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LETTER TO THE EDITOR

Rocky vegetation in South Korea and their relation to the whole Korean Peninsula

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Abstract

In 2006 and 2007, the mountain rock vegetation of the central and southern part of the Korean Peninsula (Republic of Korea) was studied using the traditional Zürich-Montpelliér school approach. Based on the classification of 223 phytocoenological relevés, twelve associations and three communities were identified in the study area. Within the *Selaginello tamariscini-Potentilletea dickinsii* class, the *Selaginello stauntonianae-Buxetalia koreanae* order, with an alliance of the same name was newly described for limestone rock plant communities. Five new associations have recently been described for the whole Korean Peninsula and simultaneously for the territory of South Korea: *Pyrrosietum linearifolio-petiolosae, Astilbo chinensis-Chrysosplenietum flagelliferi, Meehanio urticifoliae-Selaginelletum stauntonianae, Junipero rigidae-Buxetum koreanae,* and *Patrinio rupestris-Mukdenietum rossii*. A total of seventeen associations, nine subassociations and six communities included in four alliances and three orders were recently found on the territory of the Korean Peninsula. All units were documented by phytocoenological tables, descriptions of the floristic composition and structure, their habitat, the synecological characteristics and the yet known distribution.

Keywords chasmophyte vegetation · classification · Korean Peninsula · phytocoenology · *Selaginello tamariscini-Potentilletea dickinsii*

Introduction

The study of the plant communities in the rocks of northeast Asia, including the Korean Peninsula, has been a neglected component of vegetation in the past. Rock vegetation in neighboring Japan is better known because of the phytocoenological classification of its vegetation (e.g. Yamanaka 1954, 1972; Ohba 1973a, b; Miyawaki 1980–1989, 1972; Miyawaki et al. 1981, 1984, 1993; Ohno 1996). Suzuki (1979) introduced the related communities that create a transition between rock vegetation and successively more advanced units such as the *Viola utchinensis-Adiantum capillus-veneris* community from the cliffs of coastal vegetation in the Okinawa Islands.

Phytocoenological knowledge of rocky vegetation and communities has engendered works in North Korea from the north of the Myohyang-san to the south-facing Kumgang-san and Chonma-san. The data were obtained during expeditions of Czech and Slovak botanists in 1986–1990.

A class of *Selaginello tamariscini-Potentilletea dickinsii* consist of four orders (Kolbek and Jarolímek 2013). For the northern part of the Korean Peninsula, only two orders and three alliances were described: *Potentilletalia dickinsii* and *Saxifragetalia fortunaei*, and *Potentillion dickinsii*, *Selaginellion tamariscini* and *Saxifragion fortunaei*. The results were published in our papers (Kolbek et al. 1997, 1998; Kolbek and Jarolímek 2013; Kolbek and Valachovič 1996). These were described on the basis of the classification of 199 phytocoenological relevés as communities of semi-dry and

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wet rocks on predominantly granite and granodiorite substrates. Within them, twelve units were distinguished at the level of the association with seven subassociations and four units classified as communities only.

Next two orders (*Juncetalia maximowiczii* Ohba 1973a, b and *Conandretalia ramondioidis* Nakamura in Miyawaki 1982) are known only in Japan (Ohba 1973a; Miyawaki 1982) and were not found on the whole Korean Peninsula yet. We do not know of other works that extensively study these rock plant communities on the Korean Peninsula. It is remarkable, because South Korea's forest vegetation has been published in many studies.

The aim of this paper was to determine the distribution, variability and classification of rock communities. Comparisons with the communities already described in the northern part of the Peninsula was an integral part of the aims resulted in the construction of a classification scheme for rock vegetation of the Korean Peninsula based on our current knowledge and sampled data.

Study area

Follow-up research of rock vegetation was engaged in 2006 and 2007 in the territory of the Republic of Korea, from the North Korean border to the southern edge of the Peninsula, except for Cheju Island (Appendix 1). South Korea is a very mountainous country with more than 70% of the Korean Peninsula covered by mountains. Most of the gentle and steep slopes are covered by deciduous or mixed forests (usually not very permeable). Open rock vegetation occurs on steep walls without a tree layer. Additionally, shrub layer is not present in most of these communities, or the cover is very low. The visited areas mainly reside in the national parks and protected areas in the mountains: Deogyu-san, Duta-san, Gaya-san, Jiri-san, Juwang-san, Odae-san, Seorak-san, Sobaek-san, Taebaek-san, Worak-san, and many other places around settlements such as Andong, Bongwha, Donghae, Gangneung, Jeongseon, Mungyeong, Yeongwol, etc. The visited locations therefore provide a representative sample of South Korean rock vegetation.

The geology of South Korea is varied, consisting mainly of Daebo Granites, Bulguksa Granites, and rocks Cretaceous and Ordovician ages; volcanic rocks are rare. Most of the Korean Peninsula belongs to the Sino-Korean Paraplatform (Lee 1987). Shin (1970) presented two geological systems: 1 / "The granite-gneiss system of pre-Cambrian age", which occupies more than two thirds of the Korean Peninsula and is built with gneiss, granites and migmatites. 2 / "The crystalline schist system consisting mainly of quartzites, phyllites, amphibolites, dolomites, limestones and slates". Generally, the geological substrate is mostly formed by silicate rocks, e.g., gneisses, granites and crystalline schists (Kong and Watts 1993; Košťák et al. 2003). The exceptions are non-basiphilous rocks rich in calcium. Most of the rock vegetation has been observed on granite, granodiorite, slate, dolomite and limestone. Shallow soil on the silicate rocks corresponds to rankers, on calcium carbonate substrates to regosols (Shin 1970) or rendzinas in Central European conception.

Most of South Korea's territory belongs to a cool-temperate climate and an extreme south to the warm-temperate zone (temperatures significantly below −15 °C or absolute minima not <−15 °C (Ahn 2001; Box and Choi 2003). The annual mean temperature and annual precipitation reaches 11.2 °C and 1365 mm in Seoul and 14.1 °C and 1453 mm in Pusan. These data come from meteorological measuring stations in these cities. On the rock habitats in the mountains these values can be rather different, but detailed microclimate data are unavailable. An important factor is the distribution of precipitation. The largest portion falls during the summer monsoon period (mostly in June and July), which occurs over 1–2 months. According to Kong and Watts (1993) 45–60% of rainfalls are coming in summer and 3–10% in winter. However, it must be taken into account that steep rock with a minimum layer of shallow soil retains little water after rainfall events. In many cases, the organic soil layer is represented by a weathered substrate maintained on rock only by individual plants and mossy stands. Winter is usually frosty and dry with a high snow cover. However, snow may be missing on steep rocks, and thus the rock vegetation may not be protected by its layers. Lack of moisture, nutrients and harsh winter conditions are the main reasons for the selection of stress-tolerant taxa; otherwise, the plants tend to be competitively weak.

Methods

Data collection and processing

Phytocoenological data (relevés) were collected in 2006 and 2007 according to the field methods of the Zürich-Montpelliér approach, and using the 9-degree scale (Barkman et al. 1964; Braun-Blanquet 1964; van der Maarel 1979). A total of 223 relevés were stored in the TURBOVEG database (Hennekens and Schaminée 2001). The data set was analysed using the JUICE software (Tichý 2002). The NCLAS program of the SYNTAX 5.0 software package (Podani 2001) was used for hierarchical classification of relevés. A beta-flexible method ($\beta = -0.25$) combined with Ružička's index proved to be the most effective linkage method and similarity measure. The same procedure was used for the analyses of relevés in previous studies on North Korean rocky vegetation (Kolbek et al. 1997, 1998). In total, 11 clusters were obtained. To get the most comparable result with the results from North Korea, it was optimally to move a few relevés between clusters.

Therefore, a dendrogram was used as a general framework but it is not presented. All tables were constructed on the basis of floristical and habitat similarities with a large subjective input based on in situ knowledge. Some clusters (units) were highly similar to those from North Korea; other clusters were very heterogeneous due to numerous accessory species. For communities distributed throughout the Korean Peninsula, the tables were supplemented by a column with the constant values of the original tables (in *italic*). Other ones are described as new for the southern and central part of South Korea (Republic of Korea) only.

Nomenclature and abbreviations

Vascular taxa were determined by Anonymous (1972–1976, 1979, 2005); Charkewicz (1985–1989); Lee (1999, 2003); Lee (1966, 2006); Park (2003); Oh (2006); Voroshilov (1982); and with the help of manuals (Do and Im 1976; Yang et al. 2004), etc. The nomenclature of vascular taxa follows in the first place Ri and Hoang (1984), Anonymous (1979) (the reason is the possibility of comparison with the names used in works on this vegetation in North Korea) and modified according to newer knowledge for flowering plants (Lee 1999, 1966, 2006; Park 2003; Oh 2006) and ferns (Anonymous 2005). The nomenclature of mosses follows mostly Choe (1980) and lichens Lee (1988) or Yoshimura (1994). Taxa determined on the level of genus are identified as **sp.** Similarly infra-specific names are marked by an asterisk **(*)** before the last name. Their full names are listed in the Appendix. Some taxonomic complexes of the species are labelled as **agg.,** which may include a wider concept of taxa (Appendix).

The names of syntaxa follow the International Code of Phytocoenological Nomenclature (Weber et al. 2000). The syntaxa described as new by the authors of this paper contain designation of the nomenclatural type and characteristic or differential species.

Abbreviations used in the text and tables:

A – characteristic association species, **Bas.** – basionym, **c** – constant species, **dS** – differential subassociation species, $\mathbf{E_3}$ – tree layer, $\mathbf{(E_3)}$ – tree layer outside the area; shaded, $\mathbf{E_2}$ – shrub layer, $\mathbf{E_1}$ – herb layer, $\mathbf{E_0}$ – moss layer, ***N*** association species constancy in North Korean relevés, **NK** – North Korea, **NT** – nomenclatural type, **S** – association species constancy in South Korean relevés, **s1, s2** – subassociation species constancy in South Korean relevés, **SK** – South Korea, + – in column ***N*** (species constancy in relevés from North Korea) indicates the presence in the stands without determination of cover, * – in column ***N*** indicates that species of moss layer were not collected and determined quantitatively.

Authors of relevés: J = Ivan Jarolímek, K = Jiří Kolbek, S = Jong-Suk Song, V = Milan Valachovič.

Results

Plant communities

Davallietum mariesii Kolbek, Valachovič et Jarolímek 1997

A typical open species-poor community of bare and hard rocks, large boulders and in rare cases on fallen rotten trees. The stands usually have two or three layers with poorly developed or missing shrub layer. Species of the tree layer are not found in relevés, but their branches may extend from the surrounding area (Fig. 1a). In this case, they have an ecologically significant shading function, so the coverage is shown in brackets (see Table 1).

The dominant and characteristic species is the fern *Davallia mariesii*, which also determines the striking but relatively simple physiognomy of the stands (Fig. 1b). It is usually accompanied by *Carex lanceolata* agg. (*C. nanella* respectively), *C. ciliatomarginata* and other plant taxa. Typical rocky species also include *Parthenocissus tricuspidata*, *Sedum kamtschaticum*, *S. polytrichoides*, *Amitostigma gracile*, *Selaginella* spec. div., *Woodsia manchuriensis* etc. (see Table 1). The stands are usually 15–25 cm high, but the highest species, such as *Calamagrostis arundinacea*, *Spodiopogon sibiricus* and tree seedlings, can exceed 50 cm and rarely higher. There are 66 total species in the herb and shrub layer, with an average of slightly more than 9 taxa in the relevé. More than 10 species (up to 14) were found in the open herb layer in species-rich stands, with up to 20 species in the richest relevé. However, only 2–4 species were found in species-poor stands. The cover of the herb layer varies between 15 and 75%, on average more than 53% in one relevé. The number of species and their cover depends on the habitat, the age of the community and the saturation of the surrounding species. Because the community is sometimes found on smooth boulders, other rock fissure species are also missing. An important factor for the successful development of the community is a stable developed moss layer.

A poorly developed (or missing) shrub layer occurs in only 10 of 19 relevés, and its average cover is less than 10% with a span of 2–30, with exceptions reaching 40%. In total 13 species were found. One, two, and rarely three species of shrubs were found in one relevé (most commonly *Rhododendron micranthum*, *Rhus javanica*, and *Weigela florida*). The subsequent development of the shrub layer is blocked due to the succession conditions.

A total of 27 taxa were found in the moss layer. Important mosses of this community form cushions. The most common mosses are *Schistidium apocarpum* and *Hypnum plumaeforme*; other species occur with constancy below 25%. In the stands 1 to 5 species of mosses were found, on average fewer than 3 species. The coverage of this layer is highly variable and fluctuates from 3(5) to 100%, on average less than 37%. However, the height, coverage and stability of the moss layer play essential roles in

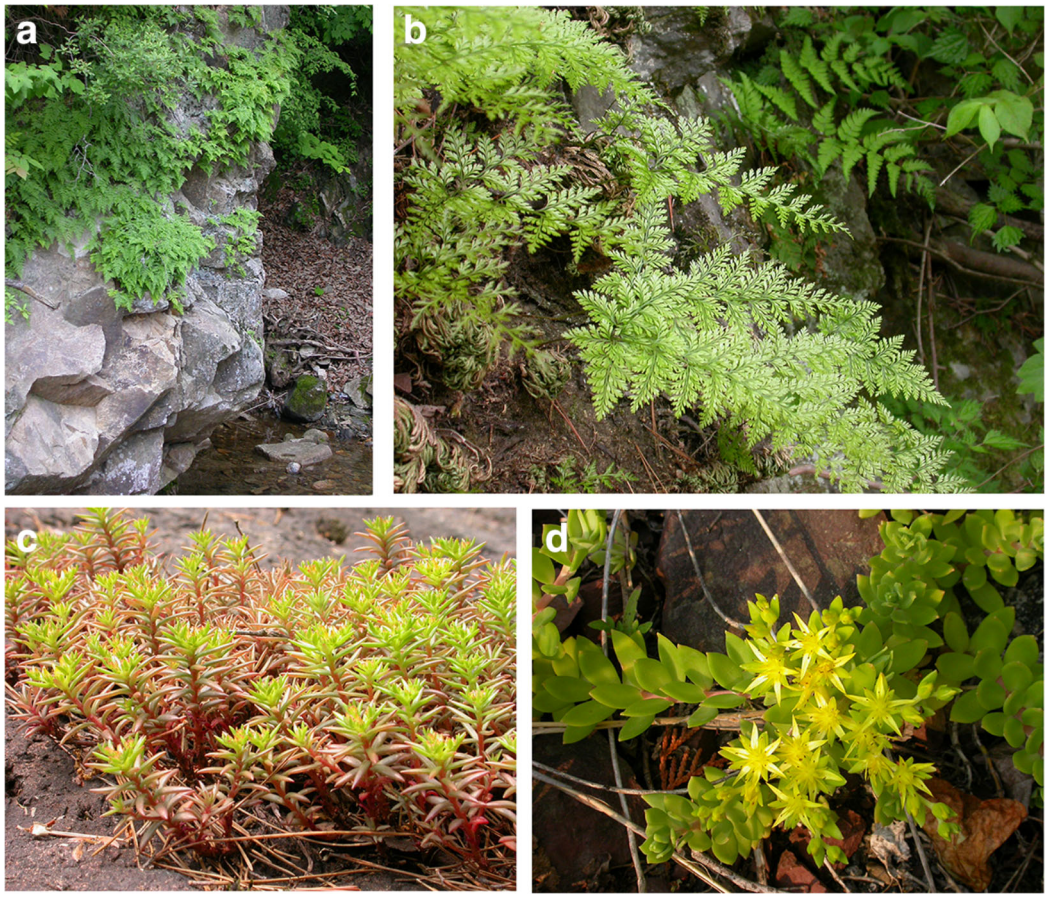

Fig. 1 Examples of plant communities on semi-dry and shaded rocks in the colline and montane belts of the Korean Peninsula. **a** Bolder with typical *Davallietum mariesii* carpet. **b** Characteristic species is the fern *Davallia mariesii*. **c** *Sedum polytrichoides* is dominant species of the association *Amitostigmato gracilis-Sedetum polytrichoidis*. **d** Heliophile species *Sedum sarmentosum*

keeping young *Davallia mariesii* plants and the subsequent development of the herb layer and its maintenance on a mostly smooth substrate. Developed stands of this fern on little moss-covered rocks are therefore very rare.

The *Davallietum mariesii* is found on silicate rocks (mostly compact granodiorite, granite), large boulders or on the rotting wood of fallen tribes at altitudes from 143 to 788 m with predominantly northern orientation. The slope of the habitats varies from (5)30° to 90° and 65° on average.

This association is distributed in both parts of the Korean Peninsula. However, it occurs only in the central and southern parts of the whole Korean Peninsula and appears to be more frequent in the south. In the cooler, northern part of the Peninsula, it has not yet been identified (Appendix 1). It is likely that due to the temperature demands of dominant and other species, this association does not occur in the north; however, suitable substrates exist there. In the northern part of the Korean Peninsula, it was also found at lower altitudes than in the southern part (Kolbek et al. 1997). It therefore appears that its occurrence is dependent on the length of the warm season, the heat input on the habitat and a milder and shorter winter, thus providing preferable climatic conditions.

Amitostigmato gracilis-Sedetum polytrichoidis Kolbek Jarolímek et Valachovič 1997

An open two- to three-layered community known and described from the central part of the Peninsula (in the territory of the D.P.R.K.) in two subassociations (Kolbek et al. 1997) and was confirmed in the southern part in these two subunits (Table 2). It is an open and mostly two-layered plant community with a slightly occurrence of shrubs. The main plant stands are therefore herb and moss layers. Each can predominate in individual plots. The total height of the stands is 20 to 30 cm, and at the time of flowering some species can even reach heights of 50 cm. However, the stands are usually very sparse.

The shrub layer occurs with low constancy, and its average cover is less than 7%. A total of 11 shrub species were found in 14 relevés. Most of the stands do not have a shrub layer. In one relevé shrub coverage achieves 40%, but based on observing various stands, this is an exception.

The dominant species of the herb layer are *Sedum polytrichoides* (Fig. 1c), *Carex lanceolata* agg. (incl. *C. nanella*), *Chrysanthemum zawadskii* agg., somewhere also *Calamagrostis arundinacea*, *Parthenocissus tricuspidata*, etc.

Table 1 *Davallietum mariesii*

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**		
Constancy (S, *N*) in total number of relevés (%)																				**S**	***N***
Number of relevés																				**19**	***5***
E_1 - Species of rock fissures																					
***Davallia mariesii* (A)**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**100**	***100***
Sedum kamtschaticum	+	1	+	1	.	.	.	.	.	1	+	.	.	.	.	.	.	1	.	37	-
Sedum polytrichoides	.	.	.	.	1	.	+	.	.	.	.	.	+	+	1	+	.	.	.	32	-
Amitostigma gracile	.	+	+	.	.	.	.	.	+	r	.	.	.	.	+	.	.	.	.	26	-
Selaginella rossii	.	3	.	.	.	.	.	.	.	.	.	.	.	3	.	.	+	1	.	21	-
Woodsia manchuriensis	.	.	.	.	.	.	.	.	.	r	.	+	r	1	.	.	.	.	.	21	-
Camptosorus sibiricus	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	r	+	.	16	-
Selaginella tamariscina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	11	*40*
Asplenium incisum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	11	*20*
Dryopteris saxifraga	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	-
Sedum verticillatum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	5	-
Sedum ussuriense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	5	-
Woodsia polystichoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	5	-
Mukdenia rossii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	5	*20*
Dennstaedtia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	5	-
E_3																					
Pinus densiflora	.	.	(2)	.	.	.	.	.	.	(2)	.	.	.	.	.	.	.	.	(2)	(16)	-
E_2																					
Rhododendron micranthum	.	+	.	2	.	.	.	.	2	.	2	.	.	.	.	.	.	1	.	26	-
Rhus javanica	.	.	2	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	r	21	-
Weigela florida	.	.	2	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	+	21	-
Deutzia uniflora	.	2	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	-
Deutzia glabrata	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	.	11	-
E_1																					
Carex lanceolata agg.	+	+	+	+	.	.	1	2	1	2	1	1	.	1	.	.	.	r	+	68	*60*
Carex ciliato-marginata	1	+	.	1	.	.	.	.	.	.	+	2	.	1	.	.	.	.	.	32	*10*
Calamagrostis arundinacea	r	+	+	.	.	.	.	.	+	r	.	.	.	.	.	.	.	2	.	32	*10*
Deutzia uniflora juv.	.	+	.	+	.	.	.	2	.	.	r	r	.	.	.	2	.	.	.	32	-
Parthenocissus tricuspidata	.	.	+	.	.	.	.	.	.	.	.	1	2	.	.	.	.	r	4	26	-
Weigela florida juv.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	16	-
Rhododendron mucronulatum juv.	+	.	.	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	16	*40*
Rhus javanica juv.	.	.	+	r	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	16	-
Rhododendron micranthum juv.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	.	.	.	.	.	16	-
Lespedeza maximowiczii juv.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	11	-
Spodiopogon sibiricus	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	-
Commelina communis	.	.	.	r	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	11	-
Rhododendron yedoense juv.	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	11	-
Fraxinus rhynchophylla juv.	.	.	.	.	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	11	-
Benzoin obtusilobum juv.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.	.	11	-
Boehmeria spicata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	11	-
E_0																					
Schistidium apocarpum	.	.	.	.	.	2	3	1	+	.	.	1	+	.	+	.	.	.	1	42	*
Hypnum plumaeforme	.	3	2	.	.	.	.	.	.	3	1	.	5	.	.	.	.	.	.	26	*
Plagiothecium cavifolium	.	1	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	2	.	16	*
Hedwigia ciliata	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	16	*
Brachiolejeunea sandwi	.	.	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	2	16	*
Weissia controversa	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	3	16	*
Brachythecium buchananii	.	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	11	*
Leucobryum neilgherrense	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	11	*
Racomitrium sudeticum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	11	*
Thuidium kanedae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	2	.	.	11	*

Table 1 (continued)

In one relevé only

$E_1 + E_2$: *Fraxinus sieboldiana* E_2 2: +; *F. sieboldiana* juv. 2: +; *Rhododendron schlippenbachii* juv. 2: +; *Betula schmidtii* E_2 4: 2; *Paraixeris denticulata* 4: +; *Deutzia prunifolia* juv. 5: 2; *Lepisorus onoei* 5: 1; *Carex erythrobasis* 7: 1; *Pinus densiflora* juv. 7: r; *Syringa* sp. juv. 8: +; *Quercus variabilis* juv. 9: 2; *Fraxinus rhynchophylla* E_2 9: 1; *Lespedeza maximowiczii* E_2 10: 1; *Viola albida* 11: +; *Quercus mongolica* juv. 11: r; *Artemisia stolonifera* 12: +; *Miscanthus sinensis* 12: +; *Paraixeris chelidoniifolia* 13: 1; *Syringa velutina* agg. 13: +; *Rubus crataegifolius* 13: r; *Clematis davidiana* E_2 14: 2; *C. koreana* 14: +; *Pinus densiflora* E_2 15: 2; *Miscanthus sacchariflorus* 15: +; *Humulus japonica* 15: r; *Corydalis speciosa* 16: 2; *Deparia japonica* 17: r; *Chrysanthemum boreale* 18: 1; *Stephanandra incisa* E_2 18: 1; *Artemisia gmelinii* 18: +; *A. keiskeana* 18: +; *Melampyrum roseum* 18: +; *Poa nemoralis* 18: +;

E_0: *Hyophila acutifolia* 1: 1; *Bryum* sp. 1: +; *Cephaloziella microphylla* 1: +; *Trachycystis microphylla* 1: +; *Macromitrium japonicum* 3: 2; *Brachythecium populeum* 5: 5; *Mnium laevinerve* 10: 1; *Tortella tortuosa* 12: +; *Ctenidium molluscum* 14: 5; *Pogonatum urnigerum* 15: 2; *Cetrelia olivetorum* 15: 1; *Leucodon sapporensis* 16: 2; *Thamnobryum sandei* 16: 1; *Leucodon sciuroides* 17: 2; *Trichostomum crispulum* 17: +; *Leptodontium flexifolium* 18: +; *Cladonia* sp. 19: 1.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

1, JKV, 6.00, 401, E/80, 0, 70, 3, Gaya-san, rock in Seoggye-dong Village near rivulet, 11. 6. 2006;
2, JK, 12.00, 399, E/40, 10, 70, 40, Sobaek-san, Yeonhwa-dong, rock near rivulet SE from village, 3. 6. 2006;
3, K, 8.00, 370, NW/80, 10, 70, 15, Yongwol, Kim Sat Gat Valley, road towards museum, granodiorite block, 22. 5. 2007;
4, JK, 6.00, 414, W/85, 40, 60, 5, Sobaek-san, Yeonhwa-dong, near rivulet SE from village, 3. 6. 2006;
5, JKS, 3.00, 490, NE/35, 0, 75, 100, Sobaek-san, Jukgye Valley, on edge of mossy boulder, 2. 6. 2006;
6, JK, 3.00, 632, NE/60, 0, 75, 20, Gaya-san, below Wondangam Monastery, top of large boulder, 10. 6. 2006;
7, JK, 3.00, 507, SE/85, 0, 75, 30, Jiri-san, 1 km above the Jikjeonmaeul Village, large boulder, 12. 6. 2006;
8, JK, 4.00, 533, NW/80, 0, 75, 5, Jiri-san, 1 km above the Jikjeonmaeul Village, near spring, 12. 6. 2006;
9, K, 2.00, 360, NNW/50, 30, 40, 40, Yongwol, Kim Sat Gat Valley, granodiorite, 22. 5. 2007;
10, K, 3.00, 365, W/5, 30, 35, 30, Yongwol, Kim Sat Gat Valley, granodiorite, 22. 5. 2007;
11, JK, 4.50, 399, SE/30, 15, 50, 5, Sobaek-san, Yeonhwa-dong, near rivulet SE from village, 3. 6. 2006;
12, JK, 4.00, 535, SSW/90, 0, 50, 5, Gaya-san, Hongnyudong Valley, steep shady rock, 10. 6. 2006;
13, JK, 4.00, 438, N/40, 0, 50, 85, Jiri-san, valley SW of Jikjeonmaeul Village, above bus stop, shady rocks, 12. 6. 2006;
14, JK, 6.00, 490, NNE/85, 10, 40, 90, Sobaek-san, Jukgye Valley, below Choamsa Temple, 2. 6. 2006;
15, K, 8.00, 510, N/80, 20, 15, 25, Jiri-san, Eoreumgol Valley, block near bridge above rivulet, 14. 6. 2006;
16, JK, 8.00, 788, WNW/50, 0, 25, 70, Deogyu-san, Gucheon-dong Valley, top of boulder near rivulet, 8. 6. 2006;
17, KV, 4.00, 349, N/85, 0, 25, 25, Juwang-san, Jeolgol Valley, rocky wall, 6. 6. 2006;
18, K, 32.00, 143, N/85, 15, 40, 40, Mungyeong, near Jin-nam, rock over river, 20. 6. 2006;
19, K, 12.00, 370, W/80, 2, 70, 65, Yongwol, Kim Sat Gat Valley, road towards museum, 22. 5. 2007.

