	81	77	23	62	64	33	53	20	88	33	14	11	50	91	95	69	47	71	82	32	
	93	94	95	94	95	94	94	95	93	95	94	94	94	94	94	94	94	94	93	94	
<i>Aster alpinus</i>										+										+	
<i>Brachythecium salebrosum</i>								1					+		+	+					
<i>Brachythecium velutinum</i>				+															+	1	
<i>Bupleurum falcatum</i>	+					+				+					+						
<i>Calamagrostis arundinacea</i>	1	1	1	+	2	2		1			+				+		1	+	+	+	
<i>Carex caryophylla</i>						+	+												+		
<i>Carex umbrosa</i>	1		+								+	1	+	+	+					1	
<i>Carum caucasicum</i>												+		+						+	
<i>Centaurea cheiranthifolia</i>															+	+	+	+			
<i>Cerastium purpurascens</i>										+	+				+						
<i>Cetraria islandica</i>	1		1		+	+	2		1	3	1	2	1	1		1	1	1	2	+	
<i>Cladonia mitis</i>							1		+					+						+	
<i>Cruciata laevipes</i>				+		+		+		+					1	+	+			+	
<i>Daphne glomerata</i>					+	1			+	+	1	1							+		
<i>Deschampsia flexuosa</i>	+	+	+	+	+	+			1		+	1	+	+	+		1	+	1		
<i>Dicranum scoparium</i>			1	2		1	+			+	1	1									
<i>Draba sibirica</i>				+		+							+								
<i>Entodon concinnus</i>											+			+			+				
<i>Erigeron caucasicus</i>										+	+								+		
<i>Festuca brunnescens</i>			+							+		+									
<i>Festuca ovina</i>	+		+		+	+	+			+	+	+	+	+	1	+	+	+	1	+	
<i>Geranium renardii</i>				+		1		+											+		
<i>Hedysarum caucasicum</i>		+			+	+			+	+									+	+	
<i>Helictotrichon versicolor</i>			+				+		+	+	+	+	+	1		+			+		
<i>Hieracium macrolepis</i>		+		+	+	+			+	+	+			+					+		
<i>Hieracium prenanthoides</i>									1	+										+	
<i>Hylocomium splendens</i>		2	2				2		1	+	4			1			1				
<i>Hypnum cupressiforme</i>		+	+											+					1	+	
<i>Hypnum revolutum</i>							1												+	+	
<i>Leontodon hispidus</i>	+			+															+		
<i>Leskeella nervosa</i>		+							+				+		+						
<i>Lotus corniculatus</i>	+									+									+		
<i>Luzula multiflora</i>						+					+			+							
<i>Minuartia circassica</i>	+	+							+	+		+		+						+	
<i>Minuartia recurva</i>									+			+								+	
<i>Myosotis alpestris</i>	+		+	+	+	+	+				+	+	+	+	+		+		1		
<i>Nardus stricta</i>						+					+	+									
<i>Peltigera canina</i>										+						1					
<i>Pleurozium schreberi</i>		2	1		2	+								+							
<i>Poa nemoralis</i>	+	+							1												
<i>Polygonum alpinum</i>	+	+			+					+											
<i>Polygonum bistorta</i>		+	+	+		+		+	1				+	+	+	+	+	+	1	1	+
<i>Potentilla crantzii</i>						+					+		+					+			
<i>Potentilla gelida</i>							1						+							+	
<i>Radula complanata</i>				+					+		+										
<i>Rhododendron caucasicum</i>		2			+							+									
<i>Rhytidadelphus triquetrus</i>									+		1				+						

Table 12.3. (continued)

Releve No.	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	
Year	81	77	23	62	64	33	53	20	88	33	14	11	50	91	95	69	47	71	82	32
Year	93	94	95	94	95	94	94	95	93	95	94	94	94	94	94	94	94	94	93	94
<i>Rosa marschalliana</i>				+					+	+										
<i>Sanionia uncinata</i>				2	+		+	2	1	2	+	1	3	2		+	3	+	1	1
<i>Saxifraga kolenatiana</i>	+				+					1	+									
<i>Taraxacum stevenii</i>											+	+				+	+			
<i>Thymus nummularius</i>							+											+	+	
<i>Trifolium ambiguum</i>														+				+		+
<i>Vaccinium myrtillus</i>					3		+	+	1	2										
<i>Veronica gentianoides</i>							+	+		+	+	+		+						
<i>Vicia cracca</i>	+													+	+					
<i>Viola altaica</i>				+			+	+			+	1		1					+	1

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

*Achillea millefolium* (50/94, 95/94), *Aconitum orientale* (14/94), *Aetheopappus caucasicus* (82/93), *Alopecurus glacialis* (88/93), *Amblystegium varium* (20/95), *Anthemis cretica* (11/94, 82/93), *Arenaria lychnidea* (153/94, 33/95), *Astrantia maxima* (147/94, 32/94), *Barbilophozia barbata* (123/95, 153/94), *Barbilophozia hatcheri* (95/94), *Barbilophozia lycopodioides* (64/95), *Bartramia ithyphylla* (33/95), *Botrychium lunaria* (133/94, 95/94), *Brachythecium albicans* (71/94), *Brachythecium reflexum* (82/93), *Brachythecium starkei* (133/94), *Bryum caespiticium* (33/95), *Bryum capillare* (153/94, 71/94), *Bryum subelegans* (20/95), *Campanula tridentata* (91/94), *Carex atrata* (50/94), *Carex digitata* (64/95), *Carex humilis* (91/94), *Cephalozia sp.* (95/94), *Cetraria cucullata* (153/94, 14/94), *Cetraria nivalis* (153/94, 14/94), *Cetraria pinastri* (50/94), *Chamaescidium acaule* (88/93), *Chamerion angustifolium* (64/95:1, 33/95:2), *Cicerbita racemosa* (95/94), *Cladonia gracilis* (91/94), *Cladonia sp.* (153/94, 11/94), *Clinopodium vulgare* (20/95), *Coeloglossum viride* (91/94), *Corydalis conorrhiza* (77/94), *Dianthus cretaceus* (71/94), *Dicranum spadiceum* (153/94:2, 88/93), *Draba siliquosa* (33/95), *Equisetum hyemale* (123/95), *Euphrasia ossica* (88/93, 82/93), *Eurhynchium pulchellum* (33/95), *Fritillaria lutea* (50/94, 91/94), *Gentiana pyrenaica* (11/94, 82/93), *Gentiana verna* (88/93), *Gymnadenia conopsea* (91/94), *Heracleum asperum* (95/94), *Koeleria eriostachya* (133/94), *Lamium album* (62/94), *Lathyrus cyaneus* (91/94, 147/94), *Lescuraea mutabilis* (33/95), *Lescuraea saxicola* (64/95, 50/94:1), *Linum hypericifolium* (88/93, 147/94), *Lophozia sp.* (95/94, 71/94), *Luzula spicata* (82/93), *Macrotomia echioides* (32/94), *Mnium stellare* (71/94), *Orthotrichum rupestre* (14/94), *Orthotrichum speciosum* (33/95), *Orthotrichum stramineum* (169/94), *Paraleucobryum enerve* (64/95), *Peltigera aphthosa* (64/95, 91/94), *Peltigera malacea* (88/93), *Peltigera sp.* (153/94, 11/94), *Phleum phleoides* (133/94, 147/94), *Plagiomnium cuspidatum* (20/95), *Plantago atrata* (91/94, 82/93), *Polygala alpicola* (33/95, 14/94), *Polygonatum verticillatum* (77/94), *Polypodium vulgare* (77/94), *Polytrichastrum alpinum* (88/93, 82/93:1), *Polytrichum commune* (82/93:1), *Polytrichum juniperinum* (33/95, 82/93), *Polytrichum piliferum* (153/94, 88/93), *Potentilla brachypetala* (77/94), *Primula algida* (11/94), *Primula veris* (20/95), *Pterigynandrum filiforme* (123/95), *Ptilidium ciliare* (153/94), *Rhodobryum roseum* (95/94:1), *Rhododendron luteum* (20/95), *Rosa tomentosa* (88/93), *Rumex alpestris* (81/93), *Saxifraga moschata* (77/94, 88/93), *Scabiosa caucasica* (133/94, 147/94), *Sempervivum caucasicum* (33/95, 71/94), *Sempervivum pumilum* (88/93), *Seseli libanotis* (62/94), *Silene vulgaris* (64/95), *Solidago virgaurea* (88/93), *Taraxacum officinale aggr.* (91/94, 95/94), *Thamnolia vermicularis* (11/94), *Thesium alpinum* (88/93), *Trifolium hybridum* (91/94, 95/94), *Trifolium polyphyllum* (82/93), *Trisetum flavescens* (50/94), *Urtica dioica* (11/94), *Valeriana alpestris* (123/95), *Veratrum album* (95/94).

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

81/93 - 22.08, 4, M.Khatipara; 77/94 - 16.07, 6, Bol.Khatipara; 123/95 - 29.08, 12, Nazalykol; 62/94 - 15.07, 12, Bol.Khatipara; 64/95 - 12.07, 10, Baduk; 133/94 - 31.07, 8, Mukhu; 153/94 - 04.09, 24, Oriuchat; 20/95 - 04.07, 10, Alibek; 88/93 - 26.08, 10, M.Khatipara; 33/95 - 07.07, 15, Chuchkhur; 14/94 - 07.07, 15, Azgek; 11/94 - 07.07, 15, Azgek; 50/94 - 12.07, 10, Kyshkadzher; 91/94 - 20.07, 12, Goralykol; 95/94 - 20.07, 10, Goralykol (D.Sukhova); 169/94 - 06.09, 12, Nazalykol; 147/94 - 04.09, 30, Oriuchat; 71/94 - 16.07, 7, Bol.Khatipara; 82/93 - 23.08, 15, M.Khatipara; 32/94 - 11.07, 12, Kyshkadzher.



<i>Peltigera rufescens</i>	+	+			+			
<i>Pohlia cruda</i>	+	+			+		+	
<i>Polygonum bistorta</i>	+						+	+
<i>Polytrichastrum alpinum</i>				+	+	+		+
<i>Polytrichum juniperinum</i>	+				+		1	
<i>Polytrichum piliferum</i>	+							+
<i>Potentilla gelida</i>	+	+			1			
<i>Rhododendron caucasicum</i>	1			+			+	+
<i>Rhytidium rugosum</i>					2	1	1	+
<i>Taraxacum stevenii</i>	+	+	+	+	+			
<i>Trifolium polyphyllum</i>	1			1				+
<i>Veronica gentianoides</i>	+	+		+				+

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

*Aetheopappus caucasicus* (29/83), *Alchemilla caucasica* (29/83:1), *Androsace albana* (11/84), *Antennaria dioica* (40/83, 11/84:1), *Anthemis cretica* (40/83, 11/84), *Astragalus levieri* (29/83:1), *Bartramia ithyphylla* (29/83, 33/91), *Blepharostoma trichophyllum* (110/95), *Brachythecium albicans* (44/89), *Bromopsis variegata* (29/83), *Bryoria bicolor* (108/95), *Bryum torquescens* (29/83), *Campanula ciliata* (29/83), *Campanula collina* (40/83:1), *Campanula saxifraga* (29/83), *Campylium radicale* (11/84), *Carex atrata* (33/91), *Carex caryophyllea* (101/94:1), *Carex sp.* (33/91), *Cerastium purpurascens* (33/91), *Ceratodon purpureus* (108/95), *Cetraria laevigata* (40/83:2, 11/84), *Chamaesciadium acaule* (29/83), *Cladonia rangiferina* (40/83), *Climacium dendroides* (33/91), *Coeloglossum viride* (44/89), *Desmatodon latifolius* (33/91, 108/95), *Dicranum bergeri* (53/94:1), *Dicranum bonjeanii* (33/91), *Dicranum congestum* (44/89), *Dicranum spadiceum* (101/94:1), *Distichium capillaceum* (33/91, 110/95), *Erigeron alpinus* (29/83, 108/95), *Eurhynchium pulchellum* (11/84), *Gentiana biebersteinii* (40/83, 29/83), *Gentiana septemfida* (29/83), *Gentiana verna* (29/83), *Gnaphalium supinum* (29/83), *Hedysarum caucasicum* (44/89), *Hylocomium splendens* (51/94, 107/95), *Hypnum cupressiforme* (107/95), *Hypnum imponens* (29/83:1), *Hypnum revolutum* (11/84), *Isopterygiopsis pulchella* (110/95), *Kobresia capilliformis* (33/91), *Kobresia schoenoides* (44/89, 110/95:1), *Lepidozia reptans* (44/89), *Luzula multiflora* (33/91:r), *Minuartia imbricata* (11/84, 33/91), *Mnium thomsonii* (110/95), *Oxytropis kubanensis* (11/84, 108/95), *Paraleucobryum enerve* (40/83, 29/83), *Pedicularis caucasica* (29/83), *Pedicularis nordmanniana* (11/84, 33/91), *Peltigera sp.* (33/91:r), *Pleurozium schreberi* (101/94, 107/95), *Poa nemoralis* (33/91), *Pogonatum urnigerum* (108/95), *Pohlia elongata* (44/89), *Primula algida* (29/83), *Primula meyeri* (11/84), *Ptilidium ciliare* (101/94), *Ranunculus oreophilus* (44/89, 33/91:1), *Rhinanthus minor* (44/89, 101/94:r), *Saelania glaucescens* (11/84, 110/95), *Sanionia uncinata* (33/91), *Saxifraga kolenatiana* (33/91), *Sedum tenellum* (29/83, 11/84), *Senecio aurantiacus* (33/91), *Seseli alpinum* (51/94, 107/95), *Sibbaldia procumbens* (11/84), *Sphenolobus minutus* (51/94, 110/95), *Vaccinium myrtillus* (11/84), *Valeriana alpestris* (29/83:1, 33/91:2), *Viola altaica* (44/89, 107/95), *Weissia sp.* (108/95).