Other species such as *Amitostigma gracile* and *Paraixeris chelidoniifolia* achieve higher constancy. In the herb and shrub layer, a total of 69 species were found. The average number of species in herb layer is cca 11, and the cover varies between 10 and 75%, with an average of 45%.

In the moss layer, the dominant species are *Hypnum plumaeforme* and *Racomitrium sudeticum*, which also have the higher constancy. A total number of determined mosses is 26, with an average number in one relevé of less than 3. The cover of the moss layer varies between (0)3% and 85%, on average less than 49%. In the stands of North Korea, *Schistidium apocarpum* was also found.

The stands occur on mild moist to mild dry rocks on large granite or granodiorite boulders with gentle to steep slopes (10–70°), cca 40° on average. The northern exposure of habitats prevails. If the community occurs on the warmer exposures, it is usually overshadowed, e.g., by surrounding trees or terrain geomorphologies. In the drier days of the growing season, the moss layer maintains the humidity under the rock surface. This layer is probably sufficient for the existence of small species such as *Amitostigma gracile*. The important role in the maintaining the required humidity also provides a cushioned and dense stands of some species, such as *Sedum polytrichoides*, *Selaginella rossii*, *Parthenocissus tricuspidata* or *Carex lanceolata* agg.

The community has been recorded in the moderately shaded or shaded habitats at altitudes between 220 and 520 m.

As in the northern part, the two subassociations already described (Kolbek et al. 1997) have been identified in the southern part of the Korean Peninsula.

Amitostigmato gracilis-Sedetum polytrichoidis spodiopogonetosum sibirici Kolbek, Valachovič et Jarolímek 1997

The first ten relevés document this subassociation in Table 2. As a differential species in the southern part of the Peninsula

Table 2 *Amitostigmato gracilis-Sedetum polytrichoidis spodiopogonetosum sibirici* (rels 1–10), *lepisoretosum ussuriensis* (rels 11–14). Column *N* contains percentual constancy of the association in North Korea (Kolbek et al. 1997: Table 3)

Relevé number	1	2	3	4	5	6	7	8	9	10		11	12	13	14			
Constancy (s1, s2, S, *N*) in total number of relevés (%)											**s1**					**s2**	**S**	***N***
Number of relevés											**10**					**4**	**14**	***20***
E_1 - Species of rock fissures																		
***Sedum polytrichoides* (A)**	**2**	**+**	**3**	**1**	**+**	**1**	**3**	**1**	**1**	**r**	**100**	**3**	**1**	**3**	**2**	**100**	**100**	***100***
***Amitostigma gracile* (A)**	**.**	**+**	**1**	**+**	**+**	**.**	**+**	**.**	**+**	**+**	**70**	**.**	**1**	**+**	**.**	**50**	**64**	***45***
***Selaginella rossii* (dS)**	**.**	**+**	**+**	**.**	**2**	**.**	**.**	**.**	**.**	**.**	**30**	**.**	**.**	**.**	**.**	**–**	**21**	***5***
***Selaginella tamariscina* (dS)**	**.**	**r**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**+**	**20**	**.**	**.**	**.**	**.**	**–**	**14**	***30***
***Orostachys malacophylla* (dS)**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**–**	**.**	**1**	**+**	**.**	**50**	**14**	**–**
***Lepisorus ussuriensis* (dS)**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	**–**	**.**	**1**	**.**	**+**	**50**	**14**	***20***
Mukdenia rossii	.	2	+	.	.	.	.	.	.	.	20	.	.	.	.	–	14	–
Pilea peploides	.	.	.	.	.	.	.	.	3	2	20	.	.	.	.	–	14	*30*
Saxifraga fortunaei	.	.	.	.	.	+	.	.	.	.	10	.	.	.	.	–	7	–
Woodsia polystichoides	.	.	.	.	.	.	+	.	.	.	10	.	.	.	.	–	7	*5*
Sedum kamtschaticum	.	.	.	.	.	.	.	.	.	+	10	.	.	.	.	–	7	–
Woodsia manchuriensis	.	.	.	.	.	.	.	.	.	.	–	+	.	.	.	25	7	–
E_2																		
Ligustrina amurensis	.	.	2	.	2	.	.	.	.	.	20	.	.	.	.	–	14	–
Lespedeza maximowiczii	.	.	.	.	1	1	.	.	.	.	20	.	.	.	.	–	14	–
E_1																		
***Chrysanthemum zawadskii* agg.(dS)**	**+**	**1**	**1**	**4**	**2**	**2**	**3**	**.**	**.**	**.**	**70**	**.**	**.**	**.**	**.**	**–**	**50**	***20***
***Calamagrostis arundinacea* (dS)**	**2**	**2**	**.**	**.**	**.**	**1**	**+**	**.**	**+**	**r**	**60**	**.**	**.**	**.**	**.**	**–**	**43**	***25***
***Spodiopogon sibiricus* (dS)**	**+**	**.**	**+**	**.**	**+**	**+**	**.**	**.**	**.**	**.**	**40**	**.**	**.**	**.**	**.**	**–**	**29**	***55***
Carex lanceolata agg.	2	2	.	+	2	r	+	.	+	r	80	.	.	.	+	25	64	*40*
Parthenocissus tricuspidata	+	.	.	+	.	4	.	2	.	.	40	2	.	.	2	50	43	*5*
Paraixeris chelidoniifolia	.	.	2	.	.	+	r	2	.	.	40	.	.	.	1	25	36	*15*
Weigela florida juv.	.	+	+	.	+	.	.	.	.	.	30	.	.	.	.	–	21	–
Rhododendron mucronulatum juv.	.	.	.	1	.	1	.	+	.	.	30	.	.	.	.	–	21	*5*
Fraxinus rhynchophylla juv.	.	.	.	r	1	+	.	.	.	.	30	.	.	r	.	25	29	*10*
Oplismenus undulatifolius	.	.	.	.	.	.	2	r	1	.	30	.	.	.	1	25	29	–
Lespedeza bicolor juv.	+	.	.	.	.	.	r	.	.	.	20	.	.	.	.	–	14	*10*
Arundinella hirta	.	2	1	.	.	.	.	.	.	.	20	.	.	.	.	–	14	–
Spiraea fritschiana juv.	.	+	1	.	.	.	.	.	.	.	20	.	.	.	.	–	14	–
Dryopteris subtripinnata	.	.	.	2	1	.	.	.	.	.	20	.	.	.	.	–	14	–
Melampyrum roseum	.	.	.	.	+	.	1	.	.	.	20	.	.	.	.	–	14	*30*
Carpinus laxiflora juv.	.	.	.	.	r	.	.	.	r	.	20	.	.	.	.	–	14	*10*
Commelina communis	.	.	+	.	.	.	.	.	.	.	10	.	.	.	+	25	14	*45*
Paraixeris denticulata	.	.	.	.	.	.	1	.	.	.	10	.	.	+	.	25	14	–
Rhus javanica juv.	.	.	.	.	.	.	+	.	.	.	10	.	.	.	r	25	14	–
E_0																		
Hypnum plumaeforme	.	.	4	4	3	2	3	4	.	4	70	.	.	.	.	–	50	*
Grimmia incurva	.	.	.	1	1	2	.	.	.	.	30	.	.	.	.	–	21	*
Campylopus japonicus	.	.	2	.	.	.	.	.	3	.	20	.	.	.	.	–	14	*
Schistidium apocarpum	.	.	.	.	.	.	+	.	2	.	20	.	.	.	.	–	14	+
Racomitrium sudeticum	.	+	.	.	.	.	.	.	.	.	10	2	3	3	.	75	29	*
Plagiomnium cuspidatum	.	.	.	.	.	.	.	.	.	.	–	.	3	2	.	50	14	*
Hedwigia ciliata	.	.	.	.	.	.	.	.	.	.	–	.	+	1	.	50	14	*

In one relevé only

E_1 + E_2: *Rhododendron micranthum* juv. 1: 2; *Quercus mongolica* juv. 1: +; *Astilbe chinensis* agg. 2: +; *Syringa dilatata* juv. 2: r; *Artemisia koidzumii* 3: +; *Betula schmidtii* juv. 3: +; *Isodon inflexus* 3: +; *Spiraea fritschiana* E_2 3: +; *Carex ciliato-marginata* 3: r; *Micromeles alnifolia* juv. 4: r; *Pinus densiflora* E_2 5: 3; *Fraxinus rhynchophylla* E_2 5: 2; *Rhododendron mucronulatum* E_2 5: 2; *Acer*

Table 2 (continued)

palmatum E_2 5: 1; *Benzoin obtusilobum* E_2 5: +; *Lespedeza maximowiczii* juv. 5: +; *Quercus serrata* juv. 5: r; *Tripterygium regelii* juv. 5: r; *Weigela florida* E_2 6: 3; *Betula schmidtii* E_2 6: 1; *Acer pseudosieboldianum* E_2 6: +; *Allium thunbergii* 7: 1; *Artemisia princeps* 7: 1; *Poa nemoralis* 7: +; *Isodon japonicus* 7: r; *Spiraea blumei* juv. 7: r; *Ulmus macrocarpa* juv. 7: r; *Deutzia uniflora* juv. 8: +; *Hosta longipes* 9: 1; *Miscanthus sinensis* 9: r; *Fraxinus sieboldiana* juv. 10: r; *Deutzia glabrata* juv. 11: 1; *Carex erythrobasis* 12: +; *Celastrus orbiculatus* juv. 13: +; *Actinidia arguta* 13: r; *Celastrus flagellaris* 13: r; *Clematis davidiana* 13: r; *Fraxinus sieboldiana* E_2 14: 2; *Vitis amurensis* 14: 2; *Isodon exscisus* 14: 1; *Benzoin obtusilobum* juv. 14: +; *Pueraria lobata* 14: +;
E_0: *Thuidium kanedae* 2: +; *Orthotrichum* sp. 3: 1; *Jamesoniella nipponica* 3: +; *Leucobryum glaucum* 4: 2; *Marsupella *tubulosa* 5: 1; *Racomitrium fasciculare* 5: 1; *Philonotis lancifolia* 7: 3; *Brachythecium buchananii* 7: 2; *Schistidium* sp. 7: +; *Pohlia longicollis* 9: 2; *Trachycystis microphylla* 10: 1; *Pogonatum urnigerum* 10: +; *Pohlia nutans* 10: +; *Thamnobryum sandei* 10: +; *Lescuraea incurvata* 11: 4; *Atrichum undulatum* 11: 1; *Rhizomnium punctatum* 13: 1; *Hyophila involuta* 14: 3; *Hypnum cupressiforme* 14: 3.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Amitostigmato gracilis-Sedetum polytrichoidis spodiopogonetosum sibirici
1, K, 9.00, 220, NW/65, 0, 35, 0, Seorak-san, side valley above Park Office, 22. 6. 2006;
2, K, 14.00, 222, NE/70, 0, 30, 3, Seorak-san, Naewonam Valley, rock around Ulsan-Bawi Trail Course, 22. 6. 2006;
3, K, 15.00, 230, N/70, 15, 45, 70, Seorak-san, Ssangcheon Valley, boulder near stream, 22. 6. 2006;
4, JS, 9.00, 341, NW/45, 0, 60, 70, Worak-san, Deokjusa Valley, above Buddhist temple, 20. 6. 2006;
5, KV, 5.00, 364, NNW/20, 40, 50, 30, Odae-san, Sogeumgang Valley, rock plate above stream, 25. 6. 2006;
6, K, 16.00, 364, N/20, 30, 75, 10, Odae-san, Sogeumgang Valley, granite rock plate, 25. 6. 2006;
7, JK, 3.00, 427, E/30, 0, 65, 80, Duta-san, Gwaneumam Temple, shady granite boulder above stream, 30. 5. 2007;
8, K, 8.00, 520, NE/70, 0, 35, 70, Jiri-san, Eorumgol Valley, large boulder above Banseon Village, near Park Office, 14. 6. 2006;
9, J, 8.00, 520, SSW/25, 0, 50, 50, Jiri-san, Piagol Valley, wet granite rock, 12. 6. 2006;
10, KV, 2.00, 345, NW/10, 0, 25, 85, Juwang-san, Jeolgol Valley, granite rock, 6. 6. 2006;

Amitostigmato gracilis-Sedetum polytrichoidis lepisoretosum ussuriensis
11, JK, 6.00, 490, NNE/30, 0, 45, 70, Sobaek-san, Jukgye Valley, boulder near stream, 2. 6. 2006;
12, JK, 10.00, 517, E/45, 0, 10, 75, Sobaek-san, Jukgye Valley, sunny granite boulder near stream, 2. 6. 2006;
13, JK, 6.00, 517, N/25, 0, 50, 40, Sobaek-san, Jukgye Valley, top of boulder near stream, 2. 6. 2006;
14, K, 12.00, 240, S/30, 10, 50, 30, Seorak-san, Jeohangryeong Valley, boulder in forest, 23. 6. 2006.

behave *Spodiopogon sibiricus*, *Chrysanthemum zawadskii* agg., *Selaginella rossii*, and *Calamagrostis arundinacea*, less often as *Selaginella tamariscina*; *Hypnum plumaeforme* and *Grimmia incurva* in the moss layer. The number of herb species varies from 6 to 21, from (0)1 to 5 in the moss layer. The stands of this subassociation are richer in species than the second subassociation. The average number of species in relevé is 12–13 in the herb layer and almost 3 in the moss layer. The canopy cover of the herb layer varies from 25% to 75%, on average 47% in relevé. The shrub layer is mostly missing; in other places its cover varies from 15 to 40%, with an average cover of less than 9% in relevé. The cover of the moss layer varies from (0)3% to 85%, on average less than 47%. Stands of the subassociation were found at altitudes between 220 and 520 m. The community occurs mostly on northern to eastern (or western) exposures with 10° to 70° slopes (on average 42°) on rocks in the Seorak-san, Worak-san, Odae-san, Duta-san, Jiri-san, and Juwang-san (Appendix 1).

Amitostigmato gracilis-Sedetum polytrichoidis lepisoretosum ussuriensis Kolbek, Jarolímek et Valachovič 1997

The second subassociation is represented by only four relevés (Table 2). It is slightly differentiated by the species *Orostachys malacophylla* and *Lepisorus ussuriensis*; differential species of the previous subassociation are missing. The stands are very species-poor, with less than 8 species on average in the herb layer and 3 mosses in relevé. The number of herb species varies from 4 to 13, from 2 to 4 in the moss layer. The shrub layer was represented in only one relevé with 10% coverage. Herb cover varies from 10% to 50% (on average

less than 39%); moss cover is more developed and varies between 30% and 75% (on average less than 54%). In the moss layer *Racomitrium sudeticum* and *Plagiomnium cuspidatum* prevail; *Lescuraea incurvata* achieves the highest values of dominance. This subassociation has been found at altitudes between 240 and 517 m, on various (mostly northern) slopes from 25° to 45° (on average cca 32°), mostly on granodiorite rocks in the Sobaek-san and Seorak-san.

Sedetum sarmentoso-middendorffianii Kolbek, Jarolímek et Valachovič 1997

The stands of *Sedum sarmentosum* reside in the northern part of the Peninsula most often accompanied by *Sedum middendorffianum* and therefore described as in association with the abovementioned name (Kolbek et al. 1997). In collecting material in the southern part of the Peninsula, we did not record the occurrence of the latter species. This species has been replaced in similar stands by *Sedum kamtschaticum* (Table 3). Some other taxa of species combination (e.g., *Commelina communis*, *Poa nemoralis*, *Viola mandshurica*, and moss *Plagiomnium cuspidatum*) are however present in these stands. Species range mostly up to 10 cm, with a maximum of 20 cm; the dominant species is only a few centimetres tall, blooming up to 10 cm. At flowering the grass is the community a little higher. The plant community of succulents and bryophytes forms a two- to three-layered stand.

In this community, a shrub layer was found only with the rare occurrence of the species *Abelia insularia* in one relevé with virtually no abundances; however, sporadic tree seedlings are present. Their growth is limited by the almost bare rocky bedrock and the minimum soil layer with fluctuating humidity.

The number of species in the herb layer of three relevés varies from 6 to 13 species, with 10 species in one relevé on average. The total number of herb plant species found in the observed stands was 26. *Sedum sarmentosum* reached the highest level of cover and constancy. *Selaginella helvetica* and *Sedum kamtschaticum* have rarely achieved the higher cover in individual stands. The total cover of the herb layer varies greatly from 10 to 90%, with an average of more than 43% in one relevé.

In the moss layer, a total of 8 species (from 0 to 4 species in one relevé; 2.7 on average) were found in the three relevés. Their cover is very different, varying from 0 to 60% in individual stands, on average 30% per relevé. *Hypnum cupressiforme* and *Encalypta ciliata* reached the highest coverage. In the stands of North Korea, *Plagiomnium cuspidatum* was also found.

Significant variation in the cover values of this very species-poor mossy and herb layer is due to the highly unstable ecological conditions of the habitat and a small number of relevés. This indicates that the community belongs to the initial units on rocky backgrounds. Its dominant, heliophile species *Sedum sarmentosum* (Fig. 1d) is comparatively weak in terms of competition and is unable to withstand the pressure of many herbs. It recedes in the absence of light when it stops blooming and forms minimal cover and poor stands. Its advantage, however, is considerable tolerance to low substrate moisture and the ability to produce relatively rapid vegetative propagation with long crawling branches.

The community was found at altitudes of 190–587 m (on average 397 m). It prefers a weak northern orientation with a slope between 30° and 85° (on average 50°) on shaded and moist granodiorite rocks.

Pyrrosietum linearifolio-petiolosae ass. nova hoc loco

Nomenclatural type: relevé 4 in Table 3, (holotypus)
Association species: *Pyrrosia linearifolia*, *Pyrrosia petiolosa*, *Sedum kamtschaticum*

Open two-layered and occasionally three-layered, mostly species-poor community of predominantly small ferns of wet and damp mossy rocks. Characteristic species are the representatives of the genus *Pyrrosia*, namely, *P. linearifolia* and *P. petiolosa* (Fig. 2a), which also form a significant aspect. In stands, there are also many ferns typical of vegetation on rocks and rock fissures, such as *Camptosorus sibiricus*, *Dryopteris lacera*, *Lepisorus ussuriensis*, and *Woodsia polystichoides*, occasionally *Hymenophyllum* cf. *wrightii*. The other species are accessory, tolerant of an environment almost without soil and fluctuating substrate moisture.

In most of the recorded relevés, the shrub layer is not usually present or has low cover. However, this is not the rule; in relevé no. 7 two species were found of which *Spiraea blumei* achieves a maximal cover of 70%. However, due to this one relevé, the average cover of the shrub layer of all relevés is yet only 15%.

A total of 25 species were recorded in the herb layer, with 5 to 11 in the relevé (on average less than 9). The cover of the herb layer in the recorded relevés varies from 10 to 60% (on average 28%) and is often lower than that of the moss layer. The average number of species in the herb and shrub layers is low and less than 9.

The cover of the moss layer is practically doubled and ranges from 40 to 80%, on average 60%. In the moss layer, a total of 16 taxa were found, with 3–8 species in a relevé (on average of more than 5 species). *Hypnum cupressiforme*, *Brachythecium buchananii*, *Hedwigia ciliata*, and undetermined lichenes of the genus *Parmelia* and *Cladonia* belong to the species with the highest constancy and abundance. But other species of the mossy layer have a quite high coverage.

In the northern part of the Korean Peninsula, fern *Pyrrosia linearifolia* (syn. *Neoniphopsis linearifolia*) absolutely predominates as a permanent and significant component in the epiphytic forest communities on old individual forest trees (Kolbek 1995). Together with this fern, *Camptosorus sibiricus*, *Dryopteris saxifraga*, *Davallia mariesii*, *Lepisorus ussuriensis*, *Dennstaedtia hirsuta*

Table 3 *Sedetum sarmentoso-middendorffianii* (rels 1–3) and *Pyrrosietum linearifolio-petiolosae* ass. nova (rels 4–8). Column *N* contains percentual constancy of the first association in North Korea (Kolbek et al. 1997: Table 7)

Relevé number	**1**	**2**	**3**			**4**	**5**	**6**	**7**	**8**	
Constancy (S, *N*) in total number of relevés (%)				**S** **3**	***N*** ***9***						**S** **5**
E_1 – Species of rock fissures											
***Sedum sarmentosum* (A)**	**2**	**1**	**5**	**3/3**	***67***	**.**	**.**	**.**	**.**	**.**	**–**
***Pyrrosia petiolosa* (A)**	**.**	**.**	**.**	**–**	**–**	**+**	**2**	**r**	**1**	**.**	**80**
***Sedum kamtschaticum* (A)**	2	.	.	1/3	–	**+**	**2**	**r**	.	.	**60**
***Pyrrosia linearifolia* (A)**	.	.	.	–	*11*	**2**	**.**	**2**	**.**	**1**	**60**
Amitostigma gracile	+	.	.	1/3	–	.	.	.	.	+	20
Davallia mariesii	+	.	.	1/3	–	.	.	.	.	.	–
Woodsia polystichoides	.	.	.	–	*11*	+	2	.	1	.	60
Dryopteris lacera	.	.	.	–	–	.	+	.	2	.	40
Camptosorus sibiricus	.	.	.	–	–	.	.	.	+	.	20
Lepisorus ussuriensis	.	.	.	–	*11*	.	.	.	.	3	20
Sedum verticillatum	.	.	.	–	*44*	.	.	.	.	1	20
E_2											
Abelia insularis	.	r	.	1/3	–	.	.	.	r	.	20
E_1											
Spodiopogon sibiricus	+	1	.	2/3	–	.	.	.	.	.	–
Humulus japonica	.	+	1	2/3	–	.	.	.	.	.	–
Ixeris sonchifolia	.	+	.	1/3	–	.	r	.	.	.	20
Commelina communis	.	.	1	1/3	*56*	.	+	.	.	.	20
Zelkova serrata juv.	.	.	+	1/3	–	.	.	.	.	r	20
Weigela florida juv.	.	.	.	–	–	+	2	+	+	.	80
Parthenocissus tricuspidata	.	.	.	–	*56*	.	+	+	1	2	80
Artemisia gmelinii	.	.	.	–	–	+	+	.	.	.	40
Ulmus macrocarpa juv.	.	.	.	–	–	r	2	.	.	.	40
Calamagrostis arundinacea	.	.	.	–	–	.	+	.	+	.	40
E_0											
Hypnum cupressiforme	4	.	.	1/3	*	1	.	3	2	4	80
Cladonia sp.	.	+	.	1/3	*	3	.	1	.	.	40
Reboulia hemisphaerica	.	+	.	1/3	*	1	.	.	.	.	20
Brachythecium buchananii	.	.	.	–	*	3	.	1	.	.	40
Ceratodon purpureus	.	.	.	–	*	1	.	1	.	.	40
Weissia controversa	.	.	.	–	*	2	.	.	2	.	40
Plagiothecium denticulatum	.	.	.	–	*	.	2	1	.	.	40
Thuidium kanedae	.	.	.	–	*	.	2	1	.	.	40
Hedwigia ciliata	.	.	.	–	*	.	1	3	.	.	40
Parmelia sp.	.	.	.	–	*	.	.	3	1	.	40

In one relevé only

$E_1 + E_2$: *Rubus oldhami* 1: +; *Lithospermum erythrorhizon* 1: r; *Paraixeris denticulata* 1: r; *Poa nemoralis* 1: r; *Quercus mongolica* juv. 1: r; *Rhus javanica* juv. 1: r; *Selaginella helvetica* 2: 2; *Artemisia princeps* 2: +; *Arundinella hirta* 2: +; *Microstegium vimineum* 2: +; *Potentilla fragarioides* 2: +; *Trigonotis radicans* 2: +; *Saussurea* sp. 2: r; *Viola mandshurica* 2: r; *Rosa multiflora* 3: 1; *Clematis apiifolia* 3: +; *Hymenophyllum* cf. *wrightii* 4: +; *Spiraea blumei* E_2 7: 4; *Boehmeria spicata* 7: +; *Rhododendron micranthum* E_2 8: 1; *Deutzia glabrata* E_2 8: +; *Polygonatum involucratum* 8: +;
E_0: *Plagiomnium cuspidatum* 1: 1; *Racomitrium sudeticum* 1: 1; *Dicranum japonicum* 1: +; *Encalypta ciliata* 2: 3; *Leskea polycarpa* 2: +; *Mnium laevinerve* 5: 2; *M. thomsonii* 7: 1; *Pyxina endohrysena* 7: +; *Thabryum coreense* 7: +; *Rhizomnium punctatum* 8: 2; *Homomallium connexum* 8: 1.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Sedetum sarmentoso-middendorffianii

1, JK, 9.00, 414, NNW/30, 0, 30, 60, Sobaek-san, Yeonhwa-dong, near rivulet SE from village, 3. 6. 2006;
2, JKSV, 6.00, 190, NNE/85, 0, 10, 30, surrounding of Andong city, old wall near Chire Village, 6. 6. 2006;
3, K, 6.00, 587, S/35, 0, 90, 0, Gaya-san, valley between Bohyeonam and Yaksuam Monasteries, shadow rocks, 10. 6. 2006;

Pyrrosietum linearifolio-petiolosae

4, JK, 1.50, 228, E/80, 0, 10, 80, Yeongwol, slate rocky outcrop, 21. 5. 2007;
5, JK, 2.00, 228, ENE/60, 0, 40, 40, Yeongwol, ca 1 km from the Gossi Cave, slate rock above rivulet, 21. 5. 2007;
6, JK, 1.00, 228, N/85, 0, 15, 60, Yeongwol, slate rock, 21. 5. 2007;
7, JK, 3.00, 186, WNW/80, 70, 15, 50, Yeongwol, rock above stream near Namhangang River, slate, 21. 5. 2007;
8, JK, 10.00, 482, NE/35, 5, 60, 70, Sobaek-san, Jukgye Valley, below Choamsa Monastery, 2. 6. 2006.