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

40/83 - 06.09, 25, M.Khatipara; 29/83 - 31.08, 25, M.Khatipara; 11/84 - 01.09, 15, M.Khatipara; 44/89 - 01.09, 25, M.Khatipara; 33/91 - 16.08, 8, Nazalykol; 51/94 - 12.07, 12, Kyshkadzher; 53/94 - 12.07, 12, Kyshkadzher; 101/94 - 21.07, 12, Goralykol; 107/95 - 05.08, 25, Mukhu; 108/95 - 05.08, 12, M.Khatipara; 110/95 - 18.08, 16, M.Khatipara.

### 13. Elfin birch woodland - *Vaccinio-Piceetea*

Prodromus

*Vaccinio-Piceetea* BRAUN-BLANQUET in BRAUN-BLANQUET *et al.* 1939

*Piceetalia excelsae* PAWLOWSKI in PAWLOWSKI *et al.* 1928

*Rhododendro caucasici-Betulion litwinowii* all.nov.

*Rhododendro caucasici-Betuletum litwinowii* ass.nov.

Derived association

*Senecioni nemorensis-Betuletum litwinowii* ass.nov. [*Rhododendro caucasici-Betulion litwinowii* / *Calamagrostion arundinaceae* OBERD 1950]

#### 13.1. *Rhododendro caucasici-Betulion litwinowii*

Elfin birch forests with dense cover of *Rhododendron caucasicum* are widespread in the Caucasus (GROSSGEIM 1949, TUMADZHANOV 1960, GULIASHVILI *et al.* 1975). We suggested a new alliance *Rhododendro caucasici-Betulion litwinowii* for such communities. Due to high frequency of several diagnostic species of *Vaccinio-Piceetea* and *Piceetalia excelsae* (*Dicranum scoparium*, *Hylocomium splendens*, *Vaccinium myrtillus*, *V.vitis-idaea*) we consider the communities within these syntaxa (MIRKIN *et al.* 1989, OBERDORFER 1992, WALLNOFFER 1993). There is one association in the alliance.

*Rhododendro caucasici-Betuletum litwinowii*

#### Floristic features

The diagnostic species set is represented by numerous species belonging to different life forms: trees (*Betula litwinowii*, *Sorbus aucuparia*), shrubs (*Rhododendron caucasicum*, *Juniperus communis*, *Rubus idaeus*), herbs (*Oxalis acetosella*, *Senecio renifolius*), bryophytes (*Hypnum pallescens*, *Barbilophozia barbata*, *Sanionia uncinata*) and lichens (*Cetraria islandica*, *Cetraria pinastri*). *Rhododendron caucasicum* and *Betula litwinowii* are the main dominants.

Floristic richness of the communities is moderate. We registered 61 vascular plant species, 41 bryophytes and 9 lichens in 10 relevés (Table 13.1.).



Table 13.1. (continued)

Releve No	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1				
	22	23	43	63	01	98	73	91	33	62	46	60	3	4	5	11	12	29	26	95		
year	93	93	94	95	95	94	94	94	95	95	83	83	93	95	95	95	95	95	94	94		
<i>D.sp. Senecioni nemorensis-Betuletum litwinowii</i>																						
<i>Senecio nemorensis</i>	-															1				1	IV	
<i>Heracleum asperum</i>	-										2	1	2	+	+					1	1	IV
<i>Poa nemoralis</i>	+	+														+	+	+	+	+	IV	
<i>Geranium sylvaticum</i>	2	r	+								1		1	1		1	+	+	+	+	IV	
<i>Pulmonaria mollissima</i>	-											1	1					1	+	1	III	
<i>Chaerophyllum aureum</i>	-												1		+	1	1		+	1	III	
<i>Cruciata laevipes</i>	-										+		+		+	+			+		III	
<i>Astrantia maxima</i>	-										1		2			1	1		+	+	III	
<i>Acer trautvetteri</i>	-											2	2	2	1	+				1	III	
<i>Silene vulgaris</i>	-										1		+			1	+			+	III	
<i>Cephalaria gigantea</i>	-										1	1				+	+		+		III	
<i>Lapsana communis</i>	-												+	+	+					+	III	
<i>Dryopteris filix-mas</i>	-										+	1		2					1	1	III	
<i>Campanula latifolia</i>	-												1	+					+	1	+	III
<i>Betonica macrantha</i>				+							1	+	+			1	2			+	III	
<i>Aconitum nasutum</i>				+						+	1	+	1	+			+				III	
<i>Hieracium umbellatum</i>	-										1	+			+	+					II	
<i>Petasites albus</i>	-											2	1	1					1		II	
<i>Pterigynandrum filiforme</i>	-													1		+	+	+			II	
<i>Galium odoratum</i>	-												2	1	+				+		II	
<i>Sedum spurium</i>	-															+		+		+	II	
<i>Cirsium obvallatum</i>	-										1		+							+	II	
<i>Bupleurum falcatum</i>	-														+	+	+				II	
<i>Ligusticum alatum</i>	-										2	1							+		II	
<i>Daphne mezereum</i>	-												+	+					+		II	
<i>Pimpinella rhodantha</i>	-												+			+				+	II	
<i>Carduus adpressus</i>	-											1	+			+					II	
<i>Athyrium filix-femina</i>	-													+					1	+	II	
<i>Polystichum lonchitis</i>	-										+	+							+		II	
<i>Millium effusum</i>	-										1	1	1							1	II	
Other species																						
<i>Aconitum orientale</i>				+									1	1						+	+	II
<i>Alchemilla vulgaris aggr.</i>	+							+				+	1	1					+	+	+	III
<i>Anthoxanthum odoratum</i>					+			+													+	-
<i>Brachythecium reflexum</i>				1	1	+														+		I
<i>Brachythecium salebrosum</i>													2	2		+	+		1	+		III
<i>Brachythecium starkei</i>						+	1	1					1	2								I
<i>Brachythecium velutinum</i>																+	+	+				II
<i>Calamagrostis arundinacea</i>	1	1	1		+	+			+	+	IV	1	2	1	+	2	3	+	+		3	V
<i>Campanula collina</i>																1	+					I
<i>Chamerion angustifolium</i>	2	+		+	+	+			1		III	2	1			1						II
<i>Cicerbita racemosa</i>	+															+	1			+		II
<i>Cladonia pyxidata</i>	+	+		+	+					+	III		+						+			I
<i>Dicranoweisia crispula</i>						+													1			I
<i>Grimmia sessitana</i>						+									+	+						I
<i>Hedysarum caucasicum</i>										+	I	1				1						I
<i>Hieracium macrolepis</i>						+													+			I

**Table 13.1.** (continued)

Releve No.	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	1		
	22	23	43	63	01	98	73	91	33	62	46	60	3	4	5	11	12	29	26	95	
Year	93	93	94	95	95	94	94	94	95	95	83	83	93	95	95	95	95	95	94	94	
<i>Hieracium prenanthoides</i>				+											+		+				
<i>Lescurea mutabilis</i>										+				1	1						
<i>Lescurea saxicola</i>		1		+		+				+							1	+		1	
<i>Leskeella nervosa</i>				+		+	+						+	+			1				
<i>Lophocolea heterophylla</i>				+				+											+		
<i>Myosotis alpestris</i>	+	+				+		+				+								+	
<i>Orthotrichum pumilum</i>				+											+	+					1
<i>Polygonatum verticillatum</i>										+			+					+			1
<i>Polygonum bistorta</i>				+														+		+	
<i>Populus tremula</i>	2				+								1								
<i>Pseudoleskea incurvata</i>										+	1			1	1				+		
<i>Racomitrium canescens</i>	+					+									+				+		
<i>Radula complanata</i>				+			+								+		+				
<i>Rhodobryum roseum</i>				+						+	1	2									
<i>Salix caprea</i>				1										1		1					
<i>Seseli alpinum</i>	+	+				1				+									+		
<i>Veratrum album</i>										+	1	+	+	+							

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

*Abietinella abietina* (46/83:1), *Achillea millefolium* (26/94), *Actaea spicata* (29/95:1), *Aegopodium podagraria* (3/93), *Agasyllis latifolia* (4/95), *Agrostis vinealis* (98/94), *Angelica purpurascens* (26/94:1), *Anomodon rugelii* (60/83:1), *Antennaria dioica* (98/94), *Anthemis macroglossa* (5/95, 12/95), *Anthriscus sylvestris* (46/83:1, 60/83:1), *Aquilegia olympica* (46/83, 26/94), *Asyneuma campanuloides* (22/93, 3/93), *Athyrium distentifolium* (46/83), *Barbilophozia hatcheri* (98/94, 62/95), *Brachypodium pinnatum* (3/93:2, 11/95:1), *Brachypodium sylvaticum* (3/93), *Brachythecium rutabulum* (63/95:1), *Bryum capillare* (46/83:1), *Bryum sp.* (98/94), *Bryum subelegans* (5/95, 29/95), *Calamagrostis epigeios* (26/94), *Campanula lactiflora* (3/93:1), *Campanula rapunculoides* (46/83:1), *Cardamine uliginosa* (3/93, 26/94), *Carduus nutans* (3/93), *Carex digitata* (63/95, 62/95), *Carex mingrelica* (12/95, 26/94), *Centaurea nigriffimbria* (11/95, 12/95), *Centaurea salicifolia* (5/95, 12/95), *Cerastium davuricum* (3/93:1), *Chamerion dodonaei* (46/83:1), *Cirsium chlorocomos* (11/95), *Cirsium vulgare* (26/94), *Cladonia ecmocyna* (22/93, 23/93), *Cladonia mitis* (98/94:1, 173/94), *Cladonia sp.* (173/94), *Clinopodium vulgare* (12/95, 195/94), *Conocephalum conicum* (3/93), *Corylus avellana* (3/93:2), *Cratoneuron filicinum* (3/93), *Crepis glabra* (3/93:1), *Crepis paludosa* (26/94:1), *Dactylis glomerata* (60/83:1, 26/94), *Delphinium schmalhausserii* (195/94), *Deschampsia caespitosa* (26/94), *Dichodontium pellucidum* (143/94), *Digitalis ciliata* (5/95, 12/95), *Doronicum macrophyllum* (60/83, 3/93:1), *Dryopteris carthusiana* (191/94), *Dryopteris oreades* (22/93), *Eleutherosperrum cicutarium* (3/93:1), *Epipactis helleborine* (29/95), *Equisetum hyemale* (195/94:1), *Equisetum palustre* (26/94), *Euphorbia macroceras* (195/94), *Eurhynchium pulchellum* (98/94), *Fagus orientalis* (11/95, 29/95), *Festuca altissima* (4/95:1), *Festuca brunnescens* (12/95), *Festuca djimilensis* (11/95), *Festuca ovina* (98/94:1), *Festuca pratensis* (46/83:1), *Filipendula ulmaria* (195/94), *Fragaria vesca* (3/93, 195/94:1), *Frullania dilatata* (29/95), *Galeopsis bifida* (195/94), *Galium verum* (46/83), *Geranium sanguineum* (11/95), *Geum urbanum* (4/95, 26/94), *Grimmia elatior* (101/95, 4/95), *Helictotrichon versicolor* (98/94), *Hieracium murorum* aggr. (62/95, 29/95), *Homalothecium philippeanum* (3/93), *Hypericum perforatum* (3/93:r), *Kemulariella caucasica* (62/95), *Lamium album* (3/93), *Lathyrus pratensis* (3/93), *Leontodon hispidus* (5/95), *Lepidozia reptans* (191/94), *Lilium monadelphum* (11/95), *Lonicera caucasica* (29/95), *Lophocolea minor* (143/94), *Luzula multiflora* (98/94, 26/94), *Luzula pilosa* (22/93, 23/93), *Melica nutans* (3/93), *Mnium stellare* (29/95), *Mycelis muralis* (29/95), *Myosotis amoena* (3/93, 4/95), *Nepeta grandiflora* (3/93), *Nephroma bellum* (29/95), *Orchis euxina* (3/93), *Orobancha purpurea* (3/93:r), *Orthodicranum montanum* (173/94), *Orthotrichum pallens* (3/93), *Orthotrichum rupestre* (11/95, 12/95), *Orthotrichum speciosum* (173/94, 4/95), *Oxyria digyna* (46/83), *Padus avium* (60/83:1), *Paraleucobryum longifolium* (63/95:1, 29/95:1), *Pedicularis condensata* (46/83), *Pedicularis wilhelmsiana* (60/83), *Peltigera canina* (23/93, 29/95), *Peltigera malacea* (22/93), *Phegopteris connectilis* (101/95), *Plagiochila porelloides* (143/94), *Plagiomnium affine* (46/83:2), *Plagiomnium medium* (60/83:1, 3/93), *Plagiomnium rostratum* (3/93), *Plagiothecium denticulatum* (63/95, 191/94), *Poa longifolia* (22/93, 143/94), *Poa palustris* (3/93), *Poa pratensis* (46/83:2), *Pohlia longicollis* (143/94), *Polygonatum multiflorum* (3/93), *Polytrichastrum alpinum* (143/94), *Polytrichum piliferum* (22/93), *Primula veris* (60/83, 26/94), *Ptilidium pulcherrimum* (173/94), *Pulsatilla aurea* (62/95), *Ranunculus caucasicus* (62/95, 46/83), *Ranunculus oreophilus* (98/94), *Ranunculus subtilis* (26/94),