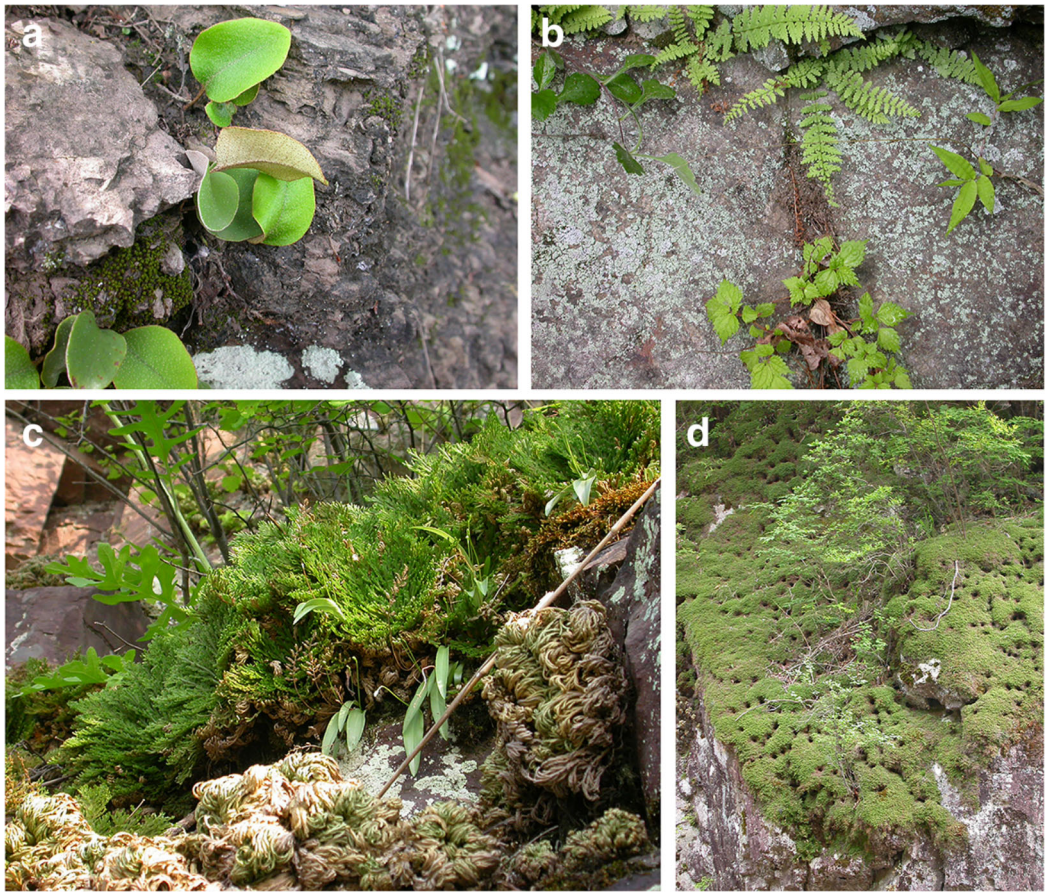

Fig. 2 Examples of ferns and spike mosses typical of vegetation on rocks and rock fissures. **a** Representative of the genus *Pyrrosia*, namely, *P. petiolosa.* **b** Shady and wet rocks covers *Woodsia manchuriensis.* **c** The dominant fern *Selaginella tamariscina* and small orchid *Amitostigma gracile*. **d** A carpet of cushioned plant species of *Selaginella rossii*

(syn. *Microlepia pilosella*), and *Amitostigma gracile* were recorded, most of which were also found in this rock association also in South Korea. The occurrence of this community on old tree trunks may therefore be an analogue of the rock units described here.

This community occurs on the mossy rock walls, most often in areas with increased humidity in the valleys of streams and rivers. It was found on the granodiorite subsoil and on the slate rock. It was recorded at altitudes between 186 and 482 m (on average 270 m) with an inclination from 35° to 85° (on average 68°) in the northern and eastern orientations.

Woodsia manchuriensis community

This community includes the unspecified and unclassified stands where *Woodsia manchuriensis* usually occurs or dominates (Fig. 2b). This is probably the initial, apparently successively blocked stage of various sociological units that did not stabilize for stationary reasons. Their further development could eventually lead to the associations *Dryopterido saxifragae-Saxifragetum fortunaei* and *Mukdenio rossii-Selaginelletum rossi*. However, further development is likely to be limited by the prevailing southern orientation, which reduces the substrate moisture and the ability to colonize a number of more demanding herb species and mosses. Due to the highly variable material, which is not supported by a sufficient number of phytocoenological relevés for classification, we place it in the "community" rank. The most abundant species of the community are *Woodsia manchuriensis*, *Weigela florida* juv., *Dryopteris saxifraga*, *Athyrium yokoscense*, *Carex lanceolata* agg., *Boehmeria spicata*, and *Camptosorus sibiricus* (Table 4).

The shrub layer is developed at only a fraction of stands, and the average barely reaches 6% of coverage. The cover of the herb layer varies between 10 and 50%, on average less than 24%. The total number of herb and shrub layer species reached 78. There were 5–15 species, per relevé, on average more than 9 species. Highly variable cover of the moss layer varies between 1 and 80%, on average 25%. In this layer, only 15 species were found, with 1–5 species in relevé (on average less than 3). The most abundant species were *Racomitrium sudeticum*, *Schistidium apocarpum*, *Tortella tortuosa*, and *Thuidium glaucinum*.

The community was found on shady and wet granite, granodiorite rocks and artificial walls. The highly variable altitude

Table 4 *Woodsia manchuriensis* community

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
Constancy (S) in total number of relevés (%)																		**S**
E_1 - Species of rock fissures																		
***Woodsia manchuriensis* (c)**	**2**	**.**	**.**	**2**	**2**	**3**	**r**	**2**	**.**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**82**
Dryopteris saxifraga	1	1	r	+	.	.	.	.	.	.	+	1	.	.	.	.	1	41
Camptosorus sibiricus	1	2	1	.	.	.	.	.	2	.	.	.	.	.	.	.	1	29
Adiantum capillus-junonis	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	+	.	18
Woodsia polystichoides	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
Lepisorus ussuriensis	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	12
Cheilanthes argentea	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
Saxifraga fortunaei	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.		12
Asplenium ruta-muraria	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		6
Sedum polytrichoides	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.		6
Mukdenia rossii	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.		6
Saxifraga oblongifolia	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.		6
Selaginella rossii	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.		6
Sedum kamtschaticum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.		6
Sedum sarmentosum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.		6
Selaginella tamariscina	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.		6
Dennstaedtia hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2		6
E_2																		
Weigela florida	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	2	.	12
E_1																		
Weigela florida juv.	r	.	2	.	.	.	.	2	.	.	1	+	+	+	+	+	r	59
Athyrium yokoscense	.	+	.	.	1	.	2	2	1	.	.	1	.	+	.	.	.	41
Carex lanceolata agg.	.	1	.	r	.	.	.	.	.	+	1	.	+	.	.	+	.	35
Boehmeria spicata	.	+	1	.	2	+	2	1	.	.	.	.	.	.	.	.	.	35
Calamagrostis arundinacea	+	+	.	.	+	.	.	.	.	.	.	.	1	.	.	+		29
Carex ciliato-marginata	.	.	.	.	.	+	.	.	.	.	.	.	+	1	+	.		24
Spiraea blumei juv.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	r		18
Poa nemoralis	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.		18
Parthenocissus tricuspidata	.	.	.	.	.	+	.	.	.	r	1	.	.	.	.	.		18
Meehania urticifolia	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+		12
Artemisia stolonifera	.	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.		12
Oplismenus undulatifolius	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.		12
Artemisia keiskeana	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.		12
Youngia japonica	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.		12
Humulus japonica	.	.	.	.	r	.	.	.	.	.	r	.	.	.	.	.		12
Galium spurium	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.		12
Deutzia uniflora juv.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.		12
E_0																		
Racomitrium sudeticum	1	.	.	.	1	.	1	.	.	+	1	+	+	1	.	+	.	53
Schistidium apocarpum	.	1	.	.	1	.	1	1	.	+	1	+	.	1	.	.	.	47
Tortella tortuosa	.	2	3	.	1	.	3	1	1	.	.	.	.	.	+	.	.	41
Thuidium glaucinum	2	.	.	.	1	.	.	1	.	.	.	.	+	1	.	.	2	35
Hypnum plumaeforme	3	.	1	.	.	.	.	.	2	.	.	.	.	.	.	3		24
Mnium laevinerve	3	.	.	.	.	.	.	1	.	.	.	3	.	.	.	3		24
Weissia controversa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1		12

In one relevé only

$E_1 + E_2$: *Carex okamotoi* 2: +; *Fraxinus sieboldiana* juv. 2: +; *Paraixeris denticulata* 2: +; *Artemisia princeps* 2: r; *Polystichum craspedosorum* 3: 2; *Galium koreanum* 3: +; *Ixeris sonchifolia* 3: r; *Deutzia prunifolia* juv. 4: +; *Acer mono* juv. 5: +; *Polystichum tripteron* 7: 2; *Astilbe chinensis* agg. 7: +; *Impatiens noli-tangere* 7: +; *Pseudostellaria palibiniana* 7: +; *Ulmus davidiana* 7: +; *Cardamine leucantha* 7: r; *Clematis koreana* 8: +; *Commelina communis* 8: +; *Corydalis speciosa* 8: +; *Impatiens textori* 8: +; *Rhynchosia acuminatifolia* 8: +; *Bilderdykia dumetorum* 8: r; *Capsella bursa-pastoris* 8: r; *Trigonotis peduncularis* 9: 1; *Arenaria serpyllifolia* 9: +; *Draba nemorosa* 9: +; *Myosoton aquaticum* 9: +; *Clematis apiifolia* 9: r; *Carex* sp. 9: r; *Erigeron annuus* 9: r; *Ixeris dentata* 9: r; *Poa annua* 9: r; *Taraxacum* sp. 9: r; *Callicarpa japonica* E_2 10: 3; *Carpinus laxiflora* E_2 10: 2; *Sasamorpha *borealis* 10: r; *Carpinus laxiflora* juv. 11: r; *Lespedeza maximowiczii* juv. 12: r; *Viola dissecta* 12: r; *Deutzia glabrata* juv. 13: +; *Rhododendron mucronulatum* juv. 13: +; *Phegopteris dryopteris* 14: +; *Acer pseudosieboldianum* juv. 14: r; *Pilea peploides* 15: +; *Fraxinus rhynchophylla* juv. 16: r;

E_0: *Campyliadelphus stellatus* 3: 2; *Gollania ruginosa* 3: 1; *Bazzania bidentula* 4: 2; *Ramalina pollinarea* 4: 2; *Hyophila acutifolia* 6: 2; *Oncophorus virescens* 10: 2; *Weissiopsis anomala* 12: 3; *Reboulia hemisphaerica* 17: 1.

Table 4 (continued)

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

1, JK, 3.75, 224, N/75, 0, 15, 80, Donghae, Mureung Valley, shady granite rock, 30. 5. 2007;
2, JK, 8.00, 530, WNW/75, 40, 25, 55, Gaya-san, Hongnyudong Valley between Haeinsa Temple and National Park Office, 10. 6. 2006;
3, JK, 7.00, 67, NW/85, 0, 20, 40, Taebaek-san, dolomite, 1. 6. 2007;
4, JK, 8.00, 623, E/90, 0, 10, 20, Sobaek-san, Bonghwa, Baekcheon Valley, 24.5. 2007;
5, JK, 5.00, 750, SSW/80, 0, 25, 5, Sobaek-san, Huibangsa Temple, granodiorite, 1. 6. 2006;
6, V, 0.45, 560, WSW/50, 0, 25, 10, Gaya-san, Seoggye-dong, 11. 6. 2006;
7, JK, 9.00, 735, N/85, 0, 30, 45, Sobaek-san, Huibangsa Temple, rocky wall, 1. 6. 2006;
8, K, 8.00, 700, W/85, 0, 50, 10, Sobaek-san, Huibang Valley, rocky wall, 1. 6. 2006;
9, KVS, 6.00, 80, SE/80, 0, 20, 2, Andong, Byeongsan Seowon, wall of confucian academy building, 31. 5. 2006;
10, JK, 12.00, 594, SE/80, 40, 25, 15, Gaya-san, Hongnyudong Valley, 10. 6. 2006;
11, JK, 6.00, 534, S/75, 0, 40, 3, Gaya-san, Hongnyudong Valley, 10. 6. 2006;
12, JK, 8.00, 534, S/85, 0, 40, 50, Gaya-san, Hongnyudong Valley, shady moss rock, 10. 6. 2006;
13, JK, 16.00, 709, S/85, 0, 10, 1, Sobaek-san, Huibang Valley, 1. 6. 2006;
14, JK, 3.75, 755, W/90, 0, 15, 5, Sobaek-san, Huibangsa Temple, 1. 6. 2006;
15 JK, 12.00, 730, WSW/90, 0, 20, 1, Sobaek-san, Huibang Valley, wet rock, 1. 6. 2006;
16, JK, 8.00, 709, SE/85, 20, 20, 3, Sobaek-san, Huibang Valley, wet rock, 1. 6. 2006;
17, K, 3.75, 224, N/75, 0, 15, 80, Donghae, Mureung Valley, first bridge, granite 30. 5. 2007.

ranged between 80 and 755 m (on average 583 m). The orientation was also very variable, with the south prevailing and the northern orientations slightly suppressed. The slope of the habitats was high, between 50° and 90°, on average almost 81°.

Dennstaedtia hirsuta community

The *Dennstaedtia hirsuta* community is very close to the association *Dryopterido saxifragae-Saxifragetum fortunaei*. However, there is no significant differential species that would allow a clear classification for some of the subassociations. Phytocoenological relevés 1–4 (Table 5) show a link to the subassociation *Dryopterido saxifragae-Saxifragetum fortunaei hydrangeetosum acuminatae*, while relevés 5–9 to the subassociation *Dryopterido saxifragae-Saxifragetum fortunaei caricetosum siderostictae*. The link to these units shows the following species: *Dryopteris subtripinnata*, *Dryopteris saxifraga*, *Saxifraga fortunaei*, *Hydrangea serrata* var. *acuminata*, and *Mukdenia rossii*. In their species composition, however, there are species of anthropogenic character such as *Artemisia princeps*, *Paraixeris denticulata*, *Boehmeria spicata*, *Erigeron annuus*, and *Oxalis stricta*.

The shrub layer is only present in a third of the relevés, and its cover reaches a maximum of 25%, but only 6% on average. The cover of the herb layer varies between 5 and 30%, on average less than 23%. Approximately 7–19 species were found in one relevé in the herb and shrub layer, on average more than 10. The total number of the species in the herb and shrub layers was 52. The cover of the moss layer fluctuates greatly between 3 and 60%, on average more than 17%. The total number of species found in the moss layer was 21. In individual stands, 2–7 species were found, on average slightly more than 4 species.

This community occurs on the rocks with a considerable slope of 80–100° (on average 87°) and with predominantly north or northeast orientation. The community occurs at lower altitudes ranging from 290 to 693 m, 461 m on average.

Lepisoro ussuriensis-Selaginelletum tamariscinae Kolbek, Jarolímek et Valachovič 1997 nom. corr. Kolbek et Jarolímek 2013

Bas. *Lepisoro ussuriensis-Selaginelletum involventis* Kolbek et al. 1997

Two-, rarely three-layered community of slightly humid, in the summer monsoon on wet and steep rocks. Typically, low stands do not exceed 20 cm, at flowering of some accessory species up to 50 cm. A characteristic feature is that the soil mostly does not cover the whole habitat and occurs only directly around individual plants. The geological backgrounds are acidic (granites, granodiorites), in South Korea also limestone and dolomite rocks, often near waterfalls or river valleys. The association has been described on the basis of 9 relevés from North Korea (Kolbek et al. 1997) as *Lepisoro ussuriensis-Selaginelletum involventis* with an erroneous determination (according to local guides) of the leading species (cf. note in Kolbek and Jarolímek 2013: 272).

The stands are mostly species-poor, with 6 to 14(18) species in the relevé, but on average, only 10 species in the herb layer. A total of 103 species were found in the herb layer, but there are many accessory species. The dominant species of

Table 5 *Dennstaedtia hirsuta* community

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Constancy (S) in total number of relevés (%)										**S**
E_1 - Species of rock fissures										
***Dennstaedtia hirsuta* (c)**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**100**
Dryopteris subtripinnata	.	.	.	.	+	+	+	+	+	56
Dryopteris saxifraga	1	+	r	1	.	.	.	.	.	44
Saxifraga fortunaei	+	.	.	.	.	1	.	.	+	33
Mukdenia rossii	.	.	.	.	.	2	3	+	.	33
Pyrrosia lingua	.	.	.	.	.	.	+	.	r	22
Saxifraga oblongifolia	2	.	.	.	.	.	.	.	.	11
Woodsia manchuriensis	1	.	.	.	.	.	.	.	.	11
*Hydrangea *acuminata*	.	r	.	.	.	.	.	.	.	11
Chrysanthemum zawadskii agg.	.	.	.	.	+	.	.	.	.	11
Sedum kamtschaticum	.	.	.	.	r	.	.	.	.	11
Crypsinus hastatus	.	.	.	.	.	2	.	.	.	11
E_1										
Carex lanceolata agg.	+	.	r	2	.	+	+	+	.	67
Rhododendron mucronulatum juv.	.	.	+	.	.	+	+	.	1	44
Carex ciliato-marginata	.	.	.	.	.	1	+	1	1	44
Deutzia uniflora juv.	.	r	.	.	.	+	r	.	.	33
Athyrium yokoscense	.	+	r	.	.	.	.	.	.	22
Pinus densiflora juv.	.	r	r	.	.	.	.	.	.	22
Weigela florida juv.	.	.	1	2	.	.	.	.	.	22
Artemisia princeps	.	.	+	1	.	.	.	.	.	22
Paraixeris denticulata	.	.	r	+	.	.	.	.	.	22
Boehmeria spicata	.	.	+	.	r	.	.	.	.	22
Rhododendron micranthum juv.	.	.	.	.	.	.	+	+	.	22
Spodiopogon sibiricus	.	.	.	.	.	.	+	r	.	22
E_0										
Hypnum plumaeforme	1	.	1	.	.	1	1	.	.	44
Racomitrium sudeticum	3	+	.	.	.	.	.	+	.	33
Brachythecium populeum	.	.	.	.	.	+	+	.	2	33
Herbertus aduncus	.	.	.	.	.	1	.	2	3	33
Pohlia nutans	.	1	1	.	.	.	.	.	.	22
Atrichum undulatum	.	+	+	.	.	.	.	.	.	22
Tortella tortuosa	.	.	.	.	.	1	1	.	.	22
Leucobryum neilgherrense	.	.	.	.	.	+	+	.	.	22
Leucobryum glaucum	.	.	.	.	.	.	.	+	+	22

In one relevé only

$E_1 + E_2$: *Rhododendron schlippenbachii* E_2 1: 2; *Rh. yedoense* E_2 1: 2; *Carpinus laxiflora* juv. 2: +; *Fraxinus mandshurica* juv. 2: +; *Microstegium vimineum* 3: +; *Potentilla fragarioides* 3: +; *Rubus crataegifolius* 3: +; *Erigeron annuus* 3: r; *Lespedeza maximowiczii* juv. 3: r; *Oxalis stricta* 3: r; *Parthenocissus tricuspidata* 3: r; *Salix caprea* 3: r; *Viola acuminata* 3: r; *Calamagrostis arundinacea* 4: 2; *Aster pekinensis* 4: +; *Spiraea blumei* juv. 4: r; *Artemisia keiskeana* 5: 1; *Athyrium vidalii* 5: +; *Asarum sieboldii* 6: +; *Deutzia uniflora* E_2 8: 2; *Rhododendron micranthum* E_2 8: 2; *Lilium lancifolium* 8: +; *Tripterygium regelii* E_2 8: +; *Lysimachia barystachys* 8: r; *Rubus oldhami* 8: r; *Betula costata* E_2 9: 2; *Rhododendron mucronulatum* E_2 9: 2; *Melampyrum roseum* 9: +;
E_0: *Hyophila propagulifera* 1: 2; *Pogonatum urnigerum* 1: 2; *Plagiothecium cavifolium* 1: 1; *Oncophorus virens* 2: +; *Pogonatum inflexum* 3: 3; *Bryum* sp. 4: 1; *Brachythecium buchananii* 4: +; *Stereocaulon coralloides* 5: 2; *Hyophila involuta* 5: +; *Cynodontium polycarpum* 7: +; *Orthotrichum* sp. 7: +; *Plicanthus birmensis* 8: +.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

1, JK, 16, 540, N/85, 10, 25, 60, Jiri-san, above Jikjeonmaeul Village, rocky spring, 12. 6. 2006;
2, JK, 6.00, 693, N/80, 0, 20, 5, Jiri-san, Hansin Valley, above torrent, 13. 6. 2006;
3, JKS, 10.00, 571, NNE/85, 0, 20, 30, Gaya-san, Seoggye-dong Village, 11. 6. 2006;
4, K, 6.00, 505, NE/80, 0, 30, 2, Andong-Taebaek road, 2. 6. 2007;
5, V, 0.60, 665, W/90, 0, 5, 10, Gaya-san, Seoggye-dong Village, 11. 6. 2006;
6, JKS, 9.00, 295, E/90, 0, 30, 3, Worak-san, Deokjusa Valley, above temple, 20. 6. 2006;
7, JKS, 18.00, 297, NE/90, 0, 30, 3, Worak-san, Deokjusa Valley, rock above the stream, 20. 6. 2006;
8, K, 9.00, 290, NE/100, 20, 20, 10, Worak-san, Deokjusa Valley, rock above the stream, 20. 6. 2006;
9, KS, 15.00, 297, NE/85, 25, 25, 35, Worak-san, Deokjusa Valley, rock above the stream, 20. 6. 2006.

Table 6 *Lepisoro ussuriensis-Selaginelletum tamariscinae selaginelletosum rossii* subass. nova (rels 1–15), *artemisietosum gmelinii* subass. nova (rels 16–26). Column *N* contains percentual constancy of the association in North Korea (Kolbek et al. 1997: Table 5)

Relevé number	1	2	3	4	5	6	8	9	7	10	11	12	13	14	15		16	17	18	19	20	21	22	23	24	25	26			
Constancy (s1, s2, S, *N*) in total number of relevés (%)															**s1**													**s2**	**S**	***N***
Number of relevés															**15**													**11**	**26**	***9***
E_1 - Species of rock fissures																														
***Selaginella tamariscina* (A)**	**1**	**2**	**4**	**4**	**3**	**2**	**2**	**2**	**2**	**2**	**4**	**2**	**2**	**r**	**2**	**100**	**2**	**3**	**3**	**2**	**3**	**+**	**2**	**3**	**1**	**4**	**5**	**100**	**100**	***10***
***Lepisorus ussuriensis* (A)**	+	.	+	+	.	.	.	.	.	.	+	.	.	1		**33**	.	.	.	.	.	.	.	.	.	.	.	–	**19**	***67***
***Sedum ussuriense* (dS)**	.	1	+	.	.	r	r	.	+	1	.	+	1	.	.	**53**	.	.	.	.	.	.	.	.	.	.	.	–	**31**	**–**
***Selaginella rossii* (dS)**	.	.	1	2	2	2	2	2	2	2	.	.	.	.	.	**53**	.	.	.	.	.	.	.	.	.	.	.	–	**31**	**–**
***Dryopteris saxifraga* (dS)**	2	.	.	.	.	r	.	.	.	.	+	+	.	.	r	**33**	.	.	.	.	.	.	.	.	+	.	.	9	**23**	**–**
***Potentilla fragarioides* (dS)**	1	.	.	+	.	+	.	.	+	.	.	.	.	.	.	**27**	.	.	.	.	.	.	.	.	.	.	.	–	**15**	**–**
***Woodsia manchuriensis* (dS)**	.	.	.	.	.	.	r	2	.	r	.	1	.	.	.	**27**	.	.	.	.	.	.	.	.	.	.	.	–	**15**	**–**
***Artemisia gmelinii* (dS)**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	2	.	.	r	.	+	+	.	+	.	45	**19**	**–**
***Spiraea pubescens* juv. (dS)**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	+	.	+	.	1	+	r	.	.	45	**19**	**–**
***Mukdenia rossii* (dS)**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	+	1	r	2	.	.	.	.	.	.	.	36	**15**	***56***
***Camptosorus sibiricus* (dS)**	.	.	.	.	.	.	.	.	.	.	+	.	.	.	r	**13**	.	.	r	.	.	r	1	.	.	2	.	36	**23**	**–**
Amitostigma gracile	+	.	r	+	.	+	+	.	+	.	+	.	.	.	.	**47**	.	.	+	.	.	.	.	1	.	+	.	27	**38**	*11*
Sedum kamtschaticum	.	.	+	+	.	r	r	.	+	r	.	.	2	.		**47**	.	+	r	+	2	1	r	r	2	1	+	91	**65**	–
Dennstaedtia hirsuta	+	.	.	.	.	+	.	.	r	+	+	.	+	.	.	**40**	.	r	.	.	.	.	.	.	1	.	.	18	**31**	*22*
Woodsia polystichoides	+	.	.	.	.	.	r	.	.	.	.	+	.	+		**27**	.	.	+	.	.	.	.	.	.	.	.	9	**19**	–
Sedum polytrichoides	.	.	.	.	.	r	.	.	.	.	.	.	2	1		**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	–
Saxifraga fortunaei	2	.	.	.	.	.	.	.	.	1	.	.	.	.		**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Pyrrosia linearifolia	.	+	.	.	r	.	.	.	.	.	.	.	.	.		**13**	2	.	.	.	.	.	.	.	.	1	.	18	**15**	–
Davallia mariesii	.	.	+	.	.	.	+	.	.	.	.	.	.	.		**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Chrysanthemum zawadskii agg.	.	.	.	.	+	.	.	.	.	.	.	.	1	.		**13**	.	+	.	.	.	.	.	+	.	.	.	18	**15**	–
Microlepia wilfordii	.	r	.	.	.	.	.	.	.	.	.	.	.	.		**7**	.	.	.	.	.	.	.	.	.	.	.	–	**4**	–
Woodsia subcordata	.	.	.	+	.	.	.	.	.	.	.	.	.	.		**7**	.	.	.	.	.	.	.	.	.	.	.	–	**4**	–
Potentilla dickinsii	.	.	.	.	+	.	.	.	.	.	.	.	.	.		**7**	.	.	.	.	.	.	.	.	.	.	.	–	**4**	–
Woodsia glabella	.	.	.	.	r	.	.	.	.	.	.	.	.	.		**7**	.	.	.	.	.	.	.	.	.	.	.	–	**4**	–
Dryopteris subtripinata	.	.	.	.	.	.	.	.	.	.	+	.	.	.		**7**	.	.	.	1	.	.	.	.	.	.	.	9	**8**	–
Selaginella helvetica	.	.	.	.	.	.	.	.	.	.	+	.	.	.		**7**	.	.	.	.	.	.	.	.	.	.	.	–	**4**	–
Crypsinus hastatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.		**–**	.	.	.	.	.	3	.	.	.	+	.	18	**8**	–
Pyrrosia petiolosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.		**–**	2	.	.	.	.	.	.	.	.	.	.	9	**4**	*22*
Sedum sarmentosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.		**–**	.	.	.	.	+	.	.	.	.	.	.	9	**4**	–
Cheilanthes argentea	.	.	.	.	.	.	.	.	.	.	.	.	.	.		**–**	.	.	.	.	.	.	.	.	.	+	.	–	**4**	–
Orostachys cf. *erubescens*	.	.	.	.	.	.	.	.	.	.	.	.	.	.		**–**	.	.	.	.	.	.	.	.	.	.	r	9	**4**	*22*
Other species																														
E_2																														
Spiraea fritschiana	2	.	2	2	.	.	.	.	.	.	2	.	.	.	.	**27**	.	.	.	.	2	.	.	.	.	1	2	27	**27**	–
Fraxinus sieboldiana	+	.	.	1	.	+	.	.	+	.	.	.	.	.	.	**27**	.	.	.	.	.	.	.	.	.	.	.	–	**15**	–
Deutzia glabrata	.	.	.	1	.	+	.	.	.	.	1	.	.	.	.	**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	–
Rhododendron mucronulatum	.	.	.	.	.	.	+	.	1	.	1	.	.	.	.	**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	*33*
Spiraea blumei	.	.	.	.	.	2	.	.	1	.	.	.	.	.	.	**13**	.	1	.	.	.	.	.	1	.	.	.	18	**15**	–
Lespedeza bicolor	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	**13**	.	.	.	.	.	.	.	2	.	.	.	9	**12**	–
Fraxinus rhynchophylla	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Securinega suffruticosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	.	1	.	.	.	.	.	1	18	**8**	–
Rhus javanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	.	+	.	.	1	.	.	1	27	**12**	–
E_1																														
Carex lanceolata agg.	.	+	+	+	.	+	+	+	+	.	.	r	.	r	.	**60**	.	+	+	r	.	.	.	.	.	.	.	27	**46**	*56*
Rhododendron mucronulatum juv.	r	.	r	r	.	+	+	r	r	.	.	.	.	.	r	**53**	.	.	.	.	.	.	.	.	.	.	.	–	**31**	*33*
Calamagrostis arundinacea	1	.	.	.	1	.	r	.	.	+	1	.	+	.	+	**47**	.	+	+	+	.	.	.	.	.	+	+	45	**46**	–
Boehmeria spicata	.	.	.	1	.	+	+	.	r	1	.	+	+	.	.	**47**	.	.	1	.	+	+	2	+	1	.	.	55	**50**	–
Carex ciliato-marginata	1	.	.	1	.	+	.	.	+	r	1	.	.	.	.	**40**	.	.	2	.	.	.	.	.	.	.	.	9	**27**	–
Spodiopogon sibiricus	.	.	.	.	.	r	+	1	1	.	.	.	.	+	.	**33**	.	.	.	.	.	.	.	.	1	.	.	9	**23**	–
Arundinella hirta	.	+	.	1	.	+	.	.	.	.	.	.	.	+	.	**27**	.	+	.	.	1	.	.	1	1	.	.	36	**31**	–
Spiraea blumei juv.	.	.	.	.	.	+	.	r	.	r	.	.	.	.	+	**27**	+	+	.	.	.	.	.	.	+	.	.	27	**27**	–
Solidago virgaurea var. *asiatica*	+	.	.	.	r	.	.	.	.	.	r	.	.	.	.	**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	–
Silene cf. *oliganthella*	.	+	.	.	.	.	.	+	.	.	.	.	r	.	.	**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	–
Fraxinus rhynchophylla juv.	.	.	.	r	.	r	.	r	.	.	.	.	.	.	.	**20**	.	.	+	r	.	.	.	.	.	.	.	18	**19**	–
Fraxinus sieboldiana juv.	.	.	.	.	.	.	r	.	.	r	r	.	.	.	.	**20**	.	.	.	.	.	.	.	.	.	.	.	–	**12**	–
Viola acuminata	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Hieracium umbellatum	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Parthenocissus tricuspidata	.	2	.	.	.	.	.	.	.	1	.	.	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Aster pekinensis	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Poa nemoralis	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Artemisia keiskeana	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Weigela florida juv.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	**13**	.	.	.	.	.	.	.	.	.	.	.	–	**8**	–
Chrysanthemum boreale	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**7**	.	.	+	.	.	.	.	.	.	.	2	18	**12**	–
Spiraea fritschiana juv.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	**7**	.	.	.	.	.	.	.	.	.	+	.	9	**8**	–
Melampyrum roseum	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	**7**	.	.	.	.	.	.	.	.	.	r	.	9	**8**	*11*
Lespedeza bicolor juv.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	**7**	.	.	.	.	.	.	.	+	.	.	.	9	**8**	–
Lespedeza maximowiczii juv.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	**7**	.	.	.	.	r	.	.	.	.	.	+	18	**12**	–
Setaria viridis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	**7**	.	.	.	.	.	.	.	.	1	.	.	9	**8**	–
Commelina communis	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	**7**	.	.	.	.	.	.	.	.	r	.	.	9	**8**	–
Viola variegata	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	**7**	.	.	.	.	r	.	.	.	.	.	.	9	**8**	–
Artemisia capillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	+	+	.	.	.	.	.	.	1	.	.	27	**12**	–
Rhus javanica juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	.	+	.	.	r	.	.	+	27	**12**	–
Deutzia glabrata juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	+	.	+	.	.	.	.	.	18	**8**	–
Lactuca indica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	+	.	r	.	.	.	.	.	18	**8**	–
Lilium amabile	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	.	r	.	.	+	.	.	.	18	**8**	–
Thymus quinquecostatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**–**	.	.	.	.	.	.	.	.	+	.	+	18	**8**	–

Table 6 (continued)

E_0																														
Hypnum plumaeforme	4	1	.	2	.	3	.	.	.	.	3	.	.	.	.	33	.	.	.	.	.	.	.	.	.	.	.	–	19	*
Schistidium apocarpum	.	.	.	.	.	.	2	+	.	.	.	.	.	1	1	27	.	+	.	.	.	.	.	.	.	.	.	9	19	+
Tortella tortuosa	.	.	.	.	.	+	+	.	.	.	.	.	2	.	.	20	2	.	2	2	.	.	1	2	1	.	.	55	35	*
Macromitrium gymnostomum	.	.	.	.	.	.	.	+	2	2	.	.	.	.	.	20	.	.	.	.	.	.	.	.	.	.	.	–	12	*
Pogonatum urnigerum	2	.	.	.	.	.	.	+	.	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Meteorium buchananii	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Pohlia nutans	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	13	.	.	2	2	.	.	.	.	.	.	.	18	15	*
Cladonia sp.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	13	.	.	.	.	.	.	.	+	.	.	.	9	12	*
Racomitrium sudeticum	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Lejeunea rotundistipula	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Weissia controversa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	13	.	.	.	.	.	.	.	.	.	.	.	–	8	+
Haplohymenium longinerve	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Leucobryum glaucum	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	13	.	.	.	.	.	.	.	.	.	.	.	–	8	+
Trachycystis ussuriensis	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Bryum sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	13	.	.	.	.	.	.	.	.	.	.	.	–	8	*
Hypnum cupressiforme	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	7	2	1	.	.	.	.	.	+	.	.	.	27	15	*
Campylium chrysophyllum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	7	.	.	1	+	.	.	.	.	.	.	.	18	12	*
Campylopus japonicus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	7	.	.	.	.	.	.	.	1	.	.	.	9	8	*
Brachythecium populeum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	7	.	.	.	.	.	2	.	.	.	.	.	9	8	*
Plagiomnium cuspidatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	1	+	2	2	.	.	.	.	.	36	15	*
Thuidium kanadae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	1	+	18	8	*

In one relevé only

$E_1 + E_2$: *Taraxacum coreanum* 1: +; *Carpinus laxiflora* E_2 1: +; *Atractylodes ovata* 1: r; *Euonymus alata* juv. 1: r; *Salix gracilistyla* E_2 1: r; *Benzoin obtusilobum* E_2 3: 1; *Weigela florida* E_2 3: 1; *Euonymus alata* E_2 3: +; *Lilium cernuum* 3: r; *Spiraea media* 4: 1; *Oplismenus undulatifolius* 5: +; *Betula schmidtii* juv. 8: r; *Peucedanum terebintaceum* 9: r; *Pinus densiflora* juv. 10: r; *Acer ginnala* juv. 11: +; *Isodon inflexus* 11: r; *Deutzia* sp. juv. 12: r; *Carpinus laxiflora* juv. 12: r; *Astilbe chinensis* agg. 13: r; *Deutzia uniflora* juv. 15: r; *Themeda japonica* 17: 1; *Isodon japonicus* 17: +; *Agropyron *transiens* 18: +; *Lilium lancifolium* 18: +; *Bidens tripartita* 18: r; *Lonicera japonica* juv. 20: +; *Securinega suffruticosa* juv. 20: +; *Androsace umbellata* 20: r; *Aster scaber* 21: r; *Cardamine flexuosa* 21: r; *Indigofera kirilowii* E_2 23: 1; *Festuca ovina* 23: +; *Rhaponticum uniflorum* 23: r; *Allium macrostemon* 24: +; *Euphorbia sieboldiana* 24: +; *Poa compressa* 24: +; *Ligustrum obtusifolium* E_2 25: 1; *Pycnostelma paniculata* 25: +; *Paraixeris denticulata* 25: r;
E_0: *Grimmia* sp. 1: 1; *Hyophila acutifolia* 4: +; *Macromitrium hymenostomum* 5: 3; *Grimmia affinis* 5: 2; *Leucodon sciuroides* 5: 1; *Barbula convoluta* 6: +; *Collema undulatum* 9: +; *Cladonia gracilis* 10: +; *Ramalina* sp. 10: +; *Pohlia longicollis* 11: 2; *Polytrichum formosum* 11: 1; *Oncophorus crispifolius* 11: +; *Plagiothecium denticulatum* 11: +; *Trichostomum crispulum* 12: 1; *Hedwigia ciliata* 14: +; *Lescuraea mutabilis* 15: 3; *Brachythecium buchananii* 15: 2; *Crepidomanes minutum* 15: +; *Nostoc* sp. 16: 2; *Encalypta rhaptocarpa* 17: +; *Anomodon giraldii* 20: 2; *Oncophorus virens* 20: 2; *Atrichum undullatum* 23: +; *Marchantia polymorpha* 23: +.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Lepisoro ussuriensis-Selaginelletum tamariscinae selaginelletosum rossii
1, JK, 8.00, 376, N/15, 10, 35, 75, Juwang., Jeoulgol Valley, 6. 6. 2006;
2, JK, 25, 337, SE/90, 0, 25, 20, Juwang, Jeoulgol Valley, 6. 6. 2006;
3, JKS, 12.50, 349, WSW/93, 15, 60, 50, Juwang., Jeoulgol Valley, 6. 6. 2006;
4, JS, 9.00, 358, -/-, 15, 70, 30, Juwang, Jeoulgol Valley, granodiorite rocky shelves, 6. 6. 2006;
5, JKS, 16.00, 361, N/85, 0, 40, 40, Juwang, narrow gorge, granodiorite, 4. 6. 2006;
6, KV, 12.00, 341, WNW/85, 25, 45, 35, Juwang, Jeoulgol Valley, rocky overhang 6. 6. 2006;
7, KV, 25.00, 377, NE/80, 2, 30, 10, Juwang., rock above stream, 4. 6. 2006;
8, KV, 8.00, 375, W/100 (overhang), 0, 20, 3, Juwang, above waterfall, 4. 6. 2006;
9, KV, 20.00, 319, ENE/80, 5, 20, 10, Juwang, below waterfall, 4. 6. 2006;
10, KV, 12.00, 319, W/80, 0, 30, 10, Juwang, near stream, 4. 6. 2006;
11, JK, 12.00, 363, WSW/85, 25, 60, 65, Juwang, Jeoulgol valley, 6. 6. 2006
12, KV, 12.00, 334, N/110 (overhang), 0, 20, 3, Juwang, Jeoulgol Valley, rocky overhang, 6. 6. 2006;
13, KV, 10.00, 349, NE/90, 0, 20, 15, Juwang, Jeoulgol Valley, 6. 6. 2006;
14, KV, 30.00, 348, S/40, 0, 10, 3, Juwang, Jeoulgol Valley, rock crest, 6. 6. 2006;
15, JKS, 3.00, 344, S/85, 0, 15, 70, Donghae, Mureung-Valley, direction to Chongoksan, Twin waterfalls, granite, 30. 5. 2007;

Lepisoro ussuriensis-Selaginelletum tamariscinae artemisietosum gmelinii
16, JK, 7.00, 209, NE/90, 0, 30, 25, Andong surrounding, dolomite rocky edge, 2. 6. 2007;
17, JK, 12.00, 207, E/40, 5, 40, 3, Andong surrounding, dolomite rocks over river, 2. 6. 2007;
18, KV, 15.00, 159, N/85, 0, 50, 25, Andong, Gounsa Temple, ca 1 km from temple, 19. 6. 2006;
19, KV, 10.00, 165, N/90, 0, 25, 10, Andong, Gounsa Temple, ca 1 km from temple, 19. 6. 2006;
20, KV, 8.00, 171, NE/60, 15, 40, 45, Andong, Gounsa Temple, ca 1 km from temple, 19. 6. 2006;
21, KV, 1.50, 135, E/90, 0, 30, 10, Andong, Gounsa Temple, ca 13 km from city, rock above the creek, 19. 6. 2006;
22, KV, 4.00, 109, NE/90, 0, 35, 3, Andong, rock terrace above the road, 19. 6. 2006;
23, JKVS, 12.00, 107, NNW/85, 25, 40, 10, Andong surrounding, Amsan, near rock gate, 5. 6. 2006;
24, JK, 10.00, 115, W/80, 0, 20, 3, Amsan Mts., rock along the road, 5. 6. 2006;
25, J, 6.00, 171, N/90, 5, 70, 15, Andong, Gounsa Temple, ca 1 km from temple, 19. 6. 2006;
26, J, 8.00, 128, E/80, 10, 90, 3, Andong, Gounsa Temple, ca 1 km from temple, 19. 6. 2006.

herb layer is *Selaginella tamariscina* (Fig. 2c), sometimes *Selaginella rossii* and *Sedum kamtschaticum* (see Table 6). The herb layer coverage varies from 10 to 90%, with an average of 26 recorded relevés of approximately 37%. The shrub layer was found in about half of the studied stands. Its coverage ranges there from 0(5) to 25% (on average cca 6%). Not more than 5 species were found in one relevé; on average, slightly more than 1 species in the relevé. The more common

Table 7 *Astilbo chinensis-Chrysosplenietum flagelliferi* ass. nova

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
Constancy (S) in total number of relevés (%)								**S**
E_1 - Species of rock fissures								
***Chrysosplenium flagelliferum* (A)**	**3**	**3**	**3**	**3**	**2**	**3**	**4**	**100**
***Astilbe chinensis* agg.(A)**	**2**	**2**	**.**	**+**	**2**	**2**	**2**	**86**
***Angelica polymorpha* (A)**	**+**	**2**	**.**	**.**	**.**	**+**	**.**	**43**
Boehmeria spicata	.	+	r	r	.	.	.	43
Deutzia uniflora juv.	.	+	.	+	.	.	r	43
*Hydrangea *acuminata*	r	.	.	1	.	.	.	29
Taraxacum sp.	.	.	r	.	r	.	.	29
E_0								
Plagiomnium cuspidatum	.	.	.	2	3	4	4	57
Rhizomnium punctatum	3	.	2	.	2	.	.	43
Conocephalum conicum	+	.	.	.	.	2	.	29
Atrichum undulatum	+	.	.	.	.	.	2	29
Brachythecium rutabulum	.	2	2	.	.	.	.	29
Plagiomnium affine	.	3	.	2	.	.	.	29

In one relevé only
E_1: *Carex erythrobasis* 1: +; *Rhododendron yedoense* juv. 1: +; *Zelkova serrata* 1: +; *Thalictrum tuberiferum* 1: r; *Impatiens textori* 2: 2; *Carex ciliato-marginata* 2: +; *Adiantum capillus-veneris* 2: r; *Impatiens noli-tangere* 2: r; *Corydalis* sp. 3: +; *Erigeron annuus* 3: +; *Hosta longipes* 3: +; *Poa nemoralis* 3: r; *Solidago *asiatica* 3: r; *Asparagus schoberioides* 5: +; *Deutzia prunifolia* juv. 5: r; *Calamagrostis arundinacea* 6: r; *Carex* sp. 7: 1; *Sorbaria stellipila* juv. 7: +; *Lastrea japonica* 7: r; **E_0:** *Brachythecium populeum* 1: 2; *Hypnum plumaeforme* 1: 2; *Trachycystis microphylla* 1: 1; *Bryum* sp. 2: 2; *Chiloscyphus polyanthus* 2: 2; *Homomallium connexum* 3: 1; *Rhizogonium dozyanum* 3: 1; *Brachythecium brotheri* 4: 4; *Bryhnia novae-angliae* 5: 2.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

1, JK, 6.00, 520, NNE/30, 0, 50, 50, Jiri-san, Piagol Valley, 1 km above Jikjeonmaeul Village, rocky spring, 12. 6. 2006;
2, KV, 3.50, 290, N/40, 0, 75, 70, Juwang-san, near complex of temples, moist rocks, 4. 6. 2006;
3, K, 2.00, 485, E/75, 0, 30, 40, Sobaek-san, Jukgye Valley, wet rocks near rivulet, 2. 6. 2006;
4, JK, 3.00, 713, WSW/35, 0, 35, 90, Jiri-san, Hansin Valley, wet rocks around rivulet, 13. 6. 2006;
5, KS, 2.00, 517, S/45, 0, 20, 80, Sobaek-san, Jukgye Valley, wet rocks near rivulet, 2. 6. 2006;
6, KV, 2.00, 340, N/85, 0, 55, 90, Juwang-san, Jeolgol Valley, 6. 6. 2006;
7, J, 10.00, 554, ESE/35, 0, 75, 60, Odae-san, Sogeumgang Valley, near the Kwangpokpo Waterfall, wet scree, 25. 6. 2006.

species was *Spiraea fritschiana*. A total of 14 species was found in the shrub layer. The presence of the shrub layer is not important for the association or both subassociations.

In the moss layer, 45 species were found in total (on average more than 2 species). The highest constancy was achieved only by *Hypnum plumaeforme* and *Tortella tortuosa*. The coverage of the moss layer in the studied stands ranged from 3 to 75% (on average, approx. 23%).

The stands were recorded at altitudes of 107 to 377 m (on average 266 m), in various orientations, with a slight predominance in the north and very various slopes (0)15–110° (overhang), almost 77° on average.

Lepisoro ussuriensis-Selaginelletum tamariscinae selaginelletosum rossii subass. nova hoc loco

Nomenclatural type: relevé 3 in Table 6, (holotypus)
Differential species: *Dryopteris saxifraga*, *Potentilla fragarioides*, *Sedum ussuriense*, *Selaginella rossii*, *Woodsia manchuriensis*

In this subassociation, two cushioned plant species of *Selaginella rossii* and *Sedum ussuriense* greatly predominate and visually distinguish it (Fig. 2d). The cover of the herb layer varies from 10 to 60%, with an average of approximately 33%. In total, 62 species were found there (on average 12 species in one relevé). The shrub layer is present in only half relevés with low abundances from 0(2) to 25% (on average cca 6%). A total of 11 species were found (on average cca 1 species in relevé). The moss layer has the wide range of cover. The lowest values reach only a few percent; however, the average of cover is less than 30%. In this subassociation, 37 species in the moss layer were found (on average less than 3 species per relevé).

Stands of the community were found at an altitude of 319 to 377 m (on average cca 350 m) with very variable orientation. The geological background consists only of silicate rocks (granites and granodiorites); we did not find this community on other rocks in Korea. The slope of the habitat is highly variable, but overwhelmingly on steep cliffs or even

overhangs (mostly 80–110°, on average cca 75°). In one case, the stand was recorded on a plain. This community was found in the Juwang-san and sporadically in the Mureung-Valley.

Lepisoro ussuriensis-Selaginelletum tamariscinae artemisietosum gmelinii subass. nova hoc loco

Nomenclatural type: relevé 17 in Table 6, (holotypus)
Differential species: *Artemisia gmelinii*, *Camptosorus sibiricus*, *Mukdenia rossii*, *Spiraea pubescens*

In this subassociation, no differential species of the previous subassociation were found. Four species of herb layer form a differential group. The greatest constancy is achieved by *Artemisia gmelinii* and *Spiraea pubescens*. The cover of the herb layer fluctuates between 20 and 90% (an average of nearly 43% in the recorded relevés). A total of 56 species were found in this layer (on average approx. 7 species). A total of 7 species were detected on the shrub layer (averaging only 1 species per relevé). This layer was recorded in only 5 relevés. Its cover was on average less than 6% in a range between 0 and 25% in stands of the subassociation. In the moss layer, only 16 species were found, on average less than 2 species. Their cover varies between 3 and 45%, less than 14% in the relevé. Stands of the subassociation have a fewer species than the previous ones.

The community was recorded at altitudes from 107 to 220 m (on average 152 m), mostly on slopes with northern orientation. The slope of the habitat ranged between (40)60 and 90°, on average 80°. The habitats were recorded on dolomite rocks, slates and granites in the vicinity of Andong city.

Astilbo chinensis-Chrysosplenietum flagelliferi ass. nova hoc loco

Nomenclatural type: relevé 6 in Table 7, (holotypus)
Association species: *Angelica polymorpha*, *Astilbe chinensis* agg., *Chrysosplenium flagelliferum*

Plant community occurring on moist to wet rocks with its occurrence on shaded boulders, rock walls and in the immediate vicinity of rivulets, brooks and smaller rivers. Dominant, characteristic and conspicuous taxon is yellow blooming *Chrysosplenium flagelliferum* with usually high coverage values. It is accompanied by other taxa that occur mostly in permanent shade or half-shade, such as *Astilbe chinensis* agg. (mostly as *Astilbe chinensis* var. *davidii*), *Angelica polymorpha*, *Boehmeria spicata* etc., which also occur in some forest communities (Table 7). The stands are particularly noticeable at the time of the dominant species flowering at the end of May and in June.

The community is very species-poor, with an average number of 6–7 species in the herb layer (from 4 to 9 species in relevé). In the seven recorded phytocoenological relevés, a total of 26 herb species were found. Although the community was found only in shady, humid, very moist to permanently wet habitats, the number of species in the moss layer is not too large. A total of 15 taxa of mosses were found with an average of 3–4 species in relevé. The most common species were *Plagiomnium cuspidatum* and *Rhizomnium punctatum*, which also reached the highest cover in the stands of this association. However, other species with lower constancy also achieve high coverage in individual stands (e.g., *Brachythecium rutabulum*, *Plagiomnium affine*). The highest coverage in one relevé was reached by species *Plagiomnium cuspidatum* and *Brachythecium brotheri*.

Stands of this community naturally lack a shrub layer, and the occurrence of trees is generally very low, just as seedlings or small individuals. The coverage of the herb layer varies between 20 and 75%, on average less than 49%. The coverage of the moss layer is slightly higher and ranges between 40 and 90%, on average almost 69%. Orientation is not important as with other rocky communities because the stands are often found in the dark shade of trees. The community forms open stands at habitats with an inclination of (30)35° to 85°, on average ca 49°. It therefore occurs on habitats with a lower slope than most other rock communities. The geological substrate is again granodiorite. For the development of the community, it is likely that higher air humidity and the presence of small droplets of water during the vegetation season affect the plants.

This association was found at altitudes of 290 to 713 m at various slope orientations. During our research of rock vegetation in the North Korea (1986–1990), the community was not found in this area (Kolbek et al. 1997, 1998). It is certainly possible, that we did not visit their sporadic occurrence on localities in the central part of the Peninsula. However, the low occurrence in North Korea (in one relevé only) of the species *Chrysosplenium flagelliferum* was recorded in the *Dryopterido saxifragae-Saxifragetum fortunaei* association (Kolbek et al. 1998: Tab. 3). The community is included in the order *Saxifragetalia fortunaei* and alliance *Saxifragion fortunaei* which includes chasmophytic vegetation on moist and wet rocky habitats. The species *Astilbe chinensis* is classified as a diagnostic taxon of this alliance and order.