*Rhynchospora elephas* (26/94), *Ribes biebersteinii* (60/83:1, 3/93), *Ribes uva-crispa* (29/95), *Rosa canina* (3/93), *Rosa iberica* (60/83:1, 12/95), *Rubus saxatilis* (143/94, 11/95), *Rumex alpestris* (46/83:1), *Salix apoda* (191/94), *Salix caprea* (46/83), *Salix kazbekensis* (22/93, 98/94:2), *Salix sp.* (60/83:1), *Salvia glutinosa* (3/93), *Scabiosa ochroleuca* (11/95:r), *Scrophularia scopolii* (3/93), *Senecio caucasicus* (191/94, 133/95), *Senecio platyphylloides* (60/83:1, 26/94:1), *Silene multifida* (60/83, 3/93:1), *Silene sp.* (62/95), *Sphenolobus minutus* (143/94), *Stellaria media* (3/93:r, 26/94), *Stellaria nemorum* (3/93, 26/94:1), *Stellaria sp.* (3/93), *Swertia iberica* (3/93:1, 26/94), *Taraxacum confusum* (98/94), *Taraxacum officinale* aggr. (5/95, 26/94), *Thesium alpinum* (5/95), *Tortula ruralis* (46/83:1), *Tragopogon reticulatus* (5/95), *Trifolium ambiguum* (12/95), *Trollius ranunculinus* (46/83:1), *Ulotia crispa* (173/94), *Urtica dioica* (60/83:1, 3/93), *Valeriana allianifolia* (3/93, 29/95), *Valeriana alpestris* (98/94), *Veronica filiformis* (3/93, 26/94), *Veronica gentianoides* (98/94), *Veronica peduncularis* (3/93, 11/95), *Vicia abbreviata* (5/95, 11/95), *Vicia balansae* (3/93:1), *Vicia sepium* (60/83:1, 26/94).

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

22/93 - 09.07, 100, Ullu-Murudzhu (N.Illarionova); 23/93 - 09.07, 25, Ullu-Murudzhu (N.Drenova); 143/94 - 31.07, 25, Mukhu; 63/95 - 12.07, 25, Baduk; 101/95 - 28.07, 25, Khadzhibey (A.Egorov); 98/94 - 21.07, 25, Goralykol; 173/94 - 07.09, 25, Oriuchat; 191/94 - 10.09, 25, Kichi-Murudzhu; 133/95 - 30.08, 25, Ullu-Murudzhu; 62/95 - 12.07, 25, Baduk; 46/83 - 08.09, 25, Bol.Khatipara; 60/83 - 15.09, 100, M.Khatipara; 3/93 - 04.07, 100, M.Khatipara (O.Gorbachevskaya); 4/95 - 02.07, 25, Alibek; 5/95 - 02.07, 25, Alibek; 11/95 - 03.07, 25, Alibek; 12/95 - 03.07, 24, Alibek; 29/95 - 05.07, 25, Amanauz; 26/94 - 09.07, 10, Dombay-Ulgen; 195/94 - 10.09, 25, Klukhor.

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Mean species numbers per releve were 17, 9 and 3 correspondingly. Moss cover is well-represented (5-35%, mean 20%), which is typical for *Vaccinio-Piceetea* communities. Typus, or nomenclature type, No. 101/95.

### Ecological features

The communities are typically found at the subalpine timberline within the altitude range 2220-2500 m (mean 2340 m). The birch forests can penetrate to lower zones along avalanche paths, because avalanches destroy coniferous forests whereas elfin birch remains undamaged. They occupy steep (5°-35°, mean 20°) "cold" (mainly northern) slopes.

Stones cover from less than 1% to 35% (mean 8%). As a whole, the communities develop at the sites of significant (several metres) snowpack accumulation and high avalanche activity (YASHINA 1981). Flexible birch trunks are often pressed to the ground by snow, but they easily spring up again after the snowmelt. Abundant water supply to the soils combined with good drainage leads to formation of acidic poor soils under the communities.

### 13.2. *Senecioni nemorensis-Betuletum litwinowii*

#### Floristic features

The other type of elfin birch woodland forms the derived association of unclear syntaxonomic position. Several *Vaccinio-Piceetea* species are poorly represented in it (*Pyrola minor*, *Dicranum scoparium*), while some frequent species are shared with the previous association (*Betula litwinowii*, *Sorbus aucuparia*, *Sanionia uncinata*, *Rubus idaeus*). On the other hand, significant species of *Mulgedio-Aconitetea* and *Calamagrostion arundinaceae* (*Geranium sylvaticum*, *Astrantia maxima*, *Silene vulgaris*, *Campanula latifolia*, *Aconitum nasutum*, *Bupleurum falcatum*, *Millium effusum*, *Calamagrostis arundinacea* etc.) are well represented. We are inclined to consider the association as a derivative syntaxon positioned between *Mulgedio-Aconitea* and *Vaccinio-Piceetea*. Physiognomy of the communities combines the features of both classes. Moss cover may be well developed (from 1 to 80%, mean 19%). On the other hand tall forbs play a significant role in vascular plant cover, whose density ranges between 25% and 95% (mean 65%). *Rhododendron caucasicum* is completely absent.

The communities are floristically very rich. We registered 160 vascular plant species, 39 bryophytes and 3 lichens in 10 relevés. The mean values per relevé were 36, 8 and less than 1 species correspondingly.

Typus, or nomenclature type, No. 3/93.

#### Ecological features

The communities occupy steep (4°-35°, mean 22°) slopes of various, but mainly southern, exposures. They are typical of the upper forest and subalpine zones within the altitude range of 1830-2500 m (mean 2080 m). Stone and bare soil may cover up to 40%, but mean stone cover is about 12%. Significant winter snowpack accumulation does not reduce growth season significantly there due to high insolation on "warm" slopes. Snow movement is less usual here, so young *Abies nordmanniana* trees can be found in some communities of this syntaxon.

## 14. Anthropogenic changes to the vegetation

Most of the described communities can be found in the protected area within the Teberda Reserve. Vegetation surrounding the preserve has been greatly changed by human impact. There are several kinds of anthropogenic factors altering the high mountain ecosystems, mainly grazing, building of roads, summer tourist recreation and winter sports activity (LUKSCHANDERL 1983).

Undoubtedly, (over) grazing is the single most important factor of vegetation disturbance in the region. We compared the composition and structure of the alpine communities in the reserve and in surrounding grazed-over areas. The following main transformations were observed.

Alpine heaths (tundra) (*Pediculari comosae-Eritrichietum caucasicum*) rapidly lose their lichen cover and change to sparse dry scree-type communities. Similar changes can be observed in dry *Festuca varia* - grasslands (*Viola altaicae-Festucion variae geranietosum renardii*). But the communities of the typical subassociation (*V.a.-F.v. typicum*) are transformed to *V.a.-F.v. nardetosum*. The cover of *Festuca varia* decreases and *Nardus stricta* increases under severe grazing. Similarly, productive alpine grasslands (*Hedysaro caucasicae-Geranietum gymnocauli*) change into *Nardus*-dominated grasslands. The snowbed communities (*Hyalopoo ponticae-Pedicularietum nordmannianae*) remained relatively stable under grazing. The percentage of *Sibbaldia procumbens* and bare soil cover increased on grazed sites in comparison with the ungrazed areas.

*Nardus stricta*-dominated communities develop under strong grazing in subalpine zone as well. On rich moist soils ruderal tall herbaceous communities (*Anthrisko sylvestris-Rumicetum alpini*) are formed on overgrazing areas. Unpalatable plants (*Rumex alpinus*, *Veratrum album*, *Cirsium pugnax*, *C.obvallatum*) come to dominate in such places.

In most cases the cover percentage of different species changes greatly under grazing, but floristic composition remains relatively stable. Therefore, we can easily determine the syntaxonomic position of the altered communities. However, under severe grazing stress near cattle or sheep enclosures the vegetation has changed drastically. A new association with the following syntaxonomic position can be suggested for such communities (MUCINA 1993b, POTT 1995) (Table 14.1.).

**Table 14.1.**

*Ranunculo oreophili - Polygonetum avicularis*

Releve No.	118	122	141	116
Year	94	94	94	94
Altitude (* 10)	245	245	240	215
Steepness	5	3	5	5
Exposition	e	n	se	sse
Vascular plant cover	80	70	50	60
Bryophyte cover	0	0	1	0
Stone cover	0	1	5	5
bare soil	10	5	10	15
<i>D.sp. Ranunculo oreophili - Polygonetum avicularis</i>				
<i>Trifolium ambiguum</i>	2	1	1	2
<i>Ranunculus oreophilus</i>	+	1	+	
<i>Phleum alpinum</i>		+	+	
<i>Cirsium munitum</i>			2	2
<i>D.sp. Polygono arenastri - Poetea annuae,</i> <i>Polygono arenastri - Poetalia annuae</i>				
<i>Polygonum aviculare</i>	4	3	+	1
<i>Poa annua</i>	2	2	+	1
<i>D.sp. Matricario matricarioidis - Polygonion arenastri</i>				
<i>Poa pratensis</i>			2	2
Other species:				
<i>Achillea millefolium</i>			1	+
<i>Alchemilla vulgaris aggr.</i>	1	1	2	1
<i>Capsella bursa-pastoris</i>	1	1	+	+
<i>Carduus nutans</i>			2	1
<i>Cerastium holosteoides</i>	+		+	
<i>Draba nemorosa</i>	1		1	1
<i>Lamium album</i>			1	1
<i>Plantago major</i>	+		+	+
<i>Rumex alpinus</i>		1		+
<i>Stellaria media</i>	1	2		+
<i>Taraxacum officinale aggr.</i>	+	2	1	1
<i>Thlaspi arvense</i>	+	2		
<i>Urtica dioica</i>			1	1
<i>Veronica verna</i>			+	+

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

*Acinos arvensis* (141/94), *Agropyron repens* (116/94), *Agrostis stolonifera* (141/94), *Alopecurus pratensis* (116/94), *Arctium tomentosum* (118/94), *Asperugo procumbens* (116/94), *Bromopsis variegata* (141/94), *Bryum argenteum* (141/94:1), *Cerastium arvense* (141/94), *Cirsium obvallatum* (141/94), *Dactylis glomerata* (122/94), *Deschampsia caespitosa* (141/94), *Entodon concinnum* (141/94), *Festuca pratensis* (122/94), *Galeopsis bifida* (116, 94), *Geranium pusillum* L. (116/94), *Veronica filiformis* (116/94).

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

118/94 - 29.07, 25, Mukhu; 122/94 - 29.07, 25, Mukhu; 141/94 - 31.07, 25, Mukhu; 116/94 - 29.07, 25, Mukhu.

*Polygono arenastri-Poetea annuae* RIVAS-MARTINEZ 1975

*Polygono arenastri-Poetalia annuae* TÜXEN in GEHU *et al* 1972

? *Matricario matricarioides-Polygonion arenastris* RIVAS-MARTINEZ 1975

*Ranunculo oreophili-Polygonetum aviculais* EGOROV ass.nov.prov.

Species of various syntaxa of ruderal vegetation are represented in the communities (*Lamium album*, *Urtica dioica*, *Elytrigia repens*, *Alopecurus pratensis*, *Capsella bursa-pastoris*, *Stellaria media*, *Thlaspi arvensis*, *Plantago major*). The communities are not floristically rich (13-26 species per releve). Lichens are completely absent and the role of bryophytes is negligible. The communities occupy gentle (3-5) slopes of various exposure near enclosures ("koshi" in local tongue) within the subalpine zone (2150-2450 m a.s.l.).

## 15. Multivariate analysis of the syntaxa

We used detrended correspondence analysis (DCA) and weighted pair group cluster analysis (MVSP Software, KOVACH 1995) to estimate the relationships between the syntaxa of the vegetation. All (47) subassociations or associations (except *Ranunculo oreophili-Polygonetum aviculais*) were included in the analysis. Each syntaxon was represented by a complete list of species with frequency classes (1-5) as the abundance value of each species. Rare species found infrequently (class 1) in one syntaxon only were excluded from the general matrix before the processing. The matrix analyzed included 651 species.