Dryopterido saxifragae-Saxifragetum fortunaei Kolbek, Valachovič et Jarolímek 1998

This association was described and based on 43 relevés from the northern part of the Korean Peninsula. The phytocoenological material described was quite homogeneous and did not need to be classified into lower units (subassociations). Material from South Korea (Table 8), however, shows a possible classification into two subassociations. Floristic and ecological differences are sufficiently conclusive. The *Dryopterido-Saxifragetum* is a two- to three-layered shrub, herb and moss plant community. It occurs

Table 8 *Dryopterido saxifragae-Saxifragetum fortunaei caricetosum siderostictae* subass. nova (rels 1–8), *hydrangeetosum acuminatae* subass. nova (rels 9–22). Column *N* contains percentual constancy of the association in North Korea (Kolbek et al. 1998: Table 3)

Relevé number	**12345678**		**1111111111222 90123456789012**			
Constancy (s1, s2, S, *N*) in total number of relevés (%)		**s1**		**s2**	**S**	***N***
Number of relevés		**8**		**14**	**22**	**43**
E_1 – Species of rock fissures						
***Saxifraga fortunaei* (A)**	**32212222**	**100**	**2233223232+322**	**100**	**100**	***100***
***Dryopteris subtripinnata* (dS)**	**..21+...**	**38**	**..+.....**	7	**18**	***9***
***Carex siderosticta* (dS)**	**..r1..+.**	**38**	**.....**	–	**14**	***28***
***Heloniopsis orientalis* (dS)**	**..r++...**	**38**	**.....**	–	**14**	**–**
***Dryopteris saxifraga* (A)**	**.....1+**	**25**	**1+.+..1..+r.++**	**57**	**45**	***30***
***Sedum polytrichoides* (dS)**	.+.....	13	**....+.1.11++..**	**43**	**32**	***5***
***Hydrangea *acuminata* (dS)**	.....	–	**+1+.+.1..21.1+**	**64**	**41**	**–**
***Arisaema amurense* (dS)**	.....	–	**.+....+.+...++**	**36**	**23**	**–**
Woodsia manchuriensis	+.++r1..	63	.1.....1r221	43	50	*19*
Dennstaedtia hirsuta	.1.+...+	38	....1+.+..2.+.	36	36	*14*
Microlepia wilfordii	.+....+.	25	.....	–	9	–
Selaginella rossii	1.....	13	..+.....	7	4	*16*
Chrysanthemum zawadskii agg.	1.....	13	.....	–	4	*9*
Woodsia polystichoides	.1.....	13	.....	–	4	*16*
Chrysosplenium flagelliferum	.+.....	13	.....	–	4	*2*
Lepisorus ussuriensis	.....1..	13	...1..+.+.+...	29	23	*30*
Asplenium oligophlebium	......1.	13	.....	–	4	–
Mukdenia rossii	.......+	13	.....	–	4	*37*
Saxifraga oblongifolia	.....	–	.....1.....3	14	9	*14*
Amitostigma gracile	.....	–	..+.....	7	4	*9*
Crypsinus hastatus	.....	–	.....1.	7	4	–
Camptosorus sibiricus	.....	–	.....+.	7	4	*16*
E_2						
Rhododendron schlippenbachii	...21...	25	1.....1	14	18	–
Fraxinus sieboldiana	...2....	13	1.2...1..2...1	36	27	–
Deutzia uniflora	....2...	13	2.2..12.....2	36	27	–
Rhododendron mucronulatum	.....	–	1.1.....2....	21	14	–
Weigela florida	.....	–	2.....2....	14	9	–
Lespedeza bicolor	.....	–	..21.....	14	9	–
E_1						
Calamagrostis arundinacea	+.r++.++	75	r.r++...++..r.	50	59	7
Hosta longipes	1.231.1.	63	1.+.....	14	32	*2*
Deutzia uniflora juv.	.2..+r+1	63	...22+++11211+	79	73	–
Rhododendron mucronulatum juv.	.r++...r	50	...+..+..+....	21	32	*35*
Carex lanceolata agg.	..+++...	38	r.r.+..+1.....	36	36	–
Fraxinus rhynchophylla juv.	r.r.....	25	..+.....	7	14	*9*
Rhododendron schlippenbachii juv.	r.....+.	25	.....r+.....	14	18	*2*
Lastrea japonica	.+.r....	25	r+.+....+....1	36	32	–
Athyrium yokoscense	.+.r....	25	+.....+2.r....	29	27	–
Poa nemoralis	.+.....+	25	.....+.....	7	14	–
Stephanandra incisa	..1r....	25	.....	–	9	*2*
Hymenophyllum cf. *wrightii*	..2.2...	25	.....	–	9	–
Astilbe chinensis agg.	..1.+...	25	.+r....+1.....	29	27	*14*
Carex erythrobasis	...2r...	25	..r.....	7	14	–
Weigela florida juv.	r.....	13	...++.....	14	14	*5*
Thalictrum tuberiferum	.r.....	13	.r.....	7	9	–
*Solidago *asiatica*	.r.....	13	...+.....	7	9	*5*
Fraxinus sieboldiana juv.	...+....	13	.....r..r..	14	14	–
Asarum sieboldii	...r....	13	..1.....r....	14	14	–
Angelica polymorpha	....+...	13	....+.....	7	9	–
Paraixeris chelidoniifolia	.....	–	...1..1.1.....	21	14	–
Carpinus laxiflora juv.	.....	–	...+..rr.....	21	14	–

Table 8 (continued)

E_0						
Hypnum plumaeforme	44..2.1+	63	2.2..12.+5..1.	50	54	*
Racomitrium fasciculare	2.....1.	25	..33.....	14	18	+
Polytrichum formosum	1..1....	25	......2.....	7	14	*
Pogonatum urnigerum	.1.....2	25	...1.....	7	14	*
Dicranum japonicum	..2.1...	25	.....	-	9	*
Dichodontium pellucidum	..1.+...	25	.....	-	9	*
Gollania ruginosa	...3+...	25	.....	-	9	+
Racomitrium sudeticum	..1.....	13	....213.2++2.3	57	41	*
Dicranum scoparium	.....1..	13	..2.....	7	9	+
Campylopus japonicus	......3.	13	1.....4.....	14	14	*
Oncophorus virens	......1.	13	.....+1..	14	14	*
Dicranella heteromalla	......1.	13	.....1.....	7	9	*
Tortella tortuosa	1	13	.....+..	7	9	*
*Rhizomnium *elatum*	.....+	13	...1.....2	14	14	*
Thuidium kanedae	.....	-	.3...43.....2	29	18	+
Schistidium apocarpum	.....	-	1.....+....	14	9	*
Hyophila acutifolia	.....	-	.....+1..	14	9	*

In one relevé only

E_1 + E_2: *Prunus* sp. juv. 2: r; *Micromeles alnifolia* juv. 3: 2; *Deutzia glabrata* juv. 3: 1; *Acer pseudosieboldianum* E_2 4: 1; *Melica nutans* 6: +; *Carex ciliato-marginata* 7: 1; *Rhododendron yedoense* juv. 7: +; *Gentiana axillariflora* 7: r; *Carex okamotoi* 9: +; *Rhus javanica* E_2 9: +; *Phegopteris polypodioides* 10: 1; *Lycopodium serratum* 10: +; *Polystichum tripteron* 10: +; *Saussurea grandiflora* 10: +; *Betula schmidtii* E_2 11: 1; *Hypericum* sp. 12: +; *Melampyrum roseum* 12: +; *Oplismenus undulatifolius* 12: +; *Tripterygium regelii* juv. 12: +; *Alnus mandshurica* juv. 12: r; *Aster scaber* 13: +; *Trigonotis icumae* 13: +; *Oxalis obtriangulata* 13: r; *Sanguisorba hakusanensis* 13: r; *Veronica* sp. 13: r; *Acer mono* juv. 15: r; *Aruncus americanus* 16: +; *Lespedeza bicolor* juv. 17: r; *Boehmeria spicata* 18: 1; *Stellaria media* 19: +; *Rubia akane* 19: r; *Magnolia sieboldii* E_2 21: 1; *Benzoin obtusilobum* juv. 21: +;

E_0: *Dicranodontium denudatum* 1: 2; *Haplocladium strictum* 2: 3; *Plagiomnium cuspidatum* 2: 2; *Jungermannia infusca* 4: 2; *Leucobryum glaucum* 4: 1; *Campylium chrysophyllum* 5: 1; *Myurella sibirica* 6: 3; *Plagiothecium denticulatum* 6: 2; *Brotherella henonii* 6: 1; *Grimmia atrata* 6: 1; *Hypnum cupressiforme* 6: +; *Glossadelphus ogotae* 7: 1; *Atrichum undulatum* 8: 2; *A. rhystophylum* (= *A. agustatum*) 8: 1; *Brachythecium buchananii* 8: 1; *Mnium laevinerve* 10: 2; *Plagiothecium cavifolium* 10: 2; *Brachythecium populeum* 10: 1; *Cirriphyllum piliferum* 10: 1; *Marchantia polymorpha* 10: 1; *Marsupella *tubulosa* 11: 1; *Herbertus aduncus* 11: +; *Jungermannia pyriflora* 12: 2; *Entodon challengeri* 13: 3; *Pohlia longicollis* 13: 2; *Jungermannia infusca* 16: 1; *J. pyriflora* 16: 1; *Chilosciphus polyanthus* 16: +; *Pohlia longirostris* 16: +; *Scapania parvidens* 17: 2; *Thamnobryum alopecurum* 19: 1; *Bryoxiphium norvegicum* 21: 2; *Dipyscium foliosum* 21: 2; *Pohlia nutans* 21: 1; *Oligotrichum paralelum* 22: 1.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Dryopterido saxifragae-Saxifragetum fortunaei caricetosum siderostictae

1, JK, 15.00, 622, NW/25, 0, 50, 75, Bonghwa, Baekcheon Valley, granite rock, 24. 5. 2007;
2, J, 8.00, 425, N/85, 0, 30, 90, Odae-san, Sogeumgang Valley, schistose fissured rock, 25. 6. 2006;
3, JK, 6.00, 664, N/80, 0, 50, 15, Deogyu-san, Hwanggol Valley, granite rock, 9. 6. 2006;
4, JK, 9.00, 678, N/70, 20, 50, 40, Deogyu-san, Hwanggol Valley, granodiorite fissured rock, 9. 6. 2006;
5, JK, 9.00, 664, N/10, 15, 45, 20, Deogyu-san, Hwanggol Valley, NW from Muryong-san, wet rock, 9. 6. 2006;
6, J, 7.50, 1067, N/85, 0, 25, 60, Deogyu-san, Baekryeonsa Temple, rock above stream, 8. 6. 2006;
7, J, 6.00, 542, N/85, 0, 30, 50, Gaya-san, Haeinsa Temple, 10. 6. 2006;
8, V, 0.25, 339, NNW/45, 0, 15, 35, Odae-san, Sogeumgang Valley, below Guryongpokpo Waterfall, 25. 6. 2006;

Dryopterido saxifragae-Saxifragetum fortunaei hydrangeetosum acuminatae

9, JK, 15.00, 611, N/85, 30, 15, 20, Deogyu-san, Anseong Valley, rock above stream, 9. 6. 2006;
10, JK, 6.00, 1126, NNW/85, 0, 30, 40, Deogyu-san, near path towards Osujagul Cave, crack rocks near stream, 8. 6. 2006;
11, JKS, 6.00, 734, NNW/100, 50, 35, 60, Jiri-san, Hansin Valley, 13. 6. 2006;
12, JKS, 9.00, 769, N/75, 5, 40, 60, Jiri-san, Hansin Valley, fissured rock, 13. 6. 2006;
13, J, 8.00, 1175, WSW/80, 0, 25, 50, Jiri-san, Nogodan, towards Hwaeomsa Temple, 16. 6. 2006;
14, J, 12.00, 1049, NNW/100, 5, 15, 70, Jiri-san, Baemsagol Valley, below cottage, granite boulder, 14. 6. 2006;
15, J, 8.00, 857, WNW/80, 10, 40, 90, Jiri-san, Baemsagol Valley, upper part of valley, granite wall, 14. 6. 2006;
16, J, 8.00, 714, -/-, 0, 20, 10, Jiri-san, Hansin Valley, 13. 6. 2006;
17, JK, 18.00, 745, W/80, 0, 40, 85, Jiri-san, Hansin Valley, granodiorite rock, 13. 6. 2006;
18, K, 8.00, 500, ENE/90, 25, 20, 80, Jiri-san, Baemsagol Valley, above Park Office, granite block, 14. 6. 2006;
19, JK, 12.00, 1186, WSW/75, 0, 15, 3, Jiri-san, ca 5 km above Hwaeomsa Temple, 1.5 km from Nogodan, granite boulder in the forest, 16. 6. 2006;
20, JK, 3.00, 1114, SSW/85, 0, 30, 25, Jiri-san, ca 5 km above Hwaeomsa Temple, shady rock, 16. 6. 2006;
21, JK, 15.00, 565, ENE/100, 5, 20, 10, Jiri-san, Piagol Trail Course, above Jikjeonmaeul Village, large boulder, 12. 6. 2006;
22, J, 6.00, 819, NW/85, 10, 45, 50, Jiri-san, Hansin Valley, 13. 6. 2006.

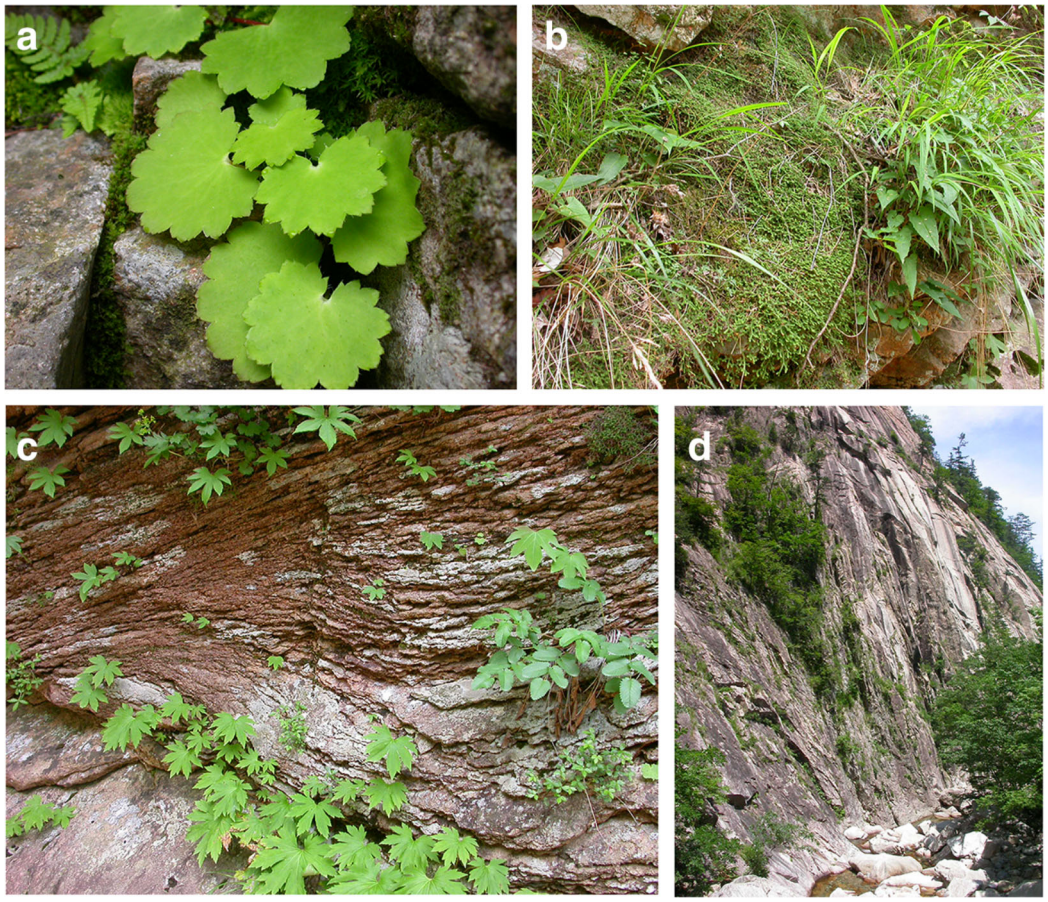

Fig. 3 Communities of shady, moist and wet rocks in the colline and montane belts in Korean Peninsula. **a** *Saxifraga fortunaei* and *Dryopteris saxifraga* prefere shady rocks with the northern orientation. **b** The *Selaginella rossii* and *Mukdenia rossii* with the occurrence of *Saussurea nivea* and *Carex lanceolata* agg. **c** A typical stand of the *Patrinio saniculaefoliae-Mukdenietum rossii*. **d** On steep slopes, a bare rock substrate can predominate, and plants have roots in crevices

on rock walls with predominantly northern, rarely eastern orientation at altitudes ranging from 339 to 1186 m (on average 771 m). The geological base consists mainly of schistose, granite or granodiorite fissured rock or large granite boulders, mostly in locations with higher air humidity, such as the valleys of streams and rivers. Although the slope of the habitat is very variable (from (10)25° to 100° in the overhang), it has a high slope with an average of 73°.

In South Korea, the number of species of herb and shrub layers fluctuates from 5 to 19 species, on average less than 12 species in the relevé. The cover of the shrub layer varies from 0 to (30)50% and reaches an average of just 8%. The herb layer varies from 15 to 50% cover, on average 31%. The total cover moss layer is larger (3–90%, on average more than 47%), but it contributes to fewer species (3–7 only, on average more than 4 species). In the stands of North Korea, also *Brachythecium buchananii*, *Gollania ruginosa*, *Racomitrium fasciculare*, and *Thuidium kanedae* were also identified.

Within the association two subassociations were distinguished.

Dryopterido saxifragae-Saxifragetum fortunaei caricetosum siderostictae subass. nova hoc loco

Nomenclatural type: relevé 7 in Table 8, (holotypus)
Differential species: *Carex siderosticta*, *Dryopteris subtripinnata*, *Heloniopsis orientalis*

Usually two-layered, more rarely three-layered plant community on granite, granodiorite and schistose fissured rocks or rocky walls with predominantly northern orientation. Stands of this subassociation were found at altitudes from 339 to 1067 m, mostly on the northern orientation. The slope of habitat varies ranging from (10)25° to 85°, on average more than 60°. In addition to the association species *Saxifraga fortunaei* and *Dryopteris saxifraga* (Fig. 3a), species *Carex siderosticta*, *Heloniopsis orientalis* and *Dryopteris subtripinnata* are differential. Other species with high constancy are *Woodsia manchuriensis*, *Hosta longipes* and generally common *Calamagrostis arundinacea*, *Deutzia uniflora* juv., *Rhododendron mucronulatum* juv., and *Carex lanceolata*

agg. The cover of the herb layer varies from 15 to 50%, on average almost 37%. In one relevé, 5–19 species of the herb and shrub layer were found (on average fewer than 12 species). Shrub layer is usually absent, rarely reaches 20% with an average of barely 5%. The most common species was here *Rhododendron schlippenbachii*. A total of 47 species of herb and shrub layers were found.

In the moss layer, 37 species were found in the relevés (average less than 5), with a high average cover of 48% (15–90%). In total, 11 taxa were found with a higher dominance of *Hypnum plumaeforme* and *Gollania ruginosa*. The most common species are *Hypnum plumaeforme*, *Racomitrium fasciculare*, *Polytrichum formosum*, *Pogonatum urnigerum*, *Dicranum japonicum*, *Dichodontium pellucidum*, and *Gollania ruginosa*.

This community was found in the Taebaek-san, Odae-san, Daegyu-san, and Gaya-san.

Dryopterido saxifragae-Saxifragetum fortunaei hydrangeetosum acuminatae subass. nova hoc loco

Nomenclatural type: relevé 15 in Table 8, (holotypus)
Differential species: *Arisaema amurense*, *Hydrangea serrata* var. *acuminata*, *Sedum polytrichoides*

Two- to three-layered community on shadow granite rocks and large boulders with different orientations but prevailing north. It is characterized by more shade than sunshine and increased air humidity near the streams, small rivers and within the forest complexes. The slope of the habitat is usually quite high, at 70–100° in the overhang (on average 80°). Exceptionally, the community can be found on the upper plateau of large boulders with a shadow and a shallow depth of the soil substrate, which does not allow for tree species growth.

A shrub layer is rarely present, or its coverage is low. In one case, it reached 50% coverage, but on average, it reached only 10%. *Fraxinus sieboldiana* and *Deutzia uniflora* were most frequent species. The herb layer's coverage fluctuates between 15 and 45%, on average less than 28%. Differential species of the subassociation are *Hydrangea serrata* var. *acuminata* and *Arisaema amurense*, which can be difficult to find during the summer. *Sedum polytrichoides* can be considered as a differential species of the subassociation but it can often be found in other rock habitats. The number of species of herb and shrub layer varies between 5 and 17, with an average of 12 species in relevé. A total of 65 species were found in the herb and shrub layers. The most common species are *Deutzia unifora* juv., *Calamagrostis arundinacea* and *Woodsia manchuriensis*.

In the moss layer, 35 species were found. Three to six species were recorded in individual stands with an average of 4 species in the relevé. Their cover is variable (3)10–90%, on average almost 47%. The most common species are *Racomitrium sudeticum* and *Hypnum plumaeforme*; the highest dominance is reached by *Hypnum plumaeforme*, *Racomitrium fasciculare*, *Campylopus japonicus*, *Thuidium kanedae*, and *Entodon challengeri*.

This community is known from altitudes between 500 and 1186 m (on average 855 m) of the Daegyu-san and Jiri-san.

Mukdenio rossii-Selaginelletum rossii Kolbek, Valachovič et Jarolímek 1998

Two- to three-layered open community on damp to wet, in dry periods to slightly drying rocks. It has already been described from the territory of North Korea on the basis of 24 relevés including two subassociations (Kolbek et al. 1998). Thirty-eight relevés taken in the southern part of the Korean Peninsula also belong to the two previously described subassociations. The community is relatively poor in species; on average, only slightly more than 12 species of herb layer and 3 species in moss layer in one relevé. In the 38 association relevés, a total of 131 species of herb and shrub layer and 49 species of bryophytes were found.

The dominant species are *Selaginella rossii* and *Mukdenia rossii* with the occurrence of *Saussurea nivea* and *Carex lanceolata* agg. in individual subassociations (Fig. 3b). These species usually achieve the highest constancy together with *Chrysanthemum zawadskii* agg., *Amitostigma gracile*, *Calamagrostis arundinacea*, *Rhododendron mucronulatum* juv., etc. (Table 9). The cover of the leading herb layer ranges from 15 to 95%, with an average of almost 55%.

Only a low cover was found in the shrub layer, on average only less than 6%. This layer is often not present at all or reaches a value of cover only rarely up to 30%. The most common species are *Rhododendron micranthum* and *R. mucronulatum*.

The cover of the moss layer fluctuates from (3)5–85%, on average more than 21% in one relevé. The dominant species are *Hypnum cupressiforme*, *H. plumaeforme*, *Plagiothecium cavifolium*, *Racomitrium fasciculare*, *Schistidium apocarpum*, and *Brachythecium buchananii*. The most common species are only *Hypnum cupressiforme* and *Schistidium apocarpum*.

This community was found at altitudes of 143–623 m (on average less than 394 m), mostly north oriented and with a slope of 11–100° (on average more than 70°). Geological bases are mostly granite and granodiorite rocks or boulders, less often black schistose dolomite or dolomite. The association has been divided into the following two subassociations.

Mukdenio rossii-Selaginelletum rossii typicum

Twenty-seven relevés from the southern part of the territory (Table 9) confirms this unit for the entire Korean Peninsula. A species of high constancy and dominance is *Selaginella rossii*. As an association species, *Mukdenia rossii* (with 33%

Table 9 *Mukdenio rossii-Selaginelletum rossii typicum* (rels 1–27), *androsacetosum cortusaefoliae* (rels 28–38). Column *N* contains percentual constancy of the association in North Korea (Kolbek et al. 1998: Table 2)

Relevé number	111111111122222222 12345678901234567890123456		22333333333 8901234567			
Constancy (s1, s2, S, *N*) in total						
number of relevés (%)		**s1**		**s2**	**S**	***N***
Number of relevés		**27**		**11**	**38**	***24***
E_1 – Species of rock fissures						
***Selaginella rossii* (A)**	3245554534343453235222453....	**85**	...45+.....	**27**	**68**	***83***
***Mukdenia rossii* (A)**	.....2221+.3232	**33**	433+2341323	**100**	**53**	***75***
***Carex ciliato-marginata* (dS)**	1+..11+.1.....+..	**26**	.....	**-**	**18**	***4***
***Arundinella hirta* (dS)**	..++..+....1.....1++.....	**26**	.+.....	**9**	**21**	**-**
***Sedum polytrichoides* (dS)**	...+.....+..+++..1.+....	**26**	...r.....	**9**	**21**	***4***
***Selaginella tamariscina* (dS)**	.....+....1.....++.++.....	**22**	...r.....	**9**	**18**	**-**
***Dennstaedtia hirsuta* (dS)**	.....+++++.....1..	**22**	.....+	**9**	**18**	***9***
***Saxifraga fortunaei* (dS)**	.2.....+.....r.....	**11**	.....12.12+	**45**	**21**	***67***
***Saussurea nivea* (dS)**	.....	**-**	.222.+....+	**45**	**13**	***21***
***Patrinia saniculaefolia* (dS)**	.....	**-**	...2++1...1	**45**	**13**	***38***
***Astilbe chinensis* agg.(dS)**	.....	**-**	1.....r..++	**36**	**11**	***29***
***Androsace cortusaefolia* (dS)**	.....	**-**	.....1+1	**27**	**8**	***46***
Chrysanthemum zawadskii agg.	1r...1+....+..+11r++11.....	48	..++.r...1.	36	45	*21*
Amitostigma gracile	...+1+2+..++1..+.++.++.....	48	.+.+.....r	27	42	*21*
Woodsia manchuriensis	...r+r+12.....1....	26	....+++....	27	26	*4*
Spodiopogon sibiricus	.....r..+12..+.....	19	...2.....	9	16	*13*
Dryopteris saxifraga	..2....r...+.+.....	15	.....+..+.+	27	18	*17*
Lepisorus ussuriensis	.....11+....1.....	15	+.....	9	13	*13*
Sedum kamtschaticum	.....++....+.....	11	.....	-	8	*8*
Dryopteris subtripinnata	.....+..+.....r	11	.....+.rr.	27	16	*4*
Davallia mariesii	....+.....2.....	7	.....	-	5	*4*
Microlepia wilfordii	.....+.+.....	7	.....	-	5	-
Crypsinus hastatus	.....+....+.....	7	.....	-	5	-
Camptosorus sibiricus	.....r+.....	7	.....	-	5	*8*
Orostachys japonica	.....+.+.....	7	.....	-	5	-
Potentilla dickinsii	.....++.....	7	...1+....+1	36	16	*33*
E_2						
Rhododendron micranthum	2...2....2.1.....+.....	19	.....	-	13	-
Rhododendron mucronulatum	..2...2.1.....2....	15	1...1.....	18	16	-
Fraxinus sieboldiana	..1.+.2...2.....	15	.....	-	11	-
Weigela florida	.....1....22.....2....	15	.....	-	11	-
Deutzia uniflora	....1...2.+.....	11	1.....	9	11	-
Spiraea blumei	.....11.....	7	.....	-	5	-
Lespedeza maximowiczii	.....1....+.....	7	....1.....	9	8	-
Rhus javanica	..+.....	4	r.....	9	5	-
E_1						
Carex lanceolata agg.	..++++1..11..+221..2112+1+.	67	+1.1+.+..11	64	66	*67*
Calamagrostis arundinacea	+111.++...1.+.1.+.1+..11+1r	63	1++.1++2+1+	91	71	*21*
Weigela florida juv.	.....+...+++r+.1r.+1.1+	44	.+..r.....	18	37	*21*
Rhododendron mucronulatum juv.	..+...+.....+1++..+..1+....	33	.+.+.+..++r	55	39	*50*
Fraxinus rhynchophylla juv.	...r.+...+...+.+r.....1	26	..r.r.r....	27	26	*4*
Deutzia uniflora juv.	.....r+.1.1.....1..r.....	22	....+.r..++	22	26	-
Spiraea fritschiana juv.	.....r...++1+.....	19	.1r...+.r.r	44	26	-
Ligustrina amurensis juv.	.....+..+2.....+	15	.1.r.....	18	13	-
Benzoin obtusilobum juv.	..+.r.....r....	11	.....	-	8	-
Lespedeza maximowiczii juv.	.....++.....r.....	11	.....r....	9	11	*4*
Fraxinus sieboldiana juv.	.....r+.....r..	11	.....	-	8	-
Rhododendron micranthum juv.	+.....2.....	7	.....	-	5	-
Rubus crataegifolius	.+.....r.....	7	.....r...	9	8	*4*
Spiraea blumei juv.	...1..r.....	7	.....	-	5	-
Rhododendron schlippenbachii juv.	....r..+.....	7	.....	-	5	-
Carpinus laxiflora juv.	.....r.....r.....	7	.....+....	9	8	-
Boehmeria spicata	.....++.....	7	.....+...	9	8	-
Aster pekinensis	.....r.....+.....	7	.....	-	5	-
Parthenocissus tricuspidata	.....1...2.....	7	.....	-	5	*4*
Lespedeza bicolor juv.	.....2....+.....	7	.....r....	9	8	*21*
Sanguisorba hakusanensis	.....r+.....	7	..1+.....22	36	16	*17*
Carex siderosticta	..1.....	4	..1..r.....	18	8	*25*
Poa nemoralis	..+.....	4	+....r.....	18	8	-
Acer pseudosieboldianum juv.	.....+.....	4	..r.....	9	5	*17*
Rhododendron yedoense juv.	.....r.....	4	+.....	9	5	-
Saxifraga stolonifera	.....+.....	4	..++.....	18	8	-
Deutzia glabrata juv.	.....+	4	.....r.1...	18	8	*4*
Lycopodium chinensis	.....	-	.....r...+.	18	5	-
Aruncus americanus	.....	-	.....+.+	18	5	-
E_0						
Hypnum cupressiforme	...143.2.1.1....2...+.....2	33	2...13.....	27	32	*
Schistidium apocarpum	...+.11..11.....2.2.	26	2...1.....	18	24	*
Hypnum plumaeforme	2.....1....+3.....	15	...2..3.122	45	24	*
Polytrichum formosum	12..2...1.....	15	.....	-	11	*
Plagiothecium cavifolium	.....+.....2....2.2.	15	.....	-	11	*
Grimmia incurva	.....2.121.....	15	.....	-	11	*
Racomitrium fasciculare	.21....2.....	11	.....12....	18	14	*
Racomitrium diminutum	1.2.....	7	.....1.....	9	8	*
Dicranodontium denudatum	21.....	7	.....	-	5	*
Racomitrium sudeticum	....1.1.....	7	.1.....121	36	16	*
Dicranella heteromalla	.....2.1.....	7	.....	-	5	*
Campylopus japonicus	.....2.....1.....	7	...21.2..3.	36	16	*
Leucobryum glaucum	.....+....2.....	7	.....	-	5	*
Oncophorus virens	.....+....1.....	7	.....	-	5	*
Brachythecium buchananii	.....2.....1....	7	.....3...	9	8	+
Bryum sp.	.....1.....+.....	7	.....	-	5	*
Totella tortuosa	.....1.....1..	7	...1.1..1..	27	13	*
Grimmia affinis	.....11.....	7	....2.....	9	8	*
Plagiothecium denticulatum	.1.....	4	2.....	9	5	*
Atrichum undulatum	.....	-	...1.11....	27	8	*