The DCA -ordination patterns are represented in Fig. 15.1. on three main axes. The results of the cluster analysis are represented in the dendrogram (Fig. 15.2.). Overall, the results showed a considerable correspondence with the position of the syntaxa in the floristic system, but some discrepancies have also been noted.

Communities of *Juncetea trifidi*, *Carici rupestris-Kobresietea bellardii* and *Polygono viviparum-Salicetum kazbekensis* form a separate group in all projections. They build a distinct cluster as well. All of these low productive alpine communities are typical of windward slopes with thin or absent snow cover in winter, so the extreme environment is responsible for their distinct floristic composition. On the other hand, as we have noted above, the floristic differences between *Juncetea trifidi* and *Carici rupestris-Kobresietea bellardii* are very subtle in our region. Perhaps, it would be better to consider them within the same class. The position of *Polygono viviparum-Salicetum kazbekensis* in *Loiseleurio-Vaccinietea* is more or less formal and might be revised in the future.

It is necessary to point out that the position of *Violo altaicae-Festucetum variae* is quite different from *Juncetea trifidi* (*Anemonion speciosae*) syntaxa. It confirms the position of the Caucasian *Festuca varia* dominated grasslands within *Nardetalia*.

All syntaxa of *Mulgedio-Aconitetea*, except one, form a separate cluster (Fig.15.2.). Their position on the DCA -axis surface is rather distinct as well. *Senecioni propinqui-Betuletum litwinowii* is positioned closely to the subalpine tall herbaceous communities, as we have discussed above (ch.13).

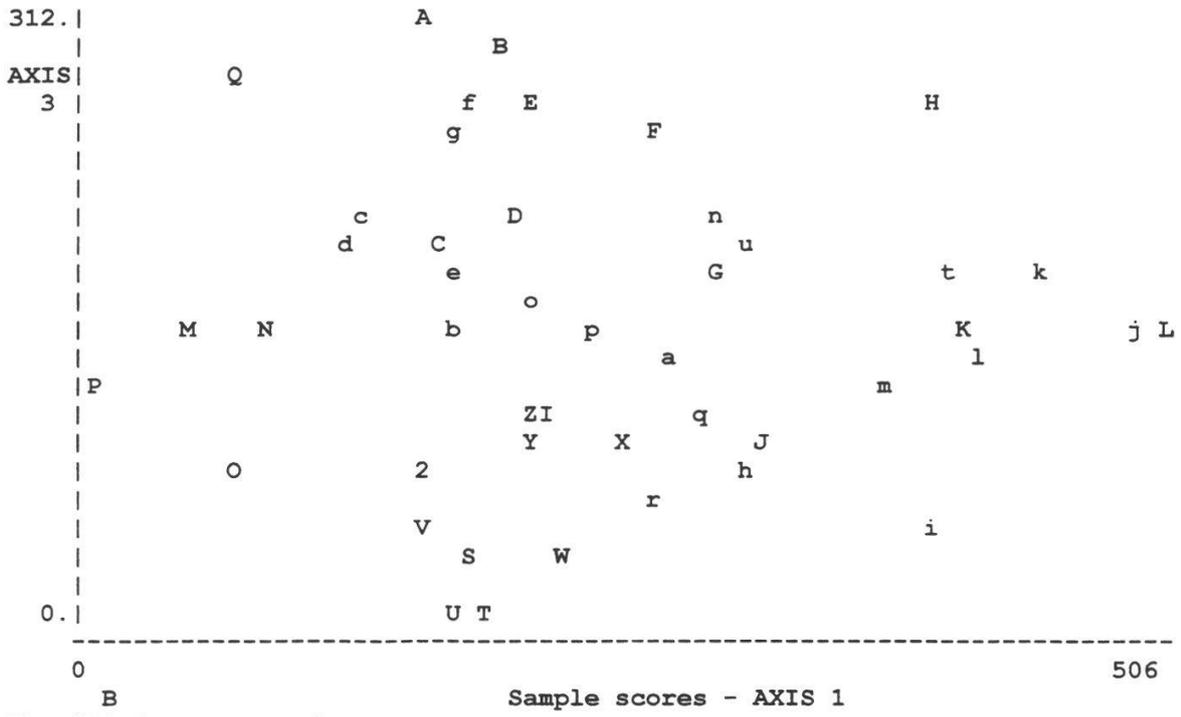
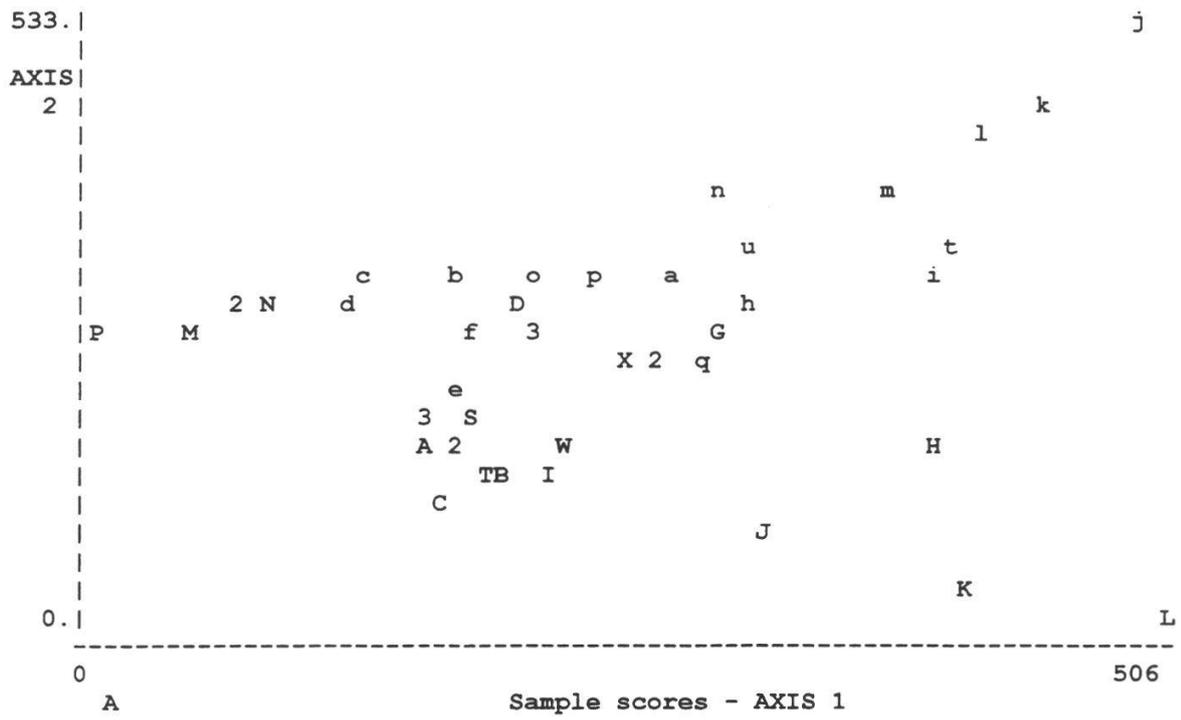
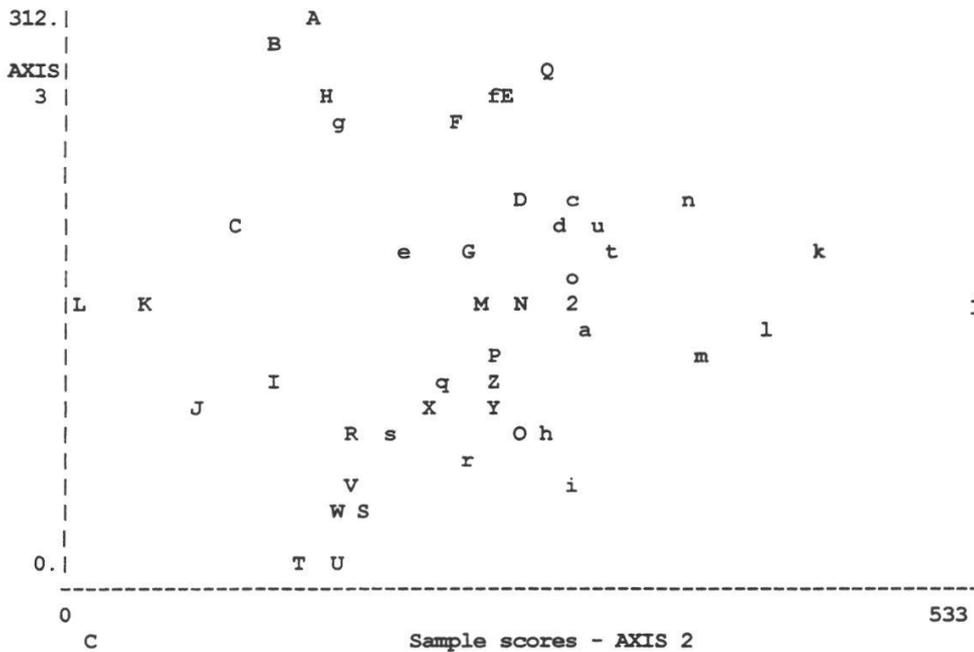


Fig. 15.1. (see next page)



**Fig. 15.1.**

Results of DCA-analysis (projection of syntaxa on three main ordination axes) Syntaxa:

*Thlaspietea rotundifolii*:

**A** - *Veronico minutae-Chaerophylletum humilis typicum*, **B** - *V.t.-Ch.h. lamietosum tomentosum*, **C** - *V.t.-Ch.h. saxifragetosum flagellaris*, **D** - *Hyalopoo ponticae-Oxyrietum digynae ranunculetosum oreophili*, **E** - *H.p.-O.d. typicum*, **F** - *Scrophulario olympicae-Epilobietum dodonaei*, **G** - *Dicranoweisio crispulae-Rubetum idaei*, **H** - *Silene compactae-Salicetum elbursensis*.

*Asplenietea trichomanis*:

**I** - *Potentilletum divinae*, **J** - *Astragaletum levieri*, **K** - *Galio valantioides-Polypodietum vulgare*, **L** - *Thymo-Seseliolum petraei*.

*Scheuchzerio-Caricetea fuscae*:

**M** - *Caro caucasici-Caricetum nigrae salicetosum kazbekensis*, **N** - *C.c.-C.n. typicum*, **O** - *Swertio ibericae-Caricetum nigrae*, **P** - *Caricetum rostratae*.

*Montio-Cardaminetea*: **Q** - *Cerastio cerastioidis-Cardaminetum uliginosi*.

*Carici rupestris-Kobresietea bellardii*:

**R** - *Drabo scabri-Kobresietum schoenoidis*, **S** - *Alchemillo-Kobresietum capilliformis*.

*Juncetea trifidi*:

**T** - *Campanulo ciliatae-Chamaesciadietum acaulis*, **U** - *Pediculari comosae-Eritrichietum caucasici oxytropidetosum kubanensis*, **V** - *P.c.-E.c. typicum*, **W** - *P.c.-E.c. bromopsietosum variegatae*.

*Calluno-Ulicetea*:

**X** - *Violo altaicae-Festucetum varia geranietosum renardii*, **Y** - *V.a.-F.v. typicum*, **Z** - *V.a.-F.v. nardetosum*, **a** - *Hedysaro caucasicae-Geranietum gymnocauli senecionetosum kolenatiani*, **b** - *H.c.-G.g. typicum*.

*Salicetea herbaceae*:

**c** - *Ranunculetum brachylobi*, **d** - *Hyalopoo ponticae-Pedicularietum nordmanniana*, **e** - *Saxifragetum sibiricae typicum*, **f** - *S.s. primuletosum amoenae*, **g** - *S.s. saxifragetosum moschatae*.

*Mulgedio-Aconitetea*:

**h** - *Betonici macranthae-Calamagrostietum arundinaceae typicum*, **i** - *B.m.-C.a. veronicetosum peduncularis*, **j** - *Anthriscio sylvestris-Rumicetum alpini typicum*, **k** - *A.s.-R.a. senecionetosum platyphyllidis*, **l** - *Cephalario giganteae-Ligusticetum alani*, **m** - *Poetum longifoliae*.

*Loiseleurio-Vaccinietea*:

**n** - *Lerchenfeldio-Rhododendretum caucasici L.-R.c. oxalidetosum*, **o** - *L.-R.c. typicum*, **p** - *L.-R.c. pleurozietosum*, **q** - *Aconito nasuti-Juniperetum typicum*, **r** - *A.n.-J. chaerophylletosum rosei*, **s** - *Polygono viviparum-Salicetum kazbekensis*.

**t** - *D.c. Senecioni nemorensis-Betuletum litwinowii*.

*Vaccinio-Piceetea*: **u** - *Rhododendro caucasici-Betuletum litwinowii*.

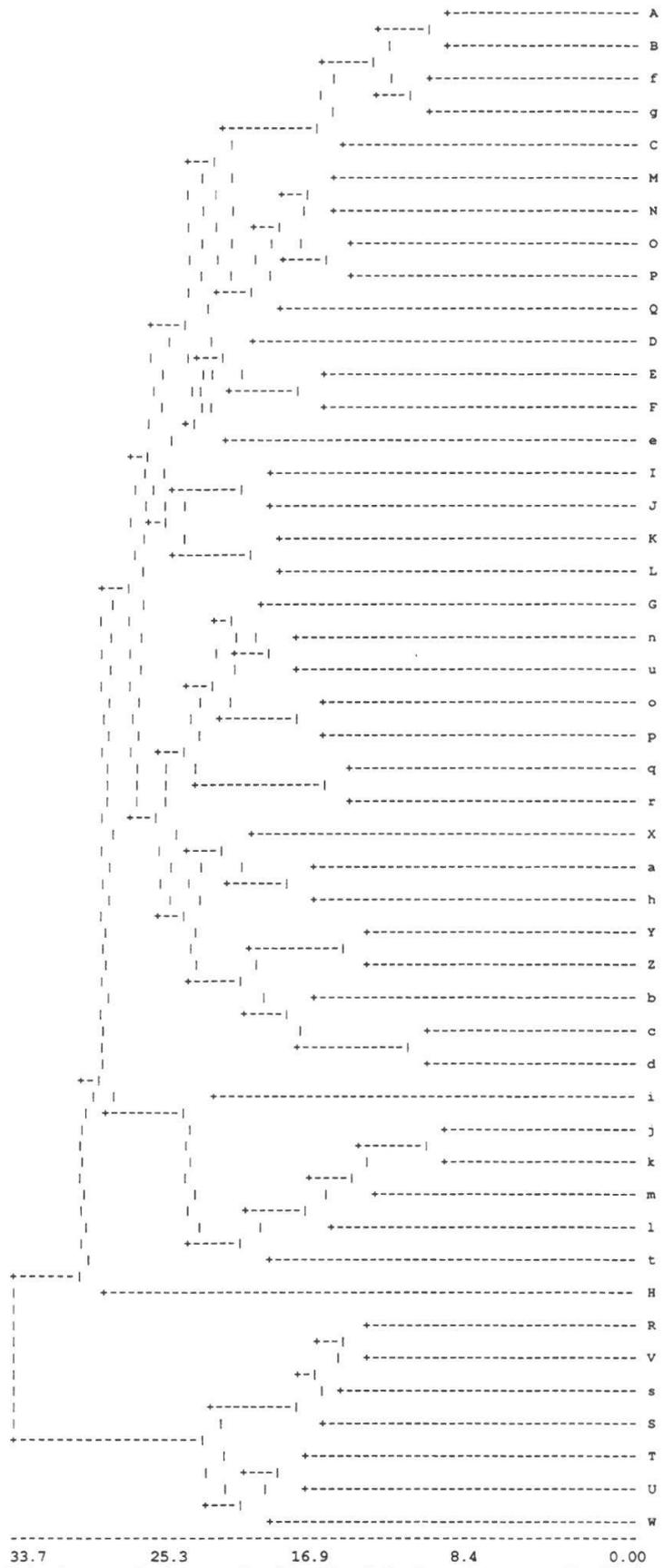


Fig.15.2. Dendrogram of cluster analysis results. For the list of syntaxa see fig.15.1.

The alpine grassland (*Calluno-Ulicetea*) forms another compact group in the dendrogram. It occupies the central part of the ordination surfaces. The position can be attributed to rather favourable ecological conditions for this community where many alpine, as well as some subalpine species can grow. We consider *Hedysaro caucasicae-Geranium gymnocauli* as the "core" (according to KEDDY 1989, 1990) alpine community.

*Rhododendron-* and *Juniperus-*shrubs (*Loiseleurio-Vaccinieta*) are positioned close to the *Nardetalia* (Fig. 15.1.). One of the birch woodlands (*Rhododendro caucasici-Betuletum litwinowii*) also fits into this group.

Despite their significant floristic variability, rock outcrop communities (*Asplenietea trichomanis*) form a separate cluster in the dendrogram (Fig. 15.2.). They assume a relatively isolated position in the ordination surfaces as well. Syntaxa of *Thlaspietea rotundifolii* can be divided into 3 groups. *Silene compactae-Salicetum elbursensis* has the most distinct position from all other communities due to its great floristic richness and varied composition. Subalpine stable screes (*Dicranoweisio crispulae-Rubetum idaei*) are very closely related to *Rhododendron* - scrub (*Lerchenfeldio-Rhododendretum caucasici*). On the other hand alpine and subalpine unstable screes are the closest to the snowbeds and fens.

Alpine fens (*Scheuchzerio-Caricetea fuscae*) demonstrated a very distinct position on the first ordination axis (Fig. 15.1.a). The dry rock communities of the lower altitudes (*Thymo-Seselietum petraei*) occupy the opposite position. Therefore, we can consider the first axis as a complex moisture-altitude gradient.

The interpretation of the ecological sense of the second axis is more difficult. Species-poor high productive *Anthriscosylvestris-Rumicetum alpini* communities occupied the extreme positions on the one side, on the other side there were species of rich unproductive dry rock communities (*Thymo-Seselietum petraei*).

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**Vascular species index**

- Abies nordmanniana* (Stev.) Spach  
*Acer trautvetteri* Medw.  
*Achillea millefolium* L.  
*Achillea nobilis* L.  
*Acinos arvensis* (Lam.) Dandy (*Acinos thymoides* Moench)  
*Aconitum nasutum* Fisch. ex Reichenb. [ *A. pubiceps* (Rupr.) Trautv.; *A. cymbulatum* (Schmalh.) Lipsky]  
*Aconitum orientale* Mill.  
*Actaea spicata* L.  
*Aegopodium podagraria* L.  
*Aetheopappus caucasicus* Sosn. [ *A. pulcherrimus* (Willd.) Gass.]  
*Aetheopappus vvedenskii* (Sosn.) Sosn.  
*Agasyllis latifolia* (Bieb.) Boiss.  
*Agropyron caninum* (L.) P.Beauv. [ *Elymus caninus* (L.) L.; *Elytrigia canina* (L.) Drub.]  
*Agropyron hispidum* Opiz [ *Agropyron intermedium* (Host) Beauv.; *Elymus hispidus* (Opiz) Melderis; *Elytrigia trichophora* (Link) Nevski]  
*Agropyron repens* (L.) Beauv. [ *Elytrigia repens* (L.) Nevski; *Elymus repens* (L.) Gould]  
*Agrostis stolonifera* L.  
*Agrostis vinealis* Schreb. (*A. tenuifolia* Bieb.; *A. platifolia* C.Koch.)  
*Ajuga orientalis* L.  
*Alchemilla caucasica* Bus.  
*Alchemilla sericea* Willd.  
*Alchemilla vulgaris* L. aggr.  
*Allium rupestre* Stev.  
*Allium saxatile* Bieb. (*Allium ruprechtii* Boiss.; *A. globosum* Bieb. ex Redoute)  
*Alnus glutinosa* (L.) Gaertn.  
*Alnus incana* (L.) Moench  
*Alopecurus dasyanthus* Trautv.  
*Alopecurus glacialis* C.Koch  
*Alopecurus ponticus* C.Koch (*A. sericeus* Albov; *A. caucasicus* Sered.)  
*Alopecurus pratensis* L.  
*Alyssum calycinum* L. [ *A. alyssoides* (L.) L.]  
*Alyssum murale* Waldst. et Kit.  
*Alyssum repens* Baumg. (*Alyssum trichostachyum* Rupr.)  
*Amelanchier rotundifolia* (Lam.) Dum.-Cours. (*A. ovalis* Medik.)  
*Androsace albana* Stev.  
*Androsace chamaejasme* Wulf. (*A. lehmanniana* Spreng.)  
*Anemone narcissiflora* L. (*A. fasciculata* L.; *Anemonastrum fasciculatum* (L.) Holub)  
*Anemone speciosa* Adam ex G.Pritz [ *Anemonastrum speciosum* (Adams ex G.Pritz.) Galushko]  
*Angelica purpurascens* (Ave-Lall.) Gilli [ *Xanthogalum purpurascens* Ave-Lall.; *A. tatianae* Bordz.; *X. tatianae* (Bordz.) Schischk.]  
*Antennaria dioica* (L.) Gaertn. (*A. caucasica* Boriss.)  
*Anthemis cretica* L. (*A. iberica* Bieb.; *A. saportana* Albov)  
*Anthemis marshalliana* Willd. (*A. sosnovskyana* Fed.; *A. rudolphiana* Ad.)  
*Anthemis melanoloma* Trautv. [ *Cota melanoloma* (Trautv.) Holub; *A. macroglossa* Somm. et Levier]  
*Anthoxanthum odoratum* L. (*A. alpinum* A. et D.Love)  
*Anthriscus sylvestris* (L.) Hoffm. [ *A. nemorosa* (Bieb.) Spreng.]  
*Anthriscus velutina* Somm. et Levier  
*Anthyllis vulneraria* L. [ *A. variegata* Boiss. ex Grossh.; *A. caucasica* (Grossh.) Juz.; *A. macrocephala* Wend.; *A. boisseri* (Sagor.) Grossh.]  
*Aquilegia olympica* Boiss.  
*Arctium tomentosum* Mill. [ *A. palladinii* (Marc.) Grossh.]  
*Arenaria lychnidea* Bieb. [ *Eremogone lychnidea* (Bieb.) Rupr.]  
*Arenaria rotundifolia* Bieb.  
*Arnebia pulchra* (Roem. et Schult.) J.R.Edmondson [ *Macrotomia echioides* (L.) Boiss. p.p.; *Huynhia pulchra* (Roem. et Schult.) Greuter et Burdet]  
*Artemisia absinthium* L.  
*Artemisia campestris* L.  
*Artemisia chamaemellifolia* Vill.  
*Artemisia taurica* Willd. [ *A. graveolens* Minatullaev; *Seriphidium tenuisetum* (Nevski) Poljak.]  
*Asperugo procumbens* L.  
*Asperula alpina* Bieb. [ *A. cristata* (Somm. et Levier) V.Krecz.]  
*Asplenium ruta-muraria* L.  
*Asplenium septentrionale* (L.) Hoffm.  
*Asplenium trichomanes* L.  
*Asplenium viride* Huds.  
*Aster alpinus* L.  
*Astragalus brachytropis* (Stev.) C.A.Mey.  
*Astragalus captiosus* Boriss. (*A. interpositus* Boriss.)  
*Astragalus demetrii* Charadze  
*Astragalus falcatus* Lam.  
*Astragalus levieri* Freyn ex Somm. et Levier  
*Astragalus monspessulanus* L. (*A. kazbeki* Charadze)  
*Astragalus oreades* C.A.Mey.  
*Astragalus psoraloides* Lam.  
*Astragalus supinus* Bunge  
*Astrantia maxima* Pall.  
*Asyneuma campanuloides* (Bieb. ex Sims) Bornm.  
*Athyrium distentifolium* Tausch ex Opiz [ *A. alpestre* (Hoppe) Nyl.]  
*Athyrium filix-femina* (L.) Roth  
*Berberis vulgaris* L.  
*Betonica macrantha* C.Koch (*B. grandiflora* Willd.; *Stachys macrantha* (C.Koch.) Jalas)  
*Betula litwinowii* Doluch.  
*Betula pendula* Roth (*B. verrucosa* Ehrh.)  
*Blysmus compressus* (L.) Panz. ex Link  
*Botrychium lunaria* (L.) Sw.  
*Brachypodium pinnatum* (L.) P.Beauv. (*B. rupestre* (Host.) Roem. et Schult.)  
*Brachypodium sylvaticum* (Huds.) P.Beauv.  
*Briza marcowiczii* Woronow