In one relevé only

E_1 + E_2: *Artemisia keiskeana* 1: +; *Deutzia prunifolia* juv. 1: +; *Fraxinus mandshurica* juv. 1: r; *Peucedanum terebintaceum* 1: r; *Saxifraga oblongifolia* 2: 2; *Hosta longipes* 2: +; *Viola verecunda* 2: r; *Quercus mongolica* E_2 3: 2; *Polygonatum inflatum* 3: 1; *Abelia insularis* E_2 3: +; *Rhododendron schlippenbachii* E_2 3: +; *Symplocarpus nipponicus* juv. 3: r; *Polygonatum *pluriflorum* 4: 1; *Rhus javanica* juv. 6: +; *Prunus*

Table 9 (continued)

sargentii juv. 6: r; *Securinega suffruticosa* E_2 7: 1; *Potentilla freyniana* 7: +; *Lilium cernuum* 7: r; *Athyrium yokoscense* 9: +; *Deutzia prunifolia* E_2 10: 2; *Fraxinus rhynchophylla* E_2 10: 1; *Carpinus coreana* juv. 10: r; *Prunus *spontanea* juv. 10: r; *Orostachys iwarenge* 11: r; *Ixeris sonchifolia* 12: r; *Prunus* sp. juv. 13: r; *Primula jezoana* 14: 1; *Pinus densiflora* juv. 16: r; *Polygonatum* sp. 17: +; *Isodon inflexus* 17: r; *Sapium japonicum* 17: r; *Syringa* sp. juv. 17: r; *Xanthium* sp. 17: r; *Erysimum aurantiacum* 18: +; *Corydalis speciosa* 18: r; *Betula schmidtii* E_2 20: 3; *Ligustrina amurensis* E_2 20: 2; *Solidago *asiatica* 20: r; *Paraixeris chelidoniifolia* 21: r; *Asplenium unilaterale* 24: +; *Euonymus alata* juv. 25: r; *Woodsia glabella* 26: +; *Asarum sieboldii* 27: +; *Rhododendron yedoense* E_2 28: 2; *Salix gracilistyla* E_2 28: 1; *Angelica polymorpha* 28: +; *Carex heterolepis* 28: +; *Carex* sp. 28: +; *Quercus serrata* E_2 28: +; *Salix gracilistyla* juv. 28: +; *Salix* sp. juv. 28: r; *Deutzia* sp. juv. 29: 1; *Thalictrum tuberiferum* 29: +; *Aster koraiensis* 29: r; *Viola dissecta* 30: r; *Quercus serrata* juv. 31: r; *Spiraea fritschiana* E_2 32: 1; *Syringa* sp. E_2 32: 1; *Deparia japonica* 33: 1; *Betula schmidtii* juv. 33: +; *Carex lasiolepis* 34: 1; *Allium thunbergii* 34: +; *Aster maackii* 34: +; *Polystichum craspedosorum* 35: 3; *Dryopteris linnaeana* 35: 2; *Asplenium varians* 35: 1; *Lastrea japonica* 36: r; *Phegopteris polypodioides* 36: r;
E_0: *Pundelia rudecta* 1: 1; *Jamesoniella autumnalis* 2: +; *Plicanthus birmensis* 2: +; *Haplohymenium triste* 4: +; *Leucobryum glaucum* 7: +; *Grimmia curvata* 9: +; *Hedwigia ciliata* 10: +; *Dicranum scoparium* 13: 1; *Homomallium japonico-adnatum* 14: 2; *Macromitrium gymnostomum* 14: +; *Bryhnia novae-angliae* 18: 3; *Orthotrichum* sp. 20: 2; *Brotherella henonii* 21: 1; *Hyophila involuta* 23: 1; *Leucobryum neilgherrense* 23: 1; *Ramalina* sp. 23: +; *Conocephalum japonicum* 28: 1; *Philonotis lancifolia* 28: 1; *Eurhynchium hians* 30: 1; *Weissia controversa* 30: 1; *Rhizomnium *elatum* 33: +; *Encalypta ciliata* 34: 1; *Pogonatum urnigerum* 34: 1; *Cratoneuron filicinum* 35: 2; *Eucladium verticillatum* 35: 2; *Marchantia tosana* 35*:* 2; *Hymenostylium curvirostre* 35: 1; *Diplohyllum albicans* 36: 2; *Scapania parvidens* 37: 1.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Mukdenio rossii-Selaginelletum rossii typicum
1, JK, 9.00, 623, NNW/85, 10, 60, 20, Bongwha SE of Taebaek-san, Baekcheon Valley, granodiorite rock, 24. 5. 2007;
2, JK, 3.00, 622, N/45, 0, 40, 30, Bongwha, Baekcheon Valley, wet granodiorite rock, 24. 5. 2007;
3, K, 12.00, 520, NW/50, 25, 70, 15, Taebaek-san, granodiorite rocks along road to Andong, 2. 6. 2007;
4, JKS, 5.00, 246, NW/40, 0, 95, 5, Duta-san, Mureung Valley, top of granitic boulder, 30. 5. 2007;
5, JK, 16.00, 434, NNW/70, 10, 80, 70, Sobaek-san, Yeonhwa-dong, near stream SE from village, 3. 6. 2006;
6, JK, 3.75, 399, NNW/80, 10, 80, 35, Juwang-san, below waterfall, wet rocks, 4. 6. 2006;
7, JKS, 9.00, 358, W/80, 30, 70, 20, Juwang-san, near waterfall, 4. 6. 2006;
8, J, 12.00, 542, N/85, 0, 80, 40, Gaya-san, Haeinsa Temple, steep granite rock, 10. 6. 2006;
9, JK, 12.00, 418, N/90, 10, 30, 10, Sobaek-san, Yeonhwa-dong Valley, near stream, 3. 6. 2006;
10, JK, 9.00, 510, NNE/85, 30, 80, 5, Sobaek-san, Jukgye Valley, top of large boulder above stream, 2. 6. 2006;
11, K, 12.00, 503, NE/70, 10, 50, 5, Taebaek-san, rocks along road to Andong, 2. 6. 2007;
12, JS, 12.00, 143, NNE/80, 10, 75, 5, Worak-san, between Jinnam and Andong, 20. 6. 2006;
13, J, 9.00, 425, NW/50, 0, 85, 20, Odae-san, Sogeumgang Valley, top of large granite boulder, 25. 6. 2006;
14, K, 14.00, 355, NW/11, 0, 50, 10, Odae-san, Sogeumgang Valley, rock overhang, 25. 6. 2006;
15, K, 20.00, 350, W/80, 0, 20, 3, Odae-san, Sogeumgang Valley, eroded rocks above river, 25. 6. 2006;
16, K, 10.00, 340, NE/70, 0, 70, 20, Odae-san, Sogeumgang Valley, rock above stream, 25. 6. 2006;
17, JS, 9.00, 256, N/45, 0, 95, 10, Seorak-san, granite rocks near Shinheungsa Temple, 22. 6. 2006;
18, K, 6.00, 350, N/90, 0, 30, 40, Seorak-san, Biseondae Rock, boulder above stream, 23. 6. 2006;
19, KS, 32.00, 400, NE/85, 0, 40, 10, Seorak-san, Osaek Valley, rock above stream, 24. 6. 2006;
20, K, 20.00, 235, NNW/75, 30, 35, 3, Seorak-san, Ulsan-Bawi, boulder in Jeohangryeong Valley, 22. 6. 2006;
21, JS, 12.00, 222, N/75, 0, 80, 30, Seorak-san, main valley, top of rock, 22. 6. 2006;
22, J, 12.00, 235, WSW/75, 0, 90, 5, Seorak-san, main valley, granite rock above stream, 22. 6. 2006;
23, JKS, 25.00, 522, E/85, 15, 40, 10, Jeongseon, black schistose dolomite, 28. 5. 2007;
24, JS, 16.00, 464, E/85, 0, 50, 15, Jeongseon, Sugam-Valley, 28. 5. 2007;
25, J, 15.00, 306, N/90, 0, 25, 3, Worak-san, Deokjusa Valley, above temple, 20. 6. 2006;
26, JKS, 16.00, 464, E/85, 0, 50, 15, Jeongseon, upper part of Sugam Valley, dolomite, 28. 5. 2007;
27, K, 16.00, 245, W/65, 0, 20, 10, Seorak-san, rock above stream, shady place, 23. 6. 2006;

Mukdenio rossii-Selaginelletum rossii androsacetosum cortusaefoliae
28, JKS, 15.00, 500, SSW/90, 15, 60, 25, Jeongseon, Hangol Valley, wet dolomite rock in alluvium of river, 28. 5. 2007;
29, JS, 12.00, 345, W/85, 0, 35, 3, Seorak-san, above waterfall in Jeohangnyeong Valley, 23. 6. 2006;
30, JS, 9.00, 339, W/100, 0, 35, 5, Seorak-san, above waterfall in Jeohangnyeong Valley, granite overhang, 23. 6. 2006;
31, V, 6.00, ca 400, NE/85, 0, 80, 40, Seorak-san, Osaek Valley, rock plate below overhang, 24. 6. 2006;
32, JS, 10.00, 422, E/85, 10, 85, 10, Seorak-san, Osaek Valley, W from temple, 24. 6. 2006;
33, V, 9.00, ca 400, N/30, 0, 35, 45, Seorak-san., Osaek Valley, rock plate near water, 24. 6. 2006;
34, JS, 25.00, 385, NNE/25, 0, 60, 75, Seorak-san, Osaek Valley, W from temple, 24. 6. 2006;
35, JKS, 2.00, 435, N/90, 0, 40, 60, Jeongseon, road to Andong City, dolomite, 27. 5. 2007;
36, J, 15.00, 402, WNW/85, 0, 35, 10, Seorak-san, above lake in Cheonbuldong Valley, granite rock, 23. 6. 2006;
37, JS, 25.00, 412, N/80, 0, 35, 40, Seorak-san, Cheonbuldong Valley, rocks above the left tributary of lake, 23. 6. 2006;
38, JS, 12.00, 425, N/90, 0, 40, 10, Seorak-san, Cheonbuldong Valley, rocks above the left tributary of lake, 23. 6. 2006.

of occurrence) and differential species of subassociation (*Arundinella hirta*, *Carex ciliato-marginata*, *Sedum polytrichoides*, *Selaginella tamariscina* and *Dennstaedtia hirsuta* represent significant species. Other species with higher constancy are *Chrysanthemum zawadskii* agg., *Amitostigma gracile*, *Carex lanceolata* agg., *Calamagrostis arundinacea* and the juvenile shrub *Weigela florida*. The total number of species of shrub and herb layers is 100; the number of species in individual relevés varies from (5)7–21 (less than 12 on average). This subassociation is characterized by the high constancy

of *Selaginella rossii* and the more frequent occurrence of some small ferns, e.g. *Woodsia manchuriensis*, *Dryopteris saxifraga*, *Lepisorus ussuriensis*, *Davallia mariesii*, *Microlepia wilfordii*, *Camptosorus sibiricus*, *Crypsinus hastatus*, etc.

The herb layer reaches a cover of 20–95% (on average approx. 59%). A shrub layer in approximately half of the relevés is missing, or its cover ranges between 10 and 30% (on average only about 7%). A total of 35 species were found in the moss layer. In individual relevés, 1–6 species of bryophytes were recorded (less than 3 on average). The most common species were *Hypnum cupressiforme* and *Schistidium apocarpum*. The cover of this layer is highly variable, between (3)5 and 40(70) % (more than 17% on average).

Phytocoenological relevés of this subassociation were recorded at altitudes of 143 to 623 m (approximately 388 m on average) on rocks with predominantly northern orientation and slope (11)40–90° (on average more than 71°). The stands of this community were found quite often in all locations mentioned in the description of the association.

Mukdenio rossii-Selaginelletum rossii androsacetosum cortusaefoliae Kolbek, Valachovič et Jarolímek 1998

The constancy of association species shows the opposite trend as in the previous subassociation (Table 9). High constancy (100%) is achieved by *Mukdenia rossii*, which is characterized as an association species, while *Selaginella rossii* only reaches approximately one-third of its occurrence. *Saussurea nivea*, *Patrinia saniculaefolia*, *Astilbe chinensis*, *Androsace cortusaefolia*, and less significantly also *Saxifraga fortunaei* behave as differential species of the subassociation. *Chrysanthemum zawadskii* agg., *Woodsia manchuriensis*, *Carex lanceolata* agg., *Calamagrostis arundinacea*, *Rhododendron mucronulatum*, and *Spiraea fritschiana* also achieve higher constancy. The total number of species of shrub and herb layers is 88; the number of species in individual relevés varies from 8 to 18 (less than 14 on average).

The developed shrub layer was found in only two relevés out of 11, and the cover did not exceed 15% (on average only approx. 2%). However, the overall constancy of individual shrubs is very low. The cover of the herb layer reaches 15 to 85% (on average approx. 45%). A total of 25 species were found in the moss layer of the community. In the individual relevés, 1–6 species were recorded (less than 4 on average). The most common species were *Hypnum cupressiforme*, *H. plumaeforme*, *Campylopus japonicus*, *Tortella tortuosa*, and *Atrichum undulatum*. The cover of this layer is also highly variable, between (3)5 and 75% (more than 31% on average). It is roughly twice that of previous units with an average of a higher number of mosses in the relevé.

The relevés of this subassociation were recorded at altitudes from 339 to 500 m (406 m on average) on the rocks with predominantly northern (partly also western) orientation and with variable slopes of 25–100° (on average more than 77°). This community was found on the localities in Seoraksan on the wet dolomite or granite rocks and in the surroundings of Jeongseon city.

Patrinio saniculaefoliae-Mukdenietum rossii Kolbek, Valachovič et Jarolímek 1998

This community was described from the rocks of Kumgangsan and its wider surroundings based on 28 phytocoenological relevés (Kolbek et al. 1998). It was also found in South Korea (Appendix 1). The largest stands were recorded on the granite rocks around the mountain streams. However, they are likely to occur on granites, granodiorites, and possibly acidic slates.

The shrub layer does not occur in most relevés; in rare cases it can reach 10% of cover (on average just over 1%). In total, only 6 shrub species were found. The herb layer is highly variable, and its cover varies between 10 and 70% (on average only less than 30%). The number of species in the relevé fluctuates between 5 and 20 (on average slightly above 10 species). A total of 42 species were found in the herb layer. Thus, the community is rather poor in species. The most common species are *Mukdenia rossii*, *Potentilla dickinsii*, *Patrinia saniculaefolia*, the juvenile shrub *Rhododendron mucronulatum*, *Sanguisorba hakusanensis*, and *Carex lanceolata* agg. (Fig. 3c). From the vicarious association *Patrinio rupestris-Mukdenietum rossii* on calcareous substrates, this community differs by the absence of especially calcareous species and the presence of acidophilic species or species tolerant to acidic bedrock (see Table 10). A total of 22 species were found in the moss layer. The most abundant species was *Campylopus japonicus*, which together with *Plagiothecium cavifolium* and *Pohlia nutans* achieved the highest cover in individual plots. Thus, on average, there are only slightly more than 2 species of bryophytes per relevé.

The community was found at altitudes between 387 and 1000 m (on average 695 m), predominantly in the southern quadrant. The slope of the rock walls was 45° to 90° (almost 80° on average, Fig. 3d). A thin layer of soil is formed in the clumps of plants and in small rocky steps. The soil is skeletal but contains a lot of humus. On very steep slopes, a bare rock substrate can predominate, and plants have roots in crevices. A significant ecological factor is permanent soil erosion.

Patrinio rupestris-Mukdenietum rossii ass. nova hoc loco

Nomenclatural type: relevé 6 in Table 10, (holotypus)
Association species: *Artemisia gmelinii*, *Artemisia princeps*, *Aster pekinensis*, *Bromus tectorum*, *Buxus koreana*, *Isodon japonicus*, *Lilium amabile*, *Paraixeris denticulata*, *Patrinia rupestris*, *Spiraea pubescens*

Table 10 Two vicariante associations: *Patrinio rupestris-Mukdenietum rossii* ass. nova (rels 1–11) and *Patrinio saniculaefoliae-Mukdenietum rossii* (rels 12–28). Column *N* contains percentual constancy of the second association in North Korea (Kolbek et al. 1998: Table 1)

Relevé number	1	2	3	4	5	6	7	8	9	10	11		12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
Constancy (S, *N*) in total number of relevés (%)											S																			S	*N*
Number of relevés											11																			17	*28*
E_1 – Species of rock fissures																															
***Mukdenia rossii* (c)**	3	4	2	2	2	2	3	3	3	3	2	100	.	.	.	.	.	2	2	1	2	r	.	+	r	2	.	2	4	59	*93*
***Potentilla dickinsii* (c)**	.	+	2	+	.	.	1	1	2	.	+	64	2	3	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	100	*68*
***Chrysanthemum zawadskii* agg.(c)**	.	.	+	r	.	+	+	+	.	.	2	55	.	.	.	.	+	.	.	.	.	1	.	+	+	+	.	2	+	41	*29*
***Patrinia rupestris* (A)**	.	.	+	.	.	+	.	.	.	.	+	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
***Selaginella rossii* (A)**	.	.	.	.	.	.	.	.	.	.	.	–	.	+	2	3	.	.	.	+	1	.	.	2	.	.	.	.	.	35	*29*
***Patrinia saniculaefolia* (A)**	.	.	.	.	.	.	.	.	.	.	.	–	.	.	+	2	.	.	+	+	+	.	.	.	.	.	.	.	+	35	*68*
Orostachys japonica	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	r	.	.	.	2	+	.	18	–
Dennstaedtia hirsuta	.	.	.	.	.	.	.	.	.	.	.	–	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	12	–
Saxifraga fortunaei	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	12	*18*
Sedum polytrichoides	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	12	*3*
Amitostigma gracile	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	12	*18*
Asplenium unilaterale	.	.	.	.	.	.	.	.	.	.	.	–	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	–
Woodsia polystichoides	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	6	*3*
Dryopteris subtripinnata	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	6	*11*
Other Association (A) species																															
***Buxus koreana* juv.**	1	+	+	+	+	1	1	.	+	+	.	82	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Aster pekinensis	.	+	+	r	r	r	r	+	.	+	+	82	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
***Spiraea pubescens* juv.**	.	1	.	+	1	r	.	+	1	+	1	73	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Artemisia gmelinii	.	.	1	+	1	+	.	r	+	+	+	73	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Isodon japonicus	.	+	+	.	.	.	r	.	r	.	+	45	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Lilium amabile	.	+	.	.	.	r	.	.	r	+	+	45	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Bromus tectorum	+	r	.	+	r	.	.	.	.	.	.	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Artemisia princeps	.	.	.	+	+	+	.	.	.	r	.	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Paraixeris denticulata	.	.	.	+	.	.	r	.	r	.	r	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
***Rhododendron mucronulatum* juv.**	.	.	.	.	.	.	.	.	.	.	.	–	r	.	2	1	.	.	.	.	1	.	+	r	.	.	1	+	r	53	*75*
Spodiopogon sibiricus	.	.	.	.	.	.	.	.	.	.	.	–	+	+	1	.	2	.	.	.	.	1	.	.	.	+	2	1	47	*21*
Sanguisorba hakusanensis	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	+	.	1	2	2	.	+	+	+	+	.	.	.	47	*61*
Saussurea nivea	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	+	+	+	1	.	.	r	+	+	.	.	.	41	*36*
***Rhododendron micranthum* juv.**	.	.	.	.	.	.	.	.	.	.	.	–	.	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	24	–
Other species																															
Calamagrostis arundinacea	.	1	2	2	+	1	2	+	1	2	2	91	.	.	+	1	.	1	.	2	+	.	+	r	.	.	.	.	1	47	*18*
Carex lanceolata agg.	2	+	.	2	.	+	+	+	.	1	2	73	r	2	+	+	1	1	1	1	.	2	1	1	2	+	.	1	1	88	*83*
Arundinella hirta	1	+	+	+	.	.	.	.	+	+	+	64	.	+	.	.	.	.	.	.	.	.	.	r	2	+	.	.	.	24	–
Ulmus macrocarpa juv.	.	+	.	+	.	.	.	.	.	+	.	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Peucedanum terebintaceum	.	.	+	.	.	.	+	+	.	.	.	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	*14*
Spiraea blumei juv.	.	.	.	+	.	+	.	.	.	.	+	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
*Agropyron *transiens*	.	.	.	.	.	+	+	r	.	.	.	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Clematis mandshurica	.	1	.	.	.	.	.	.	.	.	+	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Securinega suffruticosa juv.	.	.	.	+	.	.	.	.	r	.	.	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	–
Allium thunbergii	.	.	.	.	r	.	.	.	.	+	.	18	.	.	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	12	–
Weigela florida juv.	1	.	.	.	.	.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	.	r	1	+	1	+	.	29	*18*
Spiraea fritschiana juv.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	+	1	.	.	+	.	r	24	–
Aster yomena	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	r	r	+	+	.	24	–
Pinus densiflora juv.	.	.	.	.	.	.	.	.	.	.	.	–	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	+	.	18	–
Artemisia keiskeana	.	.	.	.	.	.	.	.	.	.	.	–	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	r	18	*11*
Lespedeza bicolor juv.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	1	.	.	.	.	r	r	.	.	.	.	.	.	18	*14*
Deutzia uniflora juv.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	r	.	.	.	+	.	+	18	–
Festuca ovina	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	+	+	r	.	.	.	18	–
Scabiosa fischeri	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	16	–
Potentilla fragarioides	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	12	–
Aster maackii	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	+	12	–
Spiraea chinensis	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	.	12	–
E_0																															
Weissia controversa	+	.	.	1	+	1	1	2	+	2	1	82	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	*
Anomodon integerrimus	.	1	+	+	1	+	+	1	1	.	.	73	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	*
Brachythecium buchananii	.	.	.	.	.	.	.	1	.	.	1	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–	*
Romalina sp.	.	.	.	.	.	.	.	+	.	.	.	9	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	*
Campylopus japonicus	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	1	2	2	.	.	.	.	2	.	+	29	*
Hyophila involuta	.	.	.	.	.	.	.	.	.	.	.	–	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	18	*
Pogonatum unigerum	.	.	.	.	.	.	.	.	.	.	.	–	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	12	*
Racomitrium sudeticum	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	.	.	12	*
Tortella tortuosa	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	.	.	12	*
Grimmia incurva	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	12	*
Orthotrichum sp.	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	12	*
Hypnum plumaeforme	.	.	.	.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6	*

In one relevé only

E_1 + E_2: *Hemerocallis middendorffii* 2: +; *Clematis apiifolia* 2: r; *Fraxinus rhynchophylla* juv. 2: r; *Themeda japonica* 3: 1; *Setaria glauca* 3: +; *Humulus japonica* 3: r; *Spiraea blumei* E_2 4: 1; *Carex neurocarpa* 4: +; *Morus bombycis* juv. 4: +; *Rhamnus schneideri* E_2 4: +; *Parthenocissus tricuspidata* 4: r; *Carex* sp. 6: +; *Poa compressa* 6: +; *Rubia cordifolia* agg. 7: +; *Lespedeza cuneata* juv. 9: r; *Festuca* sp. 10: r; *Scilla scilloides* 10: r; *Galium kinuta* 11: 1; *Hieracium umbellatum* 11: +; *Syringa* sp. juv. 11: +; *Viola variegata* 11: +; *Thalictrum rochebrunianum* 11: r; *Athyrium vidalii* 14: +; *Rhododendron mucronulatum* E_2 15: 2; *Hemerocallis* sp. 16: 1; *Quercus mongolica* juv. 16: r; *Clematis fusca* 17: r; *Bupleurum euphorbioides* 18: r; *Abelia insularis* E_2 25: 1; *Ligustrina amurensis* juv. 26: 1; *Callicarpa dichotoma* 26: +; *Commelina communis* 27: +; *Lespedeza maximowiczii* E_2 28: 2; *Acer pseudosieboldianum* E_2 28: +; *Weigela florida* E_2 28: +; *Solidago *asiatica* 28: r;

E_0: *Dicranodontium denudatum* 4: 2; *Anomodon viticulosus* 8: 1; *Reboulia hemisphaerica* 8: +; *Didymodon rigidicaulis* 10: 2; *Schistidium* sp. 10: +; *Atrichum undulatum* 20: 1; *Cetrelia olivetorum* 20: 1; *Ochrolechia szalalaensis* 20: +; *Rhizomnium *elatum* 20: +; *Umbilicaria polyrrhiza* 21: +; *Haplohymenium longinerve* 23: 1; *Bryum* sp. 25: +; *Schistidium apocarpum* 26: 2; *Plagiothecium cavifolium* 27: 3; *Pohlia nutans* 28: 3; *Gollania *coreensis* 28: 2; *Encalypta ciliata* 28: 1; *Racomitrium fasciculare* 28: +.