- Briza media* L. (*B. elatior* Sibth. et Smith.; *B. australis* Prokud.)  
*Bromus benekenii* (Lange) Trimen [*Bromus benekenii* (Lange) Holub; *Zerna benekenii* (Lange) Lindm.]  
*Bromus riparius* Rehm. [*Bromopsis riparia* (Rehm.) Holub; *Zerna riparia* (Rehm.) Nevski] *Bromopsis riparia* (Rehm.) Holub (*Bromus riparius* Rehm.)  
*Bromus tectorum* L. [*Anisantha tectorum* (L.) Nevski]  
*Bromus variegatus* Bieb. [*Bromopsis variegata* (Bieb.) Holub; *Zerna variegata* (Bieb.) Nevski]  
*Bunias orientalis* L.  
*Bupleurum falcatum* L. [*B. polymorphum* Albov; *B. polyphyllum* Ledeb.; *B. exaltatum* Bieb.; *B. nordmannianum* Ledeb.]  
*Cirsium pugnax* Somm. et Levier [*C. munitum* (Bieb.) Fisch.]  
*Calamagrostis arundinacea* (L.) Roth  
*Calamagrostis epigeios* (L.) Roth  
*Caltha palustris* L. (*C. polypetala* Hochst.)  
*Campanula bellidifolia* Adams aggr. (*C. anomala* Fomin; *C. aucheri* A.DC.; *C. saxifraga* Bieb.)  
*Campanula ciliata* Stev.  
*Campanula collina* Bieb.  
*Campanula glomerata* L. [*C. oblongifolia* (C.Koch) Charadze; *C. oblongifolioides* Galushko; *C. trautvetteri* Grossh. ex Fed.]  
*Campanula lactiflora* Bieb. [*Gadellia lactiflora* (Bieb.) Schulkina]  
*Campanula latifolia* L.  
*Campanula rapunculoides* L. (*C. cordifolia* C.Koch.; *C. grossheimii* Charadze)  
*Campanula sarmatica* Ker-Gawl. (*C. siegismundi* Fed.; *C. sommieri* Charadze)  
*Campanula tridentata* Schreb. (*C. biebersteiniana* Schult.)  
*Capsella bursa-pastoris* (L.) Medik. (*C. hircana* Grossh.)  
*Cardamine impatiens* L. (*C. pectinata* Pall. ex DC.)  
*Cardamine uliginosa* Bieb.  
*Carduus adpressus* C.A.Mey. aggr. (incl. *C. laciniatus* Ledeb.)  
*Carduus nutans* L. aggr.  
*Carex atrata* L. (*C. aterrima* Hoppe; *C. medwedewii* Leskov)  
*Carex brevicollis* DC.  
*Carex canescens* L. (*C. cinerea* Poll.)  
*Carex caryophyllea* Latourr. (*C. scabricuspis* V.Krecz.; *C. verna* Chaix)  
*Carex caucasica* Stev.  
*Carex digitata* L.  
*Carex echinata* Murr.  
*Carex humilis* Leys. (*C. buschiorum* V.Krecz.)  
*Carex limosa* L.  
*Carex mingrellica* Kuk.  
*Carex nigra* (L.) Reichard (*C. dacica* Heuff.; *C. transcaucasica* Egor.)  
*Carex oligantha* Steud.  
*Carex oreophila* C.A.Mey.  
*Carex pallescens* L.  
*Carex panicea* L.  
*Carex pyrenaica* Wahl. (*C. micropodioides* V.Krecz.)  
*Carex rostrata* Stokes  
*Carex sempervirens* Vill. (*C. tristis* Bieb.; *C. meinshauseniana* V.Krecz.)  
*Carex supina* Willd. ex Wahlenb.  
*Carex umbrosa* Host (*C. huetiana* Boiss.)  
*Carlina vulgaris* L. (*C. biebersteinii* Bernh. ex Hornem.)  
*Carum caucasicum* (Bieb.) Boiss.  
*Carum meifolium* (Bieb.) Boiss.  
*Catabrosella variegata* (Boiss.) Tzvel. [*Colpodium variegatum* (Boiss.) Griseb.]  
*Centaurea cheiranthifolia* Willd. [*C. Fischeri* Schlecht.; *Cyanus Fischeri* (Schlecht.) Sojak; *Cyanus cheiranthifolius* (Willd.) Sojak]  
*Centaurea dealbata* Willd. aggr. [*C. leucophylla* Bieb.; *C. salviifolia* (Boiss.) Sosn.; *C. troitzkyi* (Sosn.) Sosn.]  
*Centaurea montana* L. aggr. [*C. variegata* Lam.; *C. nigrofimbria* (C.Koch) Sosn.; *Cyanus nigrofimbrius* (C.Koch) Sojak]  
*Centaurea phrygia* L. [*Centaurea abbreviata* (C.Koch) Hand.-Mazz.; *C. salicifolia* Bieb.; *C. alutacea* Dobroc.; *Jacea salicifolia* (Bieb.) Sojak; *Jacea phrygia* (L.) Sojak]  
*Cephalaria gigantea* (Ledeb.) Bobrov (*C. caucasica* Litv.)  
*Cerastium arvense* L.  
*Cerastium cerastioides* (L.) Britt. [*Dichodon cerastoides* (L.) Reichenb.]  
*Cerastium davuricum* Fisch. ex Spreng. (*C. oreades* Schischk.)  
*Cerastium fontanum* Baumg. (*C. vulgatum* L.; *C. holosteoides* Fries; *C. triviale* Link)  
*Cerastium kazbek* Parrot (*C. multiflorum* C.A.Mey.)  
*Cerastium polymorphum* Rupr. (*C. undulatifolium* Somm. et Levier)  
*Cerastium purpurascens* Adams  
*Cerinthe minor* L.  
*Chaerophyllum aureum* L.  
*Chaerophyllum confusum* Woron.  
*Chaerophyllum humile* Stev.  
*Chaerophyllum roseum* Bieb. (*C. millefolium* DC.)  
*Chamaenerion angustifolium* (L.) Scop. [*Chamerion angustifolium* (L.) Holub]  
*Chamaenerion dodonaei* (Vill.) Holub  
*Chamaescidium acaule* (Bieb.) Boiss.  
*Chenopodium album* L. [*Ch. strictum* Roth]  
*Chenopodium botrys* L.  
*Cicerbita racemosa* (Willd.) Beauverd  
*Cichorium intybus* L.  
*Cirsium arvense* (L.) Scop. [*C. incanum* (S.G.Gmel.) Fisch.]  
*Cirsium chlorocomos* Somm. et Levier  
*Cirsium ciliatum* (Murr.) Moench  
*Cirsium obvallatum* (Bieb.) Fisch.  
*Cirsium simplex* C.A.Mey.  
*Cirsium vulgare* (Savi) Ten.  
*Cleistogenes serotina* (L.) Keng [*C. bulgarica* (Bornm.) Keng]

- Clinopodium vulgare* L.  
*Coeloglossum viride* (L.) C. Hartm.  
*Colchicum speciosum* Stev.  
*Convallaria majalis* L. s.l. (C. *transcaucasica* Utkin ex Grossh.)  
*Coronilla orientalis* Mill. [*Securigera orientalis* (Mill.) Lassen]  
*Coronilla varia* L. [*Securigera varia* (L.) Lassen]  
*Corydalis alpestris* C.A.Mey.  
*Corydalis conorhiza* Ledeb.  
*Corylus avellana* L.  
*Cotoneaster integerrimus* Medik.  
*Crepis glabra* Boiss.  
*Crepis paludosa* (L.) Moench (C. *caucasica* C.A.Mey.)  
*Crocus reticulatus* Stev. ex Adams (C. *variegatus* Hoppe et Hornsch.)  
*Crocus scharojanii* Rupr.  
*Cruciata laevipes* Opiz [*Galium cruciata* (L.) Scop.]  
*Cruciata valentinae* (Galushko) Galushko  
*Cryptogramma crispa* (L.) R.Br. ex Hook.  
*Cuscuta europaea* L.  
*Cystopteris fragilis* (L.) Bernh.  
*Dactylis glomerata* L.  
*Dactylorhiza euxina* (Nevski) Czer. [*D. caucasica* (Klinge) Soo; *Orchis caucasica* (Klinge) Soo]  
*Dactylorhiza urvilleana* (Steudel) Baumann et Künkele [*D. amblyoloba* (Nevski) Aver., *D. triphylla* (C.Koch.) Czer., *Orchis triphylla* C.Koch.)]  
*Daphne glomerata* Lam.  
*Daphne mezereum* L.  
*Delphinium caucasicum* C.A.Mey.  
*Delphinium schmalhausense* Albov (*D. freynii* Conrat)  
*Dentaria bipinnata* C.A.Mey.  
*Deschampsia caespitosa* (L.) P.Beauv.  
*Deschampsia flexuosa* (L.) Nees [*Lerchenfeldia flexuosa* (L.) Schur; *Avenella flexuosa* (L.) Drejer]  
*Descurainia sophia* (L.) Webb ex Prantl  
*Dianthus capitatus* Balb. ex DC. (*D. ruprechtii* Schischk.)  
*Dianthus cretaceus* Adams  
*Dianthus pallens* (*D. lanceolatus* Stev. ex Reichenb.)  
*Digitalis ciliata* Trautv.  
*Doronicum macrophyllum* Fisch. ex Hornem.  
*Doronicum oblongifolium* DC.  
*Draba hispida* Willd.  
*Draba nemorosa* L.  
*Draba rigida* Willd. (*D. bryoides* DC.)  
*Draba scabra* C.A.Mey.  
*Draba sibirica* (Pall.) Thell.  
*Draba siliquosa* Bieb. [*D. subglabra* (Rupr.) Tolm.]  
*Draba supranivalis* Rupr.  
*Dracocephalum ruyschiana* L.  
*Dryopteris abbreviata* (DC.) Newm. ex Manton (*D. oreades* Fomin)  
*D. carthusiana* (Vill.) H.P.Fuchs [*D. spinulosa* (O.F.Muell.) O.Kuntze] incl. *Dryopteris dilatata* (Hoffm.) A.Gray [*D. assimilis* S.Walker; *D. austriaca* (Jacq.) Woyнар ex Schinz et Thell  
*Dryopteris filix-mas* (L.) Schott  
*Echinops sphaerocephalus* L.  
*Echium vulgare* L.  
*Eleocharis quinqueflora* (F.X.Hartm.) O.Schwarz [*E. pauciflora* (Lightf.) Link]  
*Eleutherospermum cicutarium* (Bieb.) Boiss.  
*Empetrum nigrum* L. [*E. caucasicum* Juz.]  
*Epilobium algidum* Bieb.  
*Epilobium alpinum* L. (*E. anagallidifolium* Lam.)  
*Epilobium palustre* L.  
*Epipactis helleborine* (L.) Crantz [*E. latifolia* (L.) All.]  
*Equisetum hyemale* L. *E. trachyodon* A.Br.; *E. variegatum* Schleich. ex Web. et Mohr  
*Equisetum palustre* L.  
*Erigeron acris* L. (*E. acer* auct.; *E. orientalis* Boiss.; *E. podolicus* Bess.)  
*Erigeron alpinus* L.  
*Erigeron caucasicus* Stev. [*E. venustus* Botsch.; *E. pulchellus* (Willd.) DC.]  
*Eriophorum polystachyon* L. (*E. angustifolium* Honck.)  
*Eriophorum vaginatum* L.  
*Eritrichium caucasicum* (Albov) Grossh.  
*Erysimum cuspidatum* (Bieb.) DC. [*Acachmena cuspidata* (Bieb.) H.P. Fuchs]  
*Erysimum aureum* Bieb.  
*Eunomia rotundifolia* C.A.Mey.  
*Euphorbia iberica* Boiss. ■  
*Euphorbia leptocaula* Boiss.  
*E. macroceras* Fisch. et Mey.  
*Euphrasia ossica* Juz.  
*Euphrasia petiolaris* Wettst.  
*Fagus orientalis* Lipsky  
*Festuca altissima* All. [*F. sylvatica* (Poll.) Vill.]  
*Festuca brunnescens* (Tzvel.) Galushko  
*Festuca djimilensis* Boiss. et Bal  
*Festuca gigantea* (L.) Vill.  
*Festuca ovina* L. [*F. ruprechtii* (Boiss.) V.Krecz. et Bobr.]  
*Festuca pratensis* Huds.  
*Festuca sommieri* Litardiere [*F. longearistata* (Hack.) Somm. et Levier]  
*Festuca valesiaca* Gaudin [*F. sulcata* (Hack.) Nym. p.p.]  
*Festuca varia* Haenke (*F. Woronowii* Hack.)  
*Filipendula ulmaria* (L.) Maxim.  
*Fragaria vesca* L.  
*Fritillaria collina* Adams (*F. lutea* Bieb.; *F. lagodechiana* Charkev.)  
*Fritillaria latifolia* Willd.  
*Fumana procumbens* (Dun.) Gren. & Godr.  
*Gagea fistulosa* (Ker-Gawl. s.l. (*G. anisanthos* C.Koch.; *G. glacialis* C.Koch.; *G. sulfurea* Misch.)  
*Galeopsis tetrahit* L. (*G. bifida* Boenn.)  
*Galium aparine* L. (*G. pseudorivale* Tzvel.; *G. spurium* L.)  
*Galium odoratum* (L.) Scop. (*Asperula odorata* L.)  
*Galium valantioides* Bieb.  
*Galium verum* L. (*G. ruthenicum* Willd.)  
*Genista angustifolia* Schischk.  
*Gentiana aquatica* L.  
*Gentiana biebersteinii* Bunge [*Gentianella biebersteinii* (Bunge) Holub]

- Gentiana pyrenaica* L. (*G. djimilensis* C.Koch)  
*Gentiana septemfida* Pall.  
*Gentiana verna* L. [*G. oschtenica* (Kusn.) Woronow; *Calathiana oschtenica* (Kusn.) Holub; *G. angulosa* Bieb.]  
*Geranium gymnocaulon* DC.  
*Geranium platypetalum* Fisch. et C.A.Mey.  
*Geranium pusillum* L.  
*Geranium renardii* Trautv.  
*Geranium robertianum* L.  
*Geranium sanguineum* L.  
*Geranium sylvaticum* L.  
*Geum rivale* L.  
*Geum urbanum* L.  
*Gnaphalium supinum* L. [*Omalotheca supina* (L.) DC.]  
*Gnaphalium sylvaticum* L. [*Omalotheca sylvatica* (L.) Sch. Bip. et F.Schultz; *G. caucasicum* Somm. et Levier]  
*Grossularia reclinata* (L.) Mill. (*Ribes uva-crispa* L.)  
*Gymnadenia conopsea* (L.) R.Br.  
*Gymnocarpium dryopteris* (L.) Newm. [*Dryopteris linneana* C.Chr.; *D. pumila* (Gilib.) V.Krecz.]  
*Gypsophila elegans* Bieb.  
*Gypsophila tenuifolia* Bieb.  
*Hedysarum caucasicum* Bieb.  
*Helianthemum nummularium* (L.) Mill. [*H. ovatum* (Viv.) Dun.]  
*Helictotrichon versicolor* (Vill.) Pillger [*H. adzharicum* (Albov) Grossh.; *Avenastrum adzharicum* (Albov) Roshev.]  
*Heracleum asperum* (Hoffm.) Bieb.  
*Heracleum freynianum* Somm. et Levier (*H. colchicum* Lipsky)  
*Heracleum Leskovii* Grossh.  
*Herniaria incana* Lam. (*H. besseri* Fisch. ex Hornem.)  
*Hesperis matronalis* L. s.l. (*H. caucasica* Rupr. p.p.; *H. voronovii* N.Busch)  
*Hieracium cymosum* L. aggr. [*H. echinoides* Lumn.; *H. submirum* (Litv. et Zahn) Juxip]  
*Hieracium laevigatum* Willd. aggr. [*H. epichlorum* (Litv. et Zahn) Juxip; *H. hypopitys* (Litv. et Zahn) Juxip; *H. hypopogon* (Litv. et Zahn) Juxip; *H. macrolepis* Boiss.; *H. orthocladum* Zahn; *H. simplicicaule* (Somm. et Levier) Peter; *H. subpollichii* (Litv. et Zahn) Juxip; *H. svaneticiforme* (Litv. et Zahn) Kem.-Nath.]  
*H. lactucella* Wallr. aggr. [incl. *H. auricula* auct., *Pilosella lactucella* (Wallr.) P.D. Sell et C.West, incl. *H. thracicum* (Naeg. et Peter) Juxip] ■  
*Hieracium murorum* L. aggr. [*H. erythrocarpum* Peter; *H. cardiophyllum* Jord. ex Sudre; *H. cinereostriatum* (Woronow et Zahn) Juxip; *H. exotericum* Jord. ex Boreau; *H. retroversilobatum* (Schelk. et Zahn) Juxip; *H. sbaense* Juxip]  
*Hieracium pilosella* L. [*H. sublasiphorum* (Litv. et Zahn) Juxip]  
*Hieracium prenanthoides* Vill. [*H. bupleurifolium* Tausch; *H. chaetothyrsus* (Litv. et Zahn) Juxip; *H. chloroprenanthes* Litv. et Zahn]  
*Hieracium umbellatum* L.  
*Huperzia selago* (L.) Bernh. ex Schrank et Mart. (*Lycopodium selago* L.)  
*Hyalopoa pontica* (Bal.) Tzvel. [*Colpodium ponticum* (Bal.) Woronow]  
*Hypericum linarioides* Bosse (*H. polygonifolium* Rupr.)  
*Hypericum nummularioides* Trautv.  
*Hypericum perforatum* L.  
*Hypochoeris maculata* L. [*Achyrophorus maculatus* (L.) Scop.; *Trommsdorfa maculata* (L.) Bernh.]  
*Inula orientalis* Lam. (*I. grandiflora* Willd.)  
*Iris aphylla* L. (*I. furcata* Bieb.; *I. hungarica* Waldst. et Kit.)  
*Juncus alpigenus* C.Koch  
*Juncus articulatus* L. (*J. lampocarpus* Ehrh.ex Hoffm.; *J. geniculatus* Schrank)  
*Juncus effusus* L.  
*Juncus triglumis* L. (*J. schischkinii* Kryl. et Sumn.)  
*Juniperus communis* L. s.l. (*J. depressa* Stev.; *J. hemisphaerica* J.et C.Presl; *J. oblonga* Bieb.; *J. pygmaea* C.Koch)  
*Juniperus sabina* L.  
*Jurinea alata* (Desf.) Cass.  
*Jurinea coronopifolia* Somm. et Levier (*J. levieri* Albov)  
*Jurinella moschus* (Habl.) Bobrov (*Jurinea subacaulis* Fisch. et Mey.)  
*Kemulariella caucasica* (Willd.) Tamamsch. (*Aster caucasicus* Willd.)  
*Kobresia capillifolia* (Decne.) Clarke [*K. capilliformis* Ivanova]  
*Kobresia schoenoides* (C.A.Mey.) Steud.  
*Koeleria eriostachya* Pancic [*K. Albovii* Domin; *K. buschiana* (Domin) Gontsch.; *K. caucasica* (Domin) B.Fedtsch. p.p.; *K. Fominii* (Domin) Gontsch.]  
*Lamium album* L.  
*Lamium tomentosum* Willd.  
*Lapsana communis* L. (*L. grandiflora* Bieb.; *L. intermedia* Bieb.)  
*Lathyrus cyaneus* (Stev.) C.Koch [*Orobis cyaneus* (Stev.) C.Koch]  
*Lathyrus pratensis* L.  
*Leontodon hispidus* L. [*L. danubialis* Jacq.; *L. caucasicus* (Bieb.) Fisch.]  
*Leucanthemum vulgare* Lam.  
*Ligularia caucasica* (Bieb.) G.Don fil. [*Dolichorrhiza caucasica* (Bieb.) Galushko]  
*Ligularia renifolia* (C.A.Mey.) DC. [*Dolichorrhiza renifolia* (C.A.Mey.) Galushko]  
*Ligularia sibirica* (L.) Cass. (*L. subsagittata* Pojark.)  
*Ligusticum alatum* (Bieb.) Spreng. [*Macrosciadium alatum* (Bieb.) V.Tichomirov et Lavrova]  
*Ligusticum caucasicum* Somm. et Levier  
*Lilium monadelphum* Bieb. (*L. szovitsianum* Fisch. et Ave-Lall.; *L. georicum* Manden.)  
*Linaria genistifolia* (L.) Mill. (*L. pontica* Kuprian.)

- Linnaea borealis* L.  
*Linum hypericifolium* Salisb.  
*Lloydia serotina* (L.) Reichenb.  
*Lonicera orientalis* Lam. (*L. caucasica* Pall.)  
*Lotus corniculatus* L. s.l. (*L. caucasicus* Kuprian. ex Juz.)  
*Luzula multiflora* (Ehrh.) Lej. [ *L. pseudosudetica* (V.Krecz.) V.Krecz.]  
*Luzula pallidula* Kirschner (*L. pallescens* Sw.)  
*Luzula pilosa* (L.) Willd.  
*Luzula spicata* (L.) DC.  
*Lycopodium annotinum* L.  
*Marrubium parviflorum* Fisch. et May (*M. praecox* Janka)  
*Matricaria caucasica* (Willd.) Poir. [ *Tripleurospermum caucasicum* (Willd.) Hayek; *M. subnivalis* (Pobed.) Rauschert]  
*Medicago falcata* L. (*M. vardanis* Vass.; *M. romanica* Prod.)  
*Melampyrum arvense* L. [ *M. argyrocomum* (Fisch. ex Ledeb.) K.-Pol.]  
*Melica ciliata* L. (*M. taurica* C.Koch; *M. transsilvanica* Schur.)  
*Melica nutans* L.  
*Millium effusum* L. (*M. schmidtianum* C.Koch)  
*Minuartia aizoides* (Boiss.) Bornm.  
*Minuartia circassica* (Albov) Woronow [ *M. caucasica* (Adams ex Rupr.) Mattf.]  
*Minuartia imbricata* (Bieb.) Woronow  
*Minuartia inamoena* (C.A.Mey.) Woronow  
*Minuartia recurva* (All.) Schinz et Thell. [ *M. oreina* (Mattf.) Schischk.]  
*Molinia caerulea* (L.) Moench  
*Murbeckiella huetii* (Boiss.) Rothm. [ *Phryne huetii* (Boiss.) O.E.Schulz]  
*Muscari muscarimi* Medik. [ *M. racemosum* Mill.; *Muscarimia muscari* (L.) Losinsk.]  
*Mycelis muralis* (L.) Dumort.  
*Myosotis alpestris* F.W.Schmidt  
*Myosotis amoena* (Rupr.) Boiss.  
*Myosotis laxa* Lehm. (*M. cespitosa* K.F.Schultz)  
*Myosotis sparsiflora* Pohl  
*Myricaria germanica* (L.) Desv. (*M. bracteata* Royle; *M. alopecuroides* Schrenk)  
*Nardus stricta* L. (*N. glabriculum* Sakalo)  
*Nepeta betonicifolia* C.A.Mey. (*N. somkhetica* Kapell.; *N. grandiflora* Bieb. p.p.)  
*Nepeta supina* Stev.  
*Nonea intermedia* Ledeb.  
*Onosma caucasica* Levin ex M.Pop.  
*Origanum vulgare* L.  
*Orobanche grossheimii* Novopokr.  
*Orobanche purpurea* Jacq. [ *Phelipanche purpurea* (Jacq.) Sojak]  
*Oxalis acetosella* L.  
*Oxyria digyna* (L.) Hill (*O. elatior* R.Br. ex Meissn.)  
*Oxytropis kubanensis* Leskov  
*Padus avium* Mill. (*P. racemosa* Lam.)  
*Paederota pontica* Rupr. ex. Boiss. [ *Paederotella pontica* (Rupr. ex. Boiss.) Kem.Nath.; *Paederotella teberdensis* Kem.-Nath.]  
*Parietaria judaica* L.  
*Parnassia palustris* L.  
*Pastinaca pimpinellifolia* Bieb.  
*Pedicularis atropurpurea* Nordm.  
*Pedicularis caucasica* Bieb. (*P. pontica* Boiss.; *P. subrostrata* C.A.Mey.)  
*Pedicularis comosa* L. (*P. chroorrhyncha* Vved.; *P. sibthorpii* Boiss.)  
*Pedicularis condensata* Bieb.  
*Pedicularis crassirostris* Bunge  
*Pedicularis nordmanniana* Bunge  
*Pedicularis wilhelmsiana* Fisch. ex Bieb.  
*Petasites albus* (L.) Gaertn.  
*Peucedanum ruthenicum* Bieb.  
*Phleum alpinum* L.  
*Phleum phleoides* (L.) Karsten (*Ph. montanum* C.Koch.)  
*Phleum pratense* L. (*Ph. nodosum* L.)  
*Picea orientalis* (L.) Link  
*Pimpinella rhodantha* Boiss.  
*Pinguicula vulgaris* L.  
*Pinus sylvestris* L. s.l. [ *P. sosnowskyi* Nakai; *P. kochiana* Klotzsch ex C.Koch; *P. hamata* (Stev.) Sosn.]  
*Plantago atrata* Hoppe (*P. saxatilis* Bieb.)  
*Plantago major* L.  
*Plantago media* L. (*P. urvillei* Opiz; *P. stepposa* Kuprian.)  
*Poa alpina* L. p.p. (*P. badensis* Haenke; *Poa elbrussica* Timpko)  
*Poa annua* L.  
*Poa caucasica* Trin. (*P. naltchikensis* Roshev.)  
*Poa longifolia* Trin. (*P. meyeri* Trin. ex Roshev.)  
*Poa nemoralis* L. (*Poa seredinii* Galkin)  
*Poa palustris* L. (*P. tanfiljewii* Roshev.)  
*Poa pratensis* L.  
*Polygala alpicola* Rupr.  
*Polygala major* Jacq. [ *P. alata* (Tamamsch.) Galushko; *P. anatolica* Boiss. et Heldr.]  
*Polygonatum odoratum* (Mill.) Druce (*P. glaberrimum* C.Koch)  
*Polygonatum orientale* Desf. [ *P. polyanthemum* (Bieb.) A.Dietr.]  
*Polygonatum verticillatum* (L.) All.  
*Polygonum alpinum* All. [ *Aconogonon alpinum* (All.) Schur; *P. panjutinii* Charkev.]  
*Polygonum aviculare* L. s.l. (*P. arenastrum* Boreau)  
*Polygonum bistorta* L. (*Bistorta major* Gray; *P. carneum* C.Koch)  
*Polygonum convolvulus* L. [ *Fallopia convolvulus* (L.) A.Love]  
*Polygonum viviparum* L. [ *Bistorta vivipara* (L.) S.F.Gray]  
*Polypodium vulgare* L.  
*Polystichum lonchitis* (L.) Roth  
*Populus tremula* L.  
*Potentilla brachypetala* Fisch. et Mey. ex Lehm.  
*Potentilla crantzii* (Crantz) G.Beck ex Fritsch  
*Potentilla divina* Albov  
*Potentilla elatior* Willd. ex Schlecht.