Localities: Relevé number, Authors code, Relevé area (m²), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Table 10 (continued)

Patrinio rupestris-Mukdenietum rossii

1, JK, 8.00, 212, S/80, 0, 45, 1, Yeongwol, second bridge over Dongang River, SE from Jabong hill, schistose rocks on right side of river, 23. 5. 2007;
2, JK, 12.00, 334, E/75, 0, 60, 3, Yong-gye-cheon River, E from town Jeongseon, calcareous cliff above river, 28. 5. 2007;
3, JK, 15.00, 330, SW/85, 0, 30, 1, near the town Jeongseon, dolomite rock above river, 26. 5. 2007;
4, JK, 16.00, 325, E/75, 5, 25, 15, near the town Jeongseon, dolomite rock above river, 26. 5. 2007;
5, JK, 25.00, 317, SE/85, 0, 20, 5, Jeongseon, ca 3 km behind town, dolomite cliff above river, 27. 5. 2007;
6, JK, 12.00, 365, WNW/85, 0, 20, 3, Jeongseon, dolomite, 27. 5. 2007;
7, JK, 20.00, 366, SSW/90, 0, 30, 3, Jeongseon, dolomite, 27. 5. 2007;
8, JK, 20.00, 363, NE/80, 0, 30, 10, Jeongseon, dolomite, 27. 5. 2007;
9, JK, 12.00, 340, E/80, 0, 40, 3, Jeongseon, Yonggyegol Valley, ca 100 m N from the rel. 2 (this table), 28. 5. 2007;
10, JKS, 12.00, 383, E/75, 0, 40, 25, Jeongseon, Im-gye-cheon River, dolomite rocks above river, 29. 5. 2007;
11, JKS, 15.00, 395, ENE/85, 0, 45, 5, Jeongseon, Im-gye-cheon River, rocks by road, 29. 5. 2007;

Patrinio saniculaefoliae-Mukdenietum rossii

12, V, 0.15, 970, SW/80, 0, 20, 1, Gaya-san, Namsanjeilbong, fissures in granite rocks, 10. 6. 2006;
13, V, 0.30, 1000, W/89, 0, 40, 3, Gaya-san, Namsanjeilbong, granite rocks near summit, 10. 6. 2006;
14, V, 0.50, 992, NE/85, 0, 35, 1, Gaya-san, Namsanjeilbong, below the summit, 10. 6. 2006;
15, V, 2.25, 970, ENE/85, 10, 70, 1, Gaya-san, Namsanjeilbong, below the summit, 10. 6. 2006;
16, V, 2.00, 840, SE/45, 0, 25, 0, Seorak-san, below Yangpok shelter, 23. 6. 2006;
17, V, 15.00, 790, NW/89, 0, 10, 2, Seorak-san, left from Cheondangpokpo Waterfall, 23. 6. 2006;
18, V, 0.30, 780, E/80, 0, 15, 0, Seorak-san, Biseondae Valley, above Yangpokpokpo Waterfall, 23. 6. 2006;
19, V, 0.40, 530, W/90, 0, 15, 1, Seorak-san, Biseondae Valley, below Yangpokpokpo Waterfall, 23. 6. 2006;
20, V, 8.00, ca 400, NE/89, 0, 25, 10, Seorak-san, Osaek Hot Springs, rock above stream, 24. 6. 2006;
21, V, 0.35, 387, W/85, 0, 15, 5, Seorak-san, below Shinheungsa Temple, 24. 6. 2006;
22, J, 10.00, 658, SW/50, 0, 25, 15, Seorak-san, near path to ridge Ulsanbawi, 22. 6. 2006;
23, J, 8.00, 751, SE/85, 0, 25, 15, Seorak-san, above cableway Kwon Geum Rock, Jipseonbong Peak, 23. 6. 2006;
24, K, 10.00, 755, S/80, 0, 25, 3, Seorak-san, near Kwon Geum Rock, Jipseonbong Peak, smooth rocky plates, 23. 6. 2006;
25, K, 16.00, 760, SE/75, 0, 20, 1, Seorak-san, near Kwon Geum Rock, Jipseonbong Peak, 23. 6. 2006;
26, K, 15.00, 420, SSW/80, 0, 40, 40, Seorak-san, Osaek Hot Springs, rock above stream, 24. 6. 2006;
27, K, 12.00, 389, SSW/80, 0, 30, 30, Seorak-san, valley W from Osaek Hot Springs, rock above stream, 24. 6. 2006;
28, J, 10.00, 429, E/80, 10, 60, 60, Seorak-san, Osaek Hot Springs, side valley, 24. 6. 2006.

The association was recorded only on limestone rocks (dolomite, calcareous schistose rocks). For its occurrence the calcium carbonate content in the soil is limiting. The soils are compact, often marly, less airy and have lower humus content. The association is vicarious to the *Patrinio saniculaefoliae-Mukdenietum rossii* community on silicate substrates (occurrence on granodiorite and granite rocks).

In the herb layer, a number of species occur, including woods, bound on lime soils. Abundant examples include endemic taxon *Buxus koreana* but only in the juvenile stage, *Aster pekinensis*, *Artemisia gmelinii* and young plants *Spiraea pubescens*. Shrubs *Buxus koreana* create sparse and open stands with plenty of light for herbaceous species. The occurrence of *Lilium amabile* bound to sandy-loam or gritty-loam soils is significant. These species distinctly distinguish this association from a related unit occurring on the more acidic and nutrient-poorer substrates (see Table 10). A high constancy is achieved in this community for *Calamagrostis arundinacea* and *Arundinella hirta*. Species of the genus *Rhododendron* and the more acidic accompanying species of their stands are naturally absent. The community is not very rich in species. The number of species varies between (6)9 and 21 (with a mean of less than 14 species in the relevé) in the herb and sporadic shrub layers. The cover of the herb layer fluctuates between 20 and 60%, with an average of 35% in the relevé. The shrub layer was only recorded in one relevé with a value of 5%, and its cover is therefore unimportant for the community. The cover of the moss layer is highly variable, from 1 to 25%, with an average of less than 7% in the relevé. The number of mosses varies between 1 and 6 with an average of more than 2 species per relevé. The most abundant species are *Anomodon integerrimus* and *Weissia controversa*.

This community was recorded at altitudes from 212 to 395 m (339 m on average) with a various orientation, mostly to the south and east. It occurs on steep rock walls with a slope of 75° to 90° (on average more than 81°).

Junipero rigidae-Buxetum koreanae ass. nova hoc loco

Nomenclatural type: relevé 1 in Table 11, (holotypus)
Association species: *Asplenium ruta-muraria*, *Buxus koreana*, *Isodon japonicus*, *Juniperus rigida*, *Lilium amabile*, *Patrinia rupestris*

This newly described association represents the community of shrubs and herbs on calcareous substrates, limestones or dolomites. A rich shrub layer, reaching 3 m, or the presence of endemic of Korean Peninsula *Buxus koreana* or other shrubs, such as *Juniperus rigida*, *Spiraea blumei*, *Lespedeza bicolor*,

Table 11 *Junipero rigidae-Buxetum koreanae* ass. nova (rels 1–6) and *Meehanio urticifoliae-Selaginelletum stauntonianae* ass. nova (rels 7–23)

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**		**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	
Constancy (S) in total number of relevés (%)							**S**																		**S**
Number of relevés							**6**																		**17**
E_2																									
***Buxus koreana* (A)**	**4**	**3**	**3**	**3**	**2**	**2**	**100**	2	2	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	29
***Juniperus rigida* (A)**	**+**	.	**+**	**+**	**1**	.	**67**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
***Spiraea blumei* (c)**	**+**	**2**	**+**	**1**	.	.	**67**	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
***Lespedeza bicolor* (c)**	**1**	.	**2**	**+**	.	.	**50**	.	.	.	2	+	.	.	.	.	2	.	.	.	.	.	.	.	18
***Weigela florida* (c)**	**+**	.	.	**+**	**+**	.	**50**	.	1	.	+	+	.	.	.	+	1	.	.	.	.	.	.	.	29
Morus bombycis	2	.	2	.	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Abelia insularis	1	2	.	.	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6
Rhus javanica	+	.	.	+	.	.	33	.	.	.	+	.	.	.	.	.	.	.	2	.	.	.	.	.	12
Quercus dentata	+	.	.	.	.	+	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Fraxinus mandshurica	+	.	.	.	.	.	17	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	6
Securinega suffruticosa	.	+	.	.	.	.	17	.	.	.	1	.	.	.	.	1	.	.	+	.	.	.	.	.	18
Spiraea pubescens	.	.	.	.	1	.	17	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	12
Ulmus macrocarpa	.	.	.	.	.	+	17	.	.	.	.	1	.	.	.	1	.	.	.	2	.	.	.	.	18
Fraxinus rhynchophylla	.	.	.	.	.	.	–	+	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	18
Lespedeza maximowiczii	.	.	.	.	.	.	–	.	1	1	.	.	.	.	.	2	.	.	.	.	.	.	.	.	18
Prunus mandshurica	.	.	.	.	.	.	–	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	12
Parthenocissus tricuspidata	.	.	.	.	.	.	–	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	12
E_1 - Species of rock fissures																									
***Patrinia rupestris* (A)**	**+**	**1**	**+**	**2**	.	**+**	**83**	+	+	.	+	+	.	.	1	.	+	+	.	.	.	.	.	.	41
***Asplenium ruta-muraria* (A)**	**r**	**r**	.	.	.	.	**33**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
***Potentilla dickinsii* (c)**	.	**+**	.	.	.	**1**	**33**	.	**+**	**+**	.	.	**1**	**+**	**+**	.	.	.	**+**	.	.	.	**1**	.	**41**
***Selaginella stauntoniana* (A)**	.	.	.	.	.	.	–	**3**	**2**	**4**	**5**	**5**	**2**	**2**	**3**	**4**	**5**	**5**	**3**	**4**	**1**	**2**	**4**	**3**	**100**
***Mukdenia rossii* (A)**	.	.	.	.	2	2	33	**1**	**r**	.	.	.	**2**	**3**	.	.	.	**+**	**1**	.	**3**	**4**	**2**	**2**	**59**
***Chrysanthemum zawadskii* agg. (A)**	.	1	.	.	.	.	17	.	**2**	.	.	**+**	.	.	.	**+**	**+**	.	.	.	**2**	**2**	**2**	**+**	**47**
***Meehania urticifolia* (A)**	.	.	.	.	+	.	17	**+**	**r**	**+**	**+**	.	.	.	.	**+**	**+**	.	**+**	**+**	.	.	.	.	**47**
Sedum kamtschaticum	.	.	r	.	.	.	17	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6
Pyrrosia petiolosa	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	6
Cheilanthes argentea	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	6
Sedum sarmentosum	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6
Other species																									
***Isodon japonicus* (A)**	**1**	**+**	**1**	**+**	.	**+**	**83**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
***Buxus koreana* juv. (c)**	**+**	**2**	**+**	**+**	**+**	.	**83**	.	**+**	**+**	**+**	**1**	.	**r**	**2**	.	.	**+**	.	.	.	.	**+**	.	**47**
***Spiraea pubescens* juv. (c)**	**+**	.	**+**	**+**	**+**	**+**	**83**	**1**	.	**+**	**+**	.	**+**	.	.	**+**	**r**	**+**	**r**	.	.	.	.	**+**	**53**
***Lilium amabile* (A)**	**r**	**+**	**+**	**+**	.	.	**67**	.	.	.	.	r	.	.	.	+	.	.	.	.	.	.	.	.	12
***Artemisia gmelinii* (c)**	**+**	**+**	.	.	.	**r**	**50**	.	.	.	**+**	**1**	.	**1**	**+**	**1**	.	**+**	**+**	**r**	.	.	.	.	**47**
Carex lanceolata agg.	2	2	2	+	+	2	100	.	.	1	1	2	+	.	+	1	1	2	+	.	1	.	.	1	65
Calamagrostis arundinacea	+	2	1	+	2	1	100	+	1	+	+	+	1	2	1	2	1	1	+	+	.	.	+	1	88
Arundinella hirta	+	1	1	+	+	+	100	+	+	+	1	2	.	+	+	+	+	2	1	+	.	.	+	.	76
Themeda japonica	+	.	+	.	.	.	33	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Spodiopogon sibiricus	1	.	.	+	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Lespedeza bicolor juv.	+	.	.	+	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Dioscorea septemloba juv.	r	.	.	r	.	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Weigela florida juv.	.	+	.	.	r	.	33	.	+	.	.	.	.	+	1	+	.	.	.	.	.	.	.	r	29
Spiraea blumei juv.	+	.	.	.	.	.	17	.	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.	r	24
Fraxinus rhynchophylla juv.	+	.	.	.	.	.	17	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	12
Asparagus oligoclonus	+	.	.	.	.	.	17	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	6
Cocculus trilobus	r	.	.	.	.	.	17	.	.	.	.	.	.	.	.	+	.	+	.	2	.	.	.	.	18
Viola variegata	r	.	.	.	.	.	17	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	12
Rhus javanica juv.	.	r	.	.	.	.	17	.	.	.	.	r	.	.	.	r	.	.	r	r	.	.	.	.	24
Ulmus macrocarpa juv.	.	.	+	.	.	.	17	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	1	18
Artemisia princeps	.	.	.	+	.	.	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	6
Lespedeza maximowiczii juv.	.	.	.	r	.	.	17	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	12
Aster yomena	.	.	.	r	.	.	17	.	+	.	.	.	1	1	+	.	.	.	.	.	.	.	.	.	24
Potentilla fragarioides	.	.	.	.	2	.	17	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
Rubia cordifolia agg.	.	.	.	.	.	+	17	.	.	.	r	r	.	.	.	.	r	+	.	+	.	.	.	.	29
Aster pekinensis	.	.	.	.	.	+	17	.	.	r	.	.	.	.	.	+	.	.	.	.	.	.	.	.	12
Rhaponticum uniflorum	.	.	.	.	.	.	–	.	.	.	+	+	.	r	r	.	.	+	.	.	.	.	.	.	29
Allium thunbergii	.	.	.	.	.	.	–	.	+	+	.	.	.	+	.	.	.	.	.	.	.	.	+	.	24
Scirpus dioicus	.	.	.	.	.	.	–	+	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	18
Boehmeria spicata	.	.	.	.	.	.	–	.	1	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	18
Galium kinuta	.	.	.	.	.	.	–	.	+	.	.	.	.	.	.	2	1	.	.	.	.	.	.	.	18
Prunus mandshurica	.	.	.	.	.	.	–	.	.	.	r	r	.	.	.	.	.	+	.	.	.	.	.	.	18
Sanguisorba hakusanensis	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	r	.	18
Carex sp.	.	.	.	.	.	.	–	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	12

Table 11 (continued)

*Solidago *asiatica*	.	.	.	.	.	.	.	–	.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	12
Carpinus coreana juv.	.	.	.	.	.	.	.	–	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	12
Euphorbia ebracteolata	.	.	.	.	.	.	.	–	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	12
Thalictrum rochebrunianum	.	.	.	.	.	.	.	–	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	12
Lilium callosum	.	.	.	.	.	.	.	–	.	.	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	12
Hemerocallis minor	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	12
Taraxacum sp.	.	.	.	.	.	.	.	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	12
E_0																										
***Weissia controversa* (c)**	**+**	**+**	**1**	**+**	**1**	**+**	**100**		**2**	**2**	**.**	**.**	**2**	**.**	**.**	**.**	**2**	**.**	**2**	**+**	**1**	**.**	**.**	**2**	**2**	**53**
Hypnum plumaeforme	+	.	.	.	.	.	17		.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Tortella tortuosa	.	+	.	.	.	.	17		.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Brachythecium buchananii	.	.	1	.	.	.	17		.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	2	18
Phylliscum japonicum	.	.	1	.	.	.	17		.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
Dermatocarpon miniatum	.	.	.	.	+	.	17		.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	6
Bryum argenteum	.	.	.	.	.	.	–		.	+	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	18
Reboulia hemisphaerica	.	.	.	.	.	.	–		.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	18
Marchantia tosana	.	.	.	.	.	.	–		.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	18
Anomodon viticulosus	.	.	.	.	.	.	–		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	12

In one relevé only

E_1 + E_2: *Lithospermum erythrorhizon* 1: +; *Quercus variabilis* 1: +; *Pinus densiflora* E_2 2: 1; *Syringa wolfii* E_2 2: 1; *Abelia insularis* juv. 2: +; *Lonicera praeflorens* 2: +; *Benzoin obtusilobum* juv. 2: r; *Quercus variabilis* E_2 4: 2; *Pueraria lobata* E_2 4: 1; *Rhamnus schneideri* juv. 4: +; *Tilia amurensis* E_2 4: +; *Paraixeris denticulata* 5: r; *Bromus tectorum* 6: r; *Celastrus orbiculatus* juv. 6: r; *Benzoin obtusilobum* E_2 8: +; *Dioscorea quinqueloba* 8: r; *Carpinus coreana* E_2 9: 2; *Adenophora tetraphylla* 11: r; *Aster scaber* 13: r; *Lilium cernuum* 13: r; *Albizzia julibrissin* juv. 14: r; *Ixeris sonchifolia* 14: r; *Clerodendron trichotomum* E_2 15: +; *Dioscorea quinqueloba* E_2 15: +; *Neillia uekii* E_2 15: +; *Hemistepta lyrata* 15: r; *Smilax oldhamii* 17: r; *Euonymus alata* E_2 18: 2; *Impatiens* sp. 18: r; *Arisaema amurense* 19: +; *Lonicera morrowii* juv. 19: +; *Arenaria serpyllifolia* 20: +; *Poa trivialis* 20: +; *Parnassia palustris* 21: 2; *Rhododendron mucronulatum* juv. 21: 1; *Aruncus americanus* 21: +; *Trigonotis peduncularis* 21: +; *Potentilla yokusaiana* 23: 1; *Lespedeza daurica* juv. 23: r;
E_0: *Haplohymenium triste* 1: 1; *Parmelia* sp. 5: 1; *Encalypta rhaptocarpa* 7: 1; *Collema tenax* 9: +; *Gonohymenia* sp. 12: 2; *Barbula inguiculata* 12: 1; *Ceratodon purpureus* 12: 1; *Oncophorus virens* 13: 2; *Rhizomnium striatum* 13: 2; *Pohlia nutans* 13: 1; *Encalypta ciliata* 14: +; *Bryum* sp. 18: 1; *Thamnobryum coreense* 19: 1; *Bryum pseudotriquetrum* 20: 2; *Jungermannia exsertifolia* 20: 2; *Pohlia wahlenbegrii* 20: 1; *Campyliadelphus stellatus* 21: 3; *Cratoneuron filicinum* 21: 2; *Philonotis revoluta* 21: 1.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

Junipero rigidae-Buxetum koreanae

1, JKS, 36.00, 93, W/65, 75, 15, 3, Gangneung, ca 2 km under Sangyeri Village, calcareous rocks, 31. 5. 2007;

2, JK, 25.00, 543, WNW/70, 50, 35, 1, Taebaek, ca 10 km dir. Andong, arid rocks over road, dolomite, 2. 6. 2007;

3, JKS, 40.00, 105, WSW/65, 40, 10, 3, Gangneung, Sangyeri Village, arid calcareous rocks above the road, 31. 5. 2010;

4, JKS, 36.00, 143, SSW/45, 60, 10, 1, Gangneung, under Sangyeri Village, left side of small creek, dolomite slopes, 31. 5. 2007;

5, JK, 30.00, 237, E/85, 15, 20, 2, Yeongwol, NNW, near bridge over Mungok-cheon River, dolomite, 23. 5. 2007;

6, JS, 9.00, 313, SSE/85, 10, 25, 1, Jeongseon, rock near river, dolomite, 28. 5. 2007;

Meehanio urticifoliae-Selaginelletum stauntonianae

7, JK, 10.00, 243, WSW/40, 10, 45, 15, Yeongwol, wet rocks near road to Dongang, 1.5 km N from junction, 23. 5. 2007;

8, JKS, 12.00, 190, WNW/60, 25, 35, 10, Yeongwol, Namhangang River, steep rock over road, 20. 5. 2007;

9, JK, 25.00, 195, NW/70, 15, 80, 3, Yeongwol, dolomite, 20. 5. 2007;

10, JK, 18.00, 187, W/50, 15, 100, 0, Yeongwol, dolomite, 21. 5. 2007;

11, JK, 20.00, 188, WSW/60, 10, 95, 5, Yeongwol, dolomite, 21. 5. 2007;

12, JKS, 12.00, 176, NNW/80, 0, 15, 20, Yeongwol, Namhangang River in the Gajegol Valley, dolomite, 20. 5. 2007;

13, JKS, 12.50, 180, NW/85, 0, 60, 25, Yeongwol, Namhangang River in the Gajegol Valley, dolomite, 20. 5. 2007;

14, JKS, 8.00, 185, WNW/40, 0, 50, 1, Yeongwol, Namhangang River in the Gajegol Valley, schistose dolomite steps, 20. 5. 2007;

15, JK, 8.00, 198, NW/75, 30, 80, 5, Yeongwol, Namhangang River, dolomite, 20. 5. 2007;

16, JK, 25.00, 209, NW/50, 15, 90, 0, Yeongwol, flat rocky plate above Namhangang River, dolomite, 20. 5. 2007;

17, JK, 15.00, 185, W/45, 0, 98, 10, Yeongwol, ESE ca 1 km, dolomite slopes above Namhangang River, 21. 5. 2007;

18, JK, 10.00, 191, ESE/70, 20, 40, 3, Yeongwol, Okdong-cheon River, right side, shady slope, dolomite, 21. 5. 2007;

19, JK, 10.00, 169, ENE/55, 30, 70, 3, Yeongwol, Okdong-cheon River, near bridge, left tributary of the Namhangang River, dolomite, 21. 5. 2007;

20, JK, 16.00, 150, ENE/12, 0, 50, 20, Yeongwol, Namhangang River, SE from the Gossi Cave, schistose dolomite, 21. 5. 2007;

21, JK, 20.00, 153, N/70, 0, 70, 70, Yeongwol, Namhangang River, SE from the Gossi Cave, schistose rocks, 21. 5. 2007;

22, JK, 20.00, 250, E/75, 0, 70, 20, Youngwol, 1 km SE from the Gossi Cave, near bridge over the Namhangang River, 21. 5. 2007;

23, JK, 10.00, 250, NE/80, 0, 50, 60, Youngwol, 1 km SE from the Gossi Cave, near bridge, 22. 5. 2007.

Table 12 *Parthenocissus tricuspidata* community

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Constancy (S) in total number of relevés (%)													**S**
E_1 - Species of rock fissures													
Sedum kamtschaticum	.	.	r	.	.	2	.	2	2	.	.	.	33
Mukdenia rossii	.	.	.	3	+	.	1	.	.	.	2	.	33
Potentilla dickinsii	.	1	.	1	+	.	.	.	.	.	.	.	25
Patrinia rupestris	+	r	.	.	.	.	.	.	.	.	.	.	17
Asplenium ruta-muraria	.	.	.	.	r	.	.	.	.	.	.	.	8
Camptosorus sibiricus	.	.	.	.	.	+	.	.	.	.	.	.	8
Woodsia subcordata	.	.	.	.	.	+	.	.	.	.	.	.	8
Cheilanthes argentea	.	.	.	.	.	.	.	1	.	.	.	.	8
Sedum polytrichoides	.	.	.	.	.	.	.	.	1	.	.	.	8
Orostachys japonica	.	.	.	.	.	.	.	.	.	+	.	.	8
Cystopteris sudetica	.	.	.	.	.	.	.	.	.	.	.	+	8
Woodsia manchuriensis	.	.	.	.	.	.	.	.	.	.	.	+	8
Dryopteris saxifraga	.	.	.	.	.	.	.	.	.	.	.	+	8
E_2													
Spiraea pubescens	+	.	.	.	.	.	2	.	.	.	.	.	17
E_1													
***Parthenocissus tricuspidata* (c)**	**4**	**5**	**5**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**4**	**3**	**100**
Calamagrostis arundinacea	+	+	+	+	.	+	.	+	.	2	2	+	75
Artemisia gmelinii	+	1	.	+	2	1	2	.	1	+	.	.	67
Spiraea pubescens juv.	r	1	.	+	.	2	.	+	.	.	.	.	42
Arundinella hirta	+	+	+	.	.	.	+	.	.	.	.	.	33
Weigela florida juv.	r	.	.	+	.	1	.	.	.	.	.	+	33
Carex lanceolata agg.	.	+	+	+	.	.	.	+	.	.	.	.	33
Spiraea blumei juv.	.	+	.	2	+	.	.	.	.	.	.	.	25
Commelina communis	.	.	.	.	.	+	.	r	+	.	.	.	25
Buxus koreana juv.	r	1	.	.	.	.	.	.	.	.	.	.	17
Paraixeris denticulata	r	.	.	.	+	.	.	.	.	.	.	.	17
Aster pekinensis	.	+	.	.	+	.	.	.	.	.	.	.	17
Vitis amurensis	.	+	.	.	.	.	+	.	.	.	.	.	17
Lilium amabile	.	+	.	.	.	.	r	.	.	.	.	.	17
Lilium lancifolium	.	r	+	.	.	.	.	.	.	.	.	.	17
Poa nemoralis	.	.	.	+	.	.	.	.	.	+	.	.	17
Artemisia capillaris	.	.	.	.	r	r	.	.	.	.	.	.	17
Humulus japonica	.	.	.	.	.	+	.	.	+	.	.	.	17
Boehmeria spicata	.	.	.	.	.	+	.	.	.	.	r	.	17
Spodiopogon sibiricus	.	.	.	.	.	.	.	+	+	.	.	.	17
Setaria viridis	.	.	.	.	.	.	.	r	+	.	.	.	17
E_0													
Hypnum cupressiforme	1	.	.	.	1	1	.	.	.	.	.	.	25
Weissia controversa	+	.	.	.	.	2	.	.	.	.	.	.	17

In one relevé only

E_1 + E_2: *Clematis apiifolia* 1: 1; *Weigela florida* E_2 1: 1; *Meehania urticifolia* 1: +; *Acer ginnala* juv. 1: r; *Pinus densiflora* juv. 1: r; *Peucedanum terebintaceum* 2: 1; *Isodon japonicus* 2: +; *Rhaponticum uniflorum* 2: r; *Celastrus orbiculatus* juv. 3: 2; *Acer ginnala* E_2 3: 1; *Benzoin obtusilobum* E_2 3: 1; *Deutzia uniflora* E_2 3: 1; *Lespedeza bicolor* E_2 3: +; *Wisteria sinensis* 3: +; *Allium thunbergii* 5: 1; *Themeda japonica* 5: +; *Ulmus macrocarpa* juv. 5: +; *Lonicera japonica* juv. 5: r; *Deutzia glabrata* juv. 8: +; *Paraixeris chelidoniifolia* 8: r; *Artemisia princeps* 9: +; *Rhododendron micranthum* juv. 10: 2; *Fraxinus rhynchophylla* juv. 11: r; *F. sieboldiana* juv. 11: r; *Carex ciliato-marginata* 12: 1;
E_0: *Brachythecium buchananii* 1: +; *Didymodon rigidicaulis* 5: 1; *Dermatocarpon miniatum* 5: +; *Phylliscum japonicum* 5: +; *Tortella* sp. 8: 1; *Bryum argenteum* 10: 1; *Bryum* sp. 10: +; *Lepraria* sp. 10: +; *Oncophorus crispifolius* 12: 2.