- Potentilla erecta* (L.) Rauschel  
*Potentilla gelida* C.A.Mey.  
*Potentilla nivea* L.  
*Potentilla rupestris* L. (*P. foliosa* Somm. et Levier ex R.Keller)  
*Primula algida* Adam  
*Primula amoena* Bieb. (*P. meyeri* Rupr.)  
*Primula auriculata* Lam.  
*Primula renifolia* Volgun.  
*Primula ruprechtii* Kusn.  
*Primula veris* L. [*P. macrocalyx* Bunge]  
*Prunella vulgaris* L.  
*Pseudovesicaria digitata* (C.A.Mey.) Rupr.  
*Pulmonaria mollis* Wulf. ex Hornem. (*P. mollissima* A.Kerner; *P. dacica* Simonk.)  
*Pulsatilla albana* (Stev.) Bercht. et C.Presl [*Anemone albana* Stev.; *P. violacea* Rupr.; *P. georgica* Rupr.; *P. andina* (Rupr.) Woronow; *Anemone armena* Boiss.]  
*Pulsatilla aurea* (Somm. et Levier) Juz.  
*Pyrethrum coccineum* (Willd.) Worosch. [*P. roseum* (Adams) Bieb.; *P. carneum* Bieb.]  
*Pyrethrum corymbosum* (L.) Scop.  
*Pyrola minor* L.  
*Ranunculus brachylobus* Boiss. et Hohen. [*R. crassifolius* (Rupr.) Grossh.]  
*Ranunculus caucasicus* Bieb. (*R. raddeanus* Regel; *R. sommieri* Albov; *R. buhsei* Boiss.; *R. trisectilis* Ovcz.)  
*Ranunculus oreophilus* Bieb. (*R. acutilobus* Ledeb.; *R. suukensis* N. Busch; *R. grossheimii* Kolak.)  
*Ranunculus subtilis* Trautv.  
*Rhamnus microcarpa* Boiss.  
*Rhamnus pallasii* Fisch. et Mey.  
*Rhinanthus minor* L.  
*Rhododendron caucasicum* Pall.  
*Rhododendron luteum* Sweet  
*Rhynchosorys elephas* (L.) Griseb.  
*Ribes biebersteinii* Berl. ex DC.  
*Rosa canina* L. (*R. arensii* Juz. et Galushko; *R. boissieri* Crep.; *R. caesia* Smith; *R. corymbifera* Borkh.; *R. dumalis* Bechst.; *R. oplisthes* Boiss.; *R. svanetica* Crep.; *R. teberdensis* Chrshan)  
*Rosa marschalliana* Sosn. (*R. leucantha* Bieb.)  
*Rosa villosa* L. (*R. hirtissima* Lonacz.; *R. mollis* Smith; *R. tomentosa* Smith).  
*Rubus caesius* L.  
*Rubus idaeus* L. (*R. buschii* Grossh. ex Sinjkova)  
*Rubus saxatilis* L.  
*Rumex acetosella* L. (*R. acetoselloides* Bal.)  
*Rumex alpestris* Jacq. (*R. arifolius* All.)  
*Rumex alpinus* L.  
*Rumex longifolius* DC. (*R. domesticus* C.Hartm.)  
*S. purpurea* L. [*S. elbursensis* Boiss.; *S. roopi* (Goerz) Grossh.]  
*Sagina saginoides* (L.) Karst.  
*Salix caprea* L.  
*Salix cinerea* L.  
*Salix hastata* L. (*S. apoda* Trautv.)  
*Salix kazbekensis* A.Skvorts.  
*Salix pantosericea* Goerz  
*Salix pentandroides* A.Skvorts.  
*Salvia canescens* C.A.Mey.  
*Salvia glutinosa* L.  
*Salvia pratensis* L.  
*Salvia verticillata* L.  
*Saxifraga flagellaris* Willd. ex Sternb.  
*Saxifraga hirculus* L.  
*Saxifraga juniperifolia* Adams (*S. scleropoda* Somm. et Levier; *S. unifoveolata* Sipl.)  
*Saxifraga kolenatiana* Regel  
*Saxifraga moschata* Wulf.  
*Saxifraga sibirica* L. (*S. mollis* Smith)  
*Scabiosa caucasica* Bieb.  
*Scabiosa ochroleuca* L. (*S. bipinnata* C.Koch; *S. georgica* Sulak.)  
*Scorzonera cana* (C.A.Mey.) O.Hoffm. [*S. meyeri* (C.Koch) Lipsch.]  
*Scorzonera stricta* Hornem.  
*Scrophularia variegata* Bieb. (*S. olympica* Boiss.; *S. rupestris* Bieb. ex Willd.; *S. ruprechtii* Boiss.)  
*Scutellaria orientalis* L. (*S. oreophila* Grossh.; *S. oschtenica* Juz.; *S. polyodon* Juz.)  
*Sedum album* L.  
*Sedum hispanicum* L.  
*Sedum spurium* Bieb.  
*Sedum telephium* L. [*S. caucasicum* (Grossh.) Boriss.; *Hylotelephium caucasicum* (Grossh.) H.Ohba]  
*Sedum tenellum* Bieb.  
*Selaginella helvetica* (L.) Spring  
*Selaginella selaginoides* (L.) Link  
*Sempervivum caucasicum* Rupr. ex Boiss.  
*Sempervivum pumilum* Bieb.  
*Senecio aurantiacus* (Hoppe ex Willd.) Less. [*Tephroses aurantiacus* (Hoppe ex Willd.) Griseb. et Schenk; *S. caucasigenus* Schischk.; *S. fulvus* (Stev.) Schischk.; *S. integrifolius* (L.) Clairv. p.p.]  
*Senecio karjaginii* Sof. (*Senecio primulaefolius* Somm. et Levier)  
*Senecio kolenatianus* C.A.Mey. (*S. amphibolis* C.Koch.; *S. orientalis* Willd.; *S. pseudoorientalis* Schischk.)  
*Senecio nemorensis* L. s.l. (*S. propinquus* Schischk.)  
*Senecio platyphylloides* Somm. et Levier [*Adenostyles platyphylloides* (Somm. et Levier) Czer.]  
*Senecio subflocosus* Schischk. [*Tephroses subflocosa* (Schischk.) Czer.]  
*Senecio taraxacifolius* (Bieb.) DC.  
*Senecio vernalis* Waldst. et Kit. (*S. sosnovskyi* Sof.)  
*Seseli alpinum* Bieb. [*Carum alpinum* (Bieb.) Benth. et Hook.fil.]  
*Seseli libanotis* (L.) Koch [*S. transcaucasicum* (Schischk.) Pimenov et Sdobnina; *Libanotis transcaucasica* Schischk.]  
*Seseli petraeum* Bieb. (*S. floribundum* Somm. et Levier)  
*Sibbaldia procumbens* L. (*S. semiglabra* C.A.Mey.; *S. parviflora* Willd.)  
*Sideritis montana* L.

- Silene alba* (Miller) Krause [ *Melandrium album* (Mill.) Garcke]  
*Silene compacta* Fischer ex Hornem.  
*Silene italica* (L.) Pers.  
*Silene kubanensis* Somm. et Levier  
*Silene lychnidea* C.A.Mey.  
*Silene multifida* (Adam) Rohrb. [ *Oberna multifida* (Adams) Ikonn.]  
*Silene pygmaea* Adam  
*Silene saxatilis* Sims (*S. ruprechtii* Schischk.)  
*Silene vulgaris* (Moench) Garcke [ *S. latifolia* (Mill.) Britt. et Rendle; *Oberna behen* (L.) Ikonn.]  
*Sisymbrium lipskyi* N.Busch  
*Solidago virgaurea* L. (*S. caucasica* Kem.-Nat.)  
*Sorbus aucuparia* L. (*S. caucasigena* Kom. ex Gatsch.)  
*Spiraea hypericifolia* L.  
*Stachys germanica* L. (*S. balansae* Boiss. et Kotschy; *S. cordata* Klok.; *S. heterodonta* Zefir.; *S. lanata* Crantz)  
*Stachys recta* L. (*S. atherocalyx* C.Koch.; *S. acanthodonta* Klok.; *S. czernjaevii* Shost.)  
*Stellaria anagalloides* C.A.Mey. ex Rupr.  
*Stellaria media* (L.) Vill.  
*Stellaria nemorum* L. (*S. montana* auct.)  
*Stellaria Persica* Boiss.  
*Stipa capillata* L.  
*Stipa pulcherrima* C.Koch  
*Swertia iberica* Fisch. ex C.A.Mey.  
*Symphytum asperum* Lepech.  
*Taraxacum confusum* Schischk.  
*Taraxacum officinale* Wigg. aggr.  
*Taraxacum porphyranthum* Boiss.  
*Taraxacum stevenii* (Spreng.) DC. (*T. crepidiforme* DC.; *T. litwinowii* Schischk.)  
*Taraxacum tenuisectum* Somm. et Levier  
*Teucrium chamaedrys* L.  
*Teucrium orientale* L.  
*Teucrium polium* L.  
*Thalictrum alpinum* L.  
*Thalictrum foetidum* L.  
*Thalictrum minus* L.  
*Thelypteris phegopteris* (L.) Sloss. [ *Phegopteris connectilis* (Michx.) Watt]  
*Thesium alpinum* L.  
*Thesium arvense* Horvatovzky [ *T. ramosum* Hayne]  
*Thlaspi arvense* L.  
*Thymus marschallianus* Willd. (incl. *T. pastoralis* Iljin ex Klok.)  
*Thymus nummularius* Bieb. (*Th. buschianus* Klok. et Shost.; *T. pseudonnummularis* Klok. et Shost.; *T. pseudopulegioides* Klok. et Shost.)  
*Thlaspi pumilum* (Stev.) Ledeb. [ *Noccaea pumila* (Stev.) Steud.]  
*Tragopogon brevirostris* DC.  
*Tragopogon filifolius* Rehm. ex Boiss. (*T. Charadzeae* Kuth.)  
*Tragopogon reticulatus* Boiss. et Huet  
*Traunsteinera globosa* (L.) Reichenb. [ *T. sphaerica* (Bieb.) Schlechter]  
*Trifolium alpestre* L.  
*Trifolium ambiguum* Bieb. [ *Amoria ambigua* (Bieb.) Sojak]  
*Trifolium arvense* L.  
*Trifolium canescens* Willd.  
*Trifolium hybridum* L. [ *Amoria hybrida* (L.) C.Presl]  
*Trifolium medium* L.  
*Trifolium polyphyllum* C.A.Mey. [ *Lupinaster polyphyllum* (C.A.Mey.) Latsch.]  
*Trifolium pratense* L.  
*Trifolium repens* L. [ *Amoria repens* (L.) C.Presl]  
*Trifolium spadiceum* L.  
*Trisetum flavescens* (L.) Beauv. (*T. pratense* Huds.)  
*Trollius ranunculinus* (Smith) Stearn (*T. patulus* Salisb.)  
*Urtica dioica* L.  
*Vaccinium myrtillus* L.  
*Vaccinium vitis-idaea* L.  
*Valeriana alliariifolia* Adam (*V. tiliifolia* Troitzk.)  
*Valeriana alpestris* Stev.  
*Valeriana officinalis* L. [ *V. colchica* Utkin; *V. eriophylla* (Ledeb.) Utkin]  
*Valeriana saxicola* C.A.Mey. (*V. jelenevskyi* P.Smirn.)  
*Valeriana sisymbriifolia* Vahl (*V. cardamines* Bieb.)  
*Veratrum album* L. (*V. lobelianum* auct.; non Bernh.)  
*Verbascum austriacum* Schott [ *V. chauxii* Vill. subsp. *austriacum* (Schott) Hayek; *V. orientale* Bieb.]  
*Verbascum pyramidatum* Bieb.  
*Veronica beccabunga* L.  
*Veronica chamaedrys* L.  
*Veronica filiformis* J.E.Smith  
*Veronica gentianoides* Vahl  
*Veronica minuta* C.A.Mey. (*V. telephiifolia* Vahl)  
*Veronica monticola* Trautv.  
*Veronica multifida* L.  
*Veronica officinalis* L.  
*Veronica peduncularis* Bieb.  
*Veronica spicata* L.  
*Veronica verna* L.  
*Vicia abbreviata* Fisch. ex Spreng. (*V. truncatula* Fisch. ex Bieb.)  
*Vicia balansae* Boiss.  
*Vicia cassubica* L.  
*Vicia caucasica* Ekvtim.  
*Vicia cracca* L. (*V. grossheimii* Ekvtim.; *V. tenuifolia* Roth)  
*Vicia sepium* L.  
*Vicia tetrasperma* (L.) Schreb.  
*Viola altaica* Ker-Gawl. (*V. oreades* Bieb.)  
*Viola arvensis* Murr. (*V. kitaibeliana* Schult.)  
*Viola biflora* L. (*V. caucasica* Kolenati)  
*Viola canina* L.  
*Viola rupestris* F.W.Schmidt  
*Viola tricolor* L. (*V. vespertina* Klok.)  
*Woodsia alpina* (Bolt.) S.F. Gray