Localities: Relevé number, Authors code, Relevé area (m^2), Altitude (m), Exposition/Inclination (°), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Locality, Date.

1, JK, 24.00, 242, NNW/80, 5, 65, 3, Yeongwol, valley of the Mungok-cheon River, schistose dolomite, 23. 5. 2007;
2, JKS, 25.00, 366, W/85, 0, 95, 0, Jeongseon, dolomite, 27. 5. 2007;
3, JK, 32.00, 444, SE/90, 5, 90, 0, Jeongseon, dolomite, 27. 5. 2007;
4, JKS, 20.00, 435, SE/80, 0, 90, 0, Jeongseon, Im-gye-cheon River, rock over road near stream, schistose dolomite, 29. 5. 2007;
5, JKS, 25.00, 420, ENE/75, 0, 60, 5, Jeongseon, Im-gye-cheon River, rock over road near stream, schistose dolomite, 29. 5. 2007;
6, JKS, 25.00, 394, NE/85, 0, 90, 5, Jeongseon, road to Andong, dolomite rock, 27. 5. 2007;
7, JK, 12.00, 215, SSW/85, 15, 75, 0, Yeongwol, rock in aluvium of Dongang River, dolomite rock, 23. 5. 2007;
8, J, 12.00, 144, S/75, 0, 55, 5, Uiseong, Gounsa Temple, ca 16 km from temple, 19. 6. 2006;
9, JKS, 24.00, 269, SSE/80, 0, 75, 0, Samcheok, Singi-myeon, ca 1 km towards Hwanseongul Cave, granite rock, 1. 6. 2007;
10, K, 9.00, 558, SSW/85, 0, 60, <5, Bonghwa, Sokse-gol Valley near Seokpomyeon City, granodiorite, 26. 5. 2007;
11, K, 4.00, 245, W/10, 0, 75, 0, Seorak-san, top of shady boulder, granodiorite, 23. 6. 2006;
12, K, 12.00, 330, N/100, 0, 50, 10, Yeongwol, Local Road 88 from Kim Sat Gat Valley, granodiorite rock, 22. 5. 2007.

Weigela florida and others is an important physiognomic element (Table 11). Its coverage reaches 40 to 75% for developed stands; at stands with a less developed shrub layer, it reaches only 10 to 15%. In total, 18 species of shrubs have been found here. The average cover of the analysed stands was 45%.

The herb layer usually has a lower cover in the range of 10–25%, and in one relevé, it reaches 50%. The average cover of this layer is less than 22%. Some species, e.g., *Patrinia rupestris* and *Mukdenia rossii*, show similarity with the association *Patrinio rupestris-Mukdenietum rossii*. However, many other species are missing in this community, so it is not possible to classify it as a subunit of this association. The total number of herbs in six relevés reached 39. In individual relevés, the number of herbs and shrubs is 16–31, on average more than 20 species per relevé. Species with higher constancy are represented only by *Calamagrostis arundinacea*, *Arundinella hirta*, *Carex lanceolata* agg., and *Patrinia rupestris*. The height of the stands is variable at different parts of the vegetation season; the lower species are only 10–30 cm high, and the grass and the high species exceed the height of 1 m at flowering time.

The cover of the moss layer is very low, at only 1–3%. In one relevé, with the highest abundance of the shrub layer reached 35%. It is obvious that its value rises with the shadowing of the habitat. Its average cover, however, did not reach 8% in this rare occurrence. In individual relevés, the number of species varies between 1 and 3, with an average of more than 2 species per relevé. In total, 8 species were recorded in this community. High constancy is achieved only by moss *Weissia controversa*.

This community was found on localities with *Buxus koreana*, mostly in the western or southern orientations and inclinations of 45–85° (more than 69° on average). It is located at an altitude of 93–543 m (on average 239 m). For the optimal occurrence of the endemic species of *Buxus koreana*, the community should be protected. Its leading shrub species, with a not too wide area, could be included among the protected species of Korea, where it is still lacking (cf. Lee 2009).

Meehanio urticifoliae-Selaginelletum stauntonianae ass. nova hoc loco

Nomenclatural type: relevé 9 in Table 11, (holotypus)
Association species: *Chrysanthemum zawadskii* agg., *Meehania urticifolia*, *Mukdenia rossii*, *Selaginella stauntoniana*

An important community of calcareous rocks (dolomite, schistose dolomite). Its physiognomy is characterized by high cover and constancy of *Selaginella stauntoniana*. This species avoids acidic and hard-rocking rocks (granodiorite and granite). It was found only on limestone or dolomite rocky walls throughout the Korean Peninsula. Characteristic species of the association do not usually reach heights greater than 30 cm. Many of accompanying species are, however, considerably higher. High stability also occurs in the accessory species *Calamagrostis arundinacea*, *Arundinella hirta*, *Carex lanceolata* agg., *Spiraea pubescens*, and *Artemisia gmelinii*. *Buxus koreana* can occur in the shrub and herb layers.

Unlike the association *Junipero rigidae-Buxetum koreanae*, the shrub layer does not occur frequently. It has only low coverage, although the total number of woody species found reaches more than 20. For most relevés the shrub layer is missing; elsewhere is a cover of 10–30%; on average, only 10%. The herb and shrub layers have on average only less than 16 species in per relevé. In one relevé, 7–26 species were found. Altogether, more than 70 species have been found in the herb layer of these stands. Nevertheless, the community is not rich in species in the individual relevés. Its cover varies between (15)35 and 100%, more than 64% on average. A total of 29 species were recorded in the moss layer, with only the *Weissia controversa* being the most constant. In several relevés the moss layer is missing, elsewhere achieving a cover of 1–25(70) %, on average less than 16% per relevé. The individual relevés show only (0)1–5 species, with fewer than 3 species on average. The community is also poor in moss species. Erosion and solifluction of the soil is a significant ecological factor.

This association was found at altitudes of 150 to 250 m in various orientations with a slope of (12)40–85°, almost 60° on average. The soil of dolomite rocks consists of calcareous clay with limestone gravel. It is freshly moist. In the northern part of the Korean Peninsula, we were able to collect only one relevé by I. Jarolímek above the Taedonggang River near Pong-Ha Ri Village (Kolbek et al. 1998). It can be classified within this association.

Parthenocissus tricuspidata community

The liana *Parthenocissus tricuspidata* densely overgrows rocks (secondary also walls), which significantly influences other species composition (Table 12). However, dense stands are usually able to retain plant residues and at least partially prevent erosion of the soil substrate. High coverage during the growing season is determined mainly by its large leaves, which reduce the occurrence of other, especially lower species. The stands do not usually have any stable species composition. More frequent are only durable and often stubble species, e.g. *Calamagrostis arundinacea*, *Artemisia gmelinii*, juvenile shrubs, *Arundinella hirta*, and *Carex lanceolata* agg. Another group consists of species with rapid growth (*Sedum kamtschaticum*, *Commelina communis*, *Mukdenia rossii*) and high plant (*Lilium amabile*, *L. lancifolium*). Small and competitively weak species of rock crevices are usually absent (*Amitostigma gracile*, *Saxifraga fortunaei*).

The cover of the shrub layer is very low (maximum 15%, on average about 2%), mostly this layer does not occur in the stands. Due to large leaves of the dominant species, the cover of the herb layer reaches 50–95%, on average more than 73%.

Table 13 Abridged synoptic table of plant communities of rock habitats in South Korea

Group No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of relevés	19	14	3	5	17	9	26	7	22	38	17	11	6	17	12
Number of less frequent species	40	34	14	11	45	23	67	17	54	87	16	20	21	56	20
Characteristic species of rocks with higher constancy															
Davallia mariesii	100	.	1	.	.	.	8	.	.	5	.	.	.	.	.
Sedum polytrichoides	32	100	.	.	6	.	12	.	32	21	12	.	.	.	8
Amitostigma gracile	26	64	1	20	.	.	38	.	5	42	12	.	.	.	.
Sedum sarmentosum	.	.	3	.	6	.	4	.	.	.	.	.	.	6	.
Pyrrosia petiolosa	.	.	.	80	.	.	4	.	.	.	.	.	.	6	.
Hypnum cupressiforme E0	.	7	1	80	.	.	15	.	.	16	.	.	.	.	25
Woodsia polystichoides	5	7	.	60	12	.	19	.	5	.	.	.	.	.	.
Sedum kamtschaticum	37	7	1	60	6	11	65	.	.	8	.	.	17	6	33
Pyrrosia linearifolia	.	.	.	60	.	.	15	.	.	.	.	.	.	.	.
Woodsia manchuriensis	21	7	.	.	82	11	15	.	50	26	6	.	.	.	8
Dennstaedtia hirsuta	5	.	.	.	6	100	31	.	36	18	12	.	.	.	8
Dryopteris subtripinnata	.	14	.	.	.	56	8	.	18	16	6	.	.	.	.
Selaginella tamariscina	11	14	.	.	6	.	100	.	.	18	.	.	.	.	.
Chrysosplenium flagelliferum	.	.	.	.	.	.	.	100	5	.	.	.	.	.	.
Astilbe chinensis	.	7	.	.	6	.	4	86	27	11	.	.	.	.	.
Angelica polymorpha	.	.	.	.	.	.	.	43	9	3	.	.	.	.	.
Saxifraga fortunaei	.	7	.	.	.	33	8	.	100	21	12	.	.	.	.
Deutzia uniflora juv.	32	7	.	.	12	33	4	43	73	26	12	.	.	.	.
*Hydrangea *acuminata*	.	.	.	.	.	11	.	29	41	.	.	.	.	.	.
Selaginella rossii	21	21	.	.	6	.	31	.	5	68	35	.	.	.	.
Mukdenia rossii	5	14	.	.	6	33	15	.	5	53	59	100	33	59	33
Potentilla dickinsii	.	.	.	.	.	.	4	.	.	16	100	64	33	41	25
Sanguisorba hakusanensis	.	.	.	.	.	.	.	.	5	16	47	.	.	18	.
Saussurea nivea	.	.	.	.	.	.	.	.	.	13	41	.	.	.	.
Patrinia saniculaefolia	.	.	.	.	.	.	.	.	.	13	35	.	.	.	.
Weissia controversa E0	16	.	.	40	6	.	23	.	.	.	.	82	100	53	8
Buxus koreana juv.	.	.	.	.	.	.	.	.	.	.	.	82	83	47	17
Aster pekinensis	.	.	.	.	.	11	8	.	.	5	.	82	17	12	17
Anomodon integerrimus E0	.	.	.	.	.	.	.	.	.	.	.	73	.	.	.
Arundinella hirta	.	14	1	.	.	.	31	.	.	21	24	64	100	76	33
Lilium amabile	.	.	.	.	.	.	8	.	.	.	.	45	67	12	17
Buxus koreana E2	.	.	.	.	.	.	.	.	.	.	.	.	100	29	.
Patrinia rupestris	.	.	.	.	.	.	.	.	.	.	.	27	83	41	17
Selaginella stauntoniana	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.
Meehania urticifolia	.	.	.	.	12	.	.	.	.	.	.	.	17	47	8
Rocky species and others															
Carex lanceolata agg.	68	64	.	.	35	67	46	.	36	66	88	73	100	65	33
Chrysanthemum zawadskii agg.	.	50	.	.	.	11	15	.	5	45	41	55	17	47	17
Weigela florida juv.	16	21	.	80	59	22	8	.	14	37	29	9	33	29	33
Parthenocissus tricuspidata	26	43	.	80	18	11	8	.	.	5	.	9	.	12	100
Athyrium yokoscense	.	.	.	.	41	22	.	.	27	3	.	.	.	.	.
Boehmeria spicata	11	.	.	20	35	22	50	43	5	8	.	.	.	18	17
Calamagrostis arundinacea	32	43	.	40	29	11	46	14	59	71	47	91	100	88	75
Rhododendron mucronulatum juv.	16	21	.	.	6	44	31	.	32	39	53	.	.	6	.
Spiraea pubescens juv.	.	.	.	.	.	.	19	.	.	.	.	73	83	53	42
Artemisia gmelinii	5	.	.	40	.	.	19	.	.	.	.	73	50	47	67
Isodon japonicus	.	7	.	.	.	.	4	.	.	.	.	45	83	.	8
Spiraea blumei E2	.	.	.	20	.	.	15	.	.	5	.	9	67	6	.
Juniperus rigida E2	.	.	.	.	.	.	.	.	.	.	.	.	67	.	.
Lespedeza bicolor E2	.	.	.	.	.	.	12	.	9	.	.	.	50	18	8
Weigela florida E2	21	7	.	.	12	.	4	.	9	11	6	.	50	29	8
Carex ciliato-marginata	32	7	.	.	24	44	27	14	5	18	.	.	.	.	8
Schistidium apocarpum E0	32	.	.	.	18	.	12	.	9	8	6	.	.	.	.
Hypnum plumaeforme E0	26	43	.	.	12	33	19	14	27	8	.	.	17	6	.
Rhododendron micranthum E2	26	.	.	20	.	11	.	.	.	13	.	.	.	.	.
Plagiothecium cavifolium E0	21	.	.	.	.	11	.	.	5	8	6	.	.	.	.
Rhus javanica E2	21	.	.	.	.	.	12	.	5	5	.	.	33	12	.
Rhus javanica juv.	16	14	1	.	.	.	12	.	.	3	.	.	17	24	.
Hedwigia ciliata E0	16	14	.	40	.	.	4	.	.	3	.	.	.	.	.
Rhododendron micranthum juv.	16	7	.	.	.	22	.	.	.	5	24	.	.	.	8
Camptosorus sibiricus	16	.	.	20	29	.	23	.	5	5	.	.	.	.	8
Spodiopogon sibiricus	11	29	2	.	.	22	23	.	.	16	47	.	33	.	17
Racomitrium sudeticum E0	11	29	1	.	6	22	8	.	23	5	6	.	.	.	.
Fraxinus rhynchophylla juv.	11	29	.	.	6	.	19	.	14	26	.	9	17	12	8
Commelina communis	11	14	1	20	6	.	8	.	.	.	6	.	.	.	25
Brachythecium buchananii E0	11	7	.	40	.	11	4	.	.	8	.	18	17	18	8
Thuidium kanedae E0	11	7	.	40	.	.	8	.	5	.	.	.	.	.	.
Lespedeza maximowiczii juv.	11	7	.	.	6	11	12	.	.	11	.	.	17	12	.
Schistidium spec. E0	11	7	.	.	.	.	8	.	.	11	.	9	.	.	.
Benzoin obtusilobum juv.	11	7	.	.	.	.	.	.	5	8	.	.	17	.	.
Deutzia uniflora E2	11	.	.	.	.	11	.	.	27	11	.	.	.	.	8
Paraixeris chelidoniifolia	5	36	.	.	.	.	.	.	14	3	.	.	.	.	8
Paraixeris denticulata	5	14	1	.	6	22	4	.	.	.	.	36	17	.	17
Melampyrum roseum	5	14	.	.	.	11	8	.	5	.	.	.	.	.	.
Lespedeza maximowiczii E2	5	14	.	.	.	.	4	.	.	8	6	.	.	18	.
Poa nemoralis	5	7	1	.	18	.	8	14	14	8	.	.	.	.	17
Fraxinus sieboldiana juv.	5	7	.	.	6	.	12	.	14	8	.	.	.	.	8
Pogonatum urnigerum E0	5	7	.	.	.	11	8	.	5	.	.	.	.	.	.
Fraxinus sieboldiana E2	5	7	.	.	.	.	15	.	27	11	.	.	.	.	.
Fraxinus rhynchophylla E2	5	7	.	.	.	.	8	.	.	3	.	.	.	18	.
Humulus japonica	5	.	2	.	12	.	.	.	.	.	.	9	.	.	17
Cladonia spec. E0	5	.	1	40	.	.	12	.	.	.	.	.	.	.	.
Dryopteris saxifraga	5	.	.	20	41	44	23	.	45	16	.	.	.	.	8
Tortella tortuosa E0	5	.	.	.	12	11	38	.	5	.	.	.	17	6	.
Artemisia keiskeana	5	.	.	.	12	11	8	.	.	3	18	.	.	.	.
Pinus densiflora juv.	5	.	.	.	.	22	4	.	.	3	18	.	.	.	8
Brachythecium populeum E0	5	.	.	.	.	11	8	14	5	.	.	.	.	.	.
Bryum spec. E0	5	.	.	.	.	11	8	14	.	3	6	.	.	6	8
Sedum ussuriense	5	.	.	.	.	.	31	.	.	.	.	.	.	.	.

Table 13 (continued)

Oplismenus undulatifolius	.	29	.	.	12	.	4	.	5	.	.	.	.	.	.
Plagiomnium cuspidatum E0	.	14	*1*	.	.	.	15	43	.	.	.	.	.	.	.
Lepisorus ussuriensis	.	14	.	20	12	.	19	.	23	13	.	.	.	.	.
Carpinus laxiflora juv.	.	14	.	.	6	11	4	.	14	8	.	.	.	.	.
Lespedeza bicolor juv.	.	14	.	.	.	.	8	.	5	8	18	.	33	.	.
Spiraea fritschiana juv.	.	14	.	.	.	.	8	.	.	24	24	.	.	.	.
Artemisia princeps	.	7	*1*	.	6	22	.	.	.	.	.	36	17	6	8
Ulmus macrocarpa	.	7	.	40	.	.	.	.	.	.	.	27	17	18	8
Rhizomnium punctatum E0	.	7	.	20	.	.	.	43	5	.	.	.	.	.	.
Spiraea blumei juv.	.	7	.	.	18	11	27	.	.	5	.	27	17	24	25
Deutzia glabrata juv.	.	7	.	.	6	.	8	.	5	8	.	.	.	.	8
Pohlia nutans E0	.	7	.	.	.	22	15	.	5	.	.	.	.	6	.
Atrichum undullatum E0	.	7	.	.	.	22	4	14	.	.	.	.	.	.	.
Rhododendron mucronulatum E2	.	7	.	.	.	11	12	.	14	16	6	.	.	.	.
Spiraea fritschiana E2	.	7	.	.	.	.	27	.	.	3	.	.	.	.	.
Campylopus japonicus E0	.	7	.	.	.	.	8	.	9	3	6	.	.	.	.
Hosta longipes	.	7	.	.	.	.	.	14	32	3	.	.	.	.	.
Allium thunbergii	.	7	.	.	.	.	.	.	.	3	12	18	.	24	8
Ixeris sonchifolia	.	.	*1*	20	6	.	.	.	.	3	.	.	.	6	.
Reboulia hemisphaerica E0	.	.	*1*	20	6	.	.	.	.	.	.	9	.	18	.
Abelia insularis E2	.	.	*1*	20	.	.	.	.	.	3	6	.	33	6	.
Potentilla fragarioides	.	.	*1*	.	.	11	15	.	.	.	12	.	17	12	.
Plagiothecium denticulatum E0	.	.	.	40	.	.	4	.	.	5	.	.	.	.	.
Parmelia spec. E0	.	.	.	40	.	.	.	.	.	.	.	.	17	.	.
Ceratodon purpureus E0	.	.	.	40	.	.	.	.	.	.	.	.	.	6	.
Oncophorus virens E0	.	.	.	.	6	11	4	.	9	5	.	.	.	6	.
Taraxacum spec.	.	.	.	.	6	.	.	29	.	.	.	.	.	12	.
Carex spec.	.	.	.	.	6	.	.	14	.	3	.	9	.	12	.
Asplenium ruta-muraria	.	.	.	.	6	.	.	.	.	.	.	.	33	.	8
Leucobryum glaucum E0	.	.	.	.	.	22	12	.	5	3	.	.	.	.	.
Plicanthus birmensis E0	.	.	.	.	.	22	.	.	.	3	.	.	.	.	.
Pyrrosia lingua	.	.	.	.	.	22	.	.	.	.	.	.	.	.	.
Herbertus aduncus E0	.	.	.	.	.	22	.	.	.	.	.	.	.	.	.
Dicranum scoparium E0	.	.	.	.	.	22	.	.	.	.	.	.	.	.	.
*Solidago *asiatica*	.	.	.	.	.	.	12	14	9	3	6	.	.	12	.
Peucedanum terebintaceum	.	.	.	.	.	.	4	.	.	3	.	27	.	.	8
*Agropyron *transiens*	.	.	.	.	.	.	4	.	.	.	.	27	.	.	.
Themeda japonica	.	.	.	.	.	.	4	.	.	.	.	9	33	6	8
Rhaponticum uniflorum	.	.	.	.	.	.	4	.	.	.	.	.	.	29	8
Conocephalum conicum E0	.	.	.	.	.	.	.	29	.	.	.	.	.	.	.
Plagiomnium affine E0	.	.	.	.	.	.	.	29	.	.	.	.	.	.	.
Brachythecium rutabulum E0	.	.	.	.	.	.	.	29	.	.	.	.	.	.	.
Lastrea japonica	.	.	.	.	.	.	.	14	32	3	.	.	.	.	.
Arisaema amurense	.	.	.	.	.	.	.	.	23	.	.	.	.	6	.
Aster yomena	.	.	.	.	.	.	.	.	.	.	24	.	17	24	.
Bromus tectorum	.	.	.	.	.	.	.	.	.	.	.	36	17	.	.
Rubia cordifolia agg.	.	.	.	.	.	.	.	.	.	.	.	9	17	29	.
Morus bombycis E2	.	.	.	.	.	.	.	.	.	.	.	.	33	.	.
Quercus dentata E2	.	.	.	.	.	.	.	.	.	.	.	.	33	.	.
Dioscorea septemloba	.	.	.	.	.	.	.	.	.	.	.	.	33	.	.

A total of 60 species were found in the shrub and herb layer, with 6–17 species in individual stands (on average more than 10). A moss layer due to strong shade does not occur or is greatly suppressed and reaches a maximum coverage of 10%, on average less than 3%. A total of 11 species were found here. In the individual stands, but mosses are often lacking or occur at only 1–4 species, on average slightly more than 1 per relevé.

This community is highly abundant throughout the Korean Peninsula and variable due to ecological conditions (schistose dolomite, granodiorite, granite, location in the field) and phytogeography. The community was recorded in the southern Korean Peninsula at altitudes of 144–558 m. The orientation is very variable, with a slope of 10–100° (on average 78°).

Classification and distribution of rock and wall plant communities found on the whole Korean Peninsula

Table 13 highlights groups of diagnostic species that are characteristic of given units. These species are usually characterized by high or higher constancy, or their occurrence is significant or unique for a given unit. It is clear that the validity of the groups depends not only on the number of relevés, but also on the size of the area of the unit and its coverage by the collected relevés. The sufficiently explored territory of South Korea and the possibility of comparison with results from North Korea demonstrate actual described units. Naturally, depending on the species richness of the units, groups of diagnostic species are different in number.

For the rock communities of the whole Korean Peninsula, one class, three orders, four alliances, 17 associations, 9 subassociations and 6 units at the community level were distinguished. In each part of the Korean Peninsula (southern and northern), 12 associations were confirmed but not identical for each of these parts. A total of 9 subassociations were recorded; 6 in the southern part and 8 in the northern part. Six units at the community level were found in the whole territory but were not identical for both territorial parts. Only 8 associations and communities are common to both parts of Korea, and it is certain that these numbers will grow after further research. Therefore, this current survey must not mislead and does not imply that all the

rocky communities are included. Therefore, it contains only those communities that were recorded during our expeditions. A great part of the Korean Peninsula did not coincide with our field excursions for various, mostly technical and time reasons. In addition, collecting material in difficult conditions of rock sites requires considerable time to collect them. It is therefore more than obvious that further research will bring significant enrichment in terms of new syntaxa as well as knowledge of their species and ecological variability and subsequent expansion.

The following overview is the result of the known occurrence and classification of rock and wall communities in the Korean Peninsula in 1986–2007. It is clear that new units will be added to the more detailed research in the future, and the overall classification may be revised. However, the proposed system is the first to deal with the rocky vegetation of the Korean Peninsula. The maps (Appendix 1) show communities that occur in South Korea, respectively in both Korean states. (Communities found **only** in North Korea are not drawn.)

CLASS *Selaginello tamariscini-Potentilletea dickinsii* Kolbek et al. 1997 nom. corr. Kolbek et Jarolímek 2013
Communities of rocky and wall habitats in the colline and montane (exceptionally in subalpine) belts of Japan and Korea.
Bas. *Selaginello involventis-Potentilletea dickinsii* **Kolbek et al. 1997**
NT *Potentilletalia dickinsii* Ohba 1973 (lectotypus see in Kolbek et al. 1997: 519)

ORDER 1 *Potentilletalia dickinsii* Ohba 1973
Semi-dry, dry, sunny or shaded rock plant communities in the colline and montane (exceptionally in subalpine) belts of Japan and the Korean Peninsula.
NT *Potentillion dickinsii* Ohba 1973 (lectotypus see in Kolbek et al. 1997: 519)

ALLIANCE A *Potentillion dickinsii* Ohba 1973
Dry and semi-dry, sunny rock plant communities in the colline and montane belts of Japan and the Korean Peninsula.
NT *Agrostio hideoi-Potentilletum dickinsii* Ohba 1973 (lectotypus see in Kolbek et al. 1997: 519)
***Rhododendro mucronulati-Potentilletum dickinsii* Kolbek, Jarolímek et Valachovič 1997**
NT Kolbek et al. (1997): Table 1, relevé 21
NK Relatively frequent in the Sujang-san, Kumgang-san and Chonma-san (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea. In the northern part of the territory, a possible occurrence can be expected.

ALLIANCE B *Selaginellion tamariscini* Kolbek et al. 1997 nom. corr. Kolbek et Jarolímek 2013
Plant communities on semi-dry and shaded rocks in the colline and montane (exceptionally in subalpine) belts of the Korean Peninsula.
Bas. *Selaginellion involventis* Kolbek et al. 1997
NT *Lepisoro ussuriensis-Selaginelletum tamariscinae* Kolbek, Jarolímek and Valachovič 1997: 519 nom. corr. Kolbek and Jarolímek 2013

***Artemisio keiskeanae-Chrysanthemetum coreani* Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 2, relevé 10.
Subass. a) *arundinelletosum hirtae* Kolbek et al. 1997
Subass. b) *orostachyetosum erubescentis* Kolbek et al. 1997
Subass. c) *asteretosum maackii* Kolbek et al. 1997
NK Relatively frequent in the Chonma-san, Sujang-san and in the vicinity of Sohungho Lake (Kumgang-san). In the Myohyang-san, it was found only in fragments in the subalpine belt (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea. In the northern part of the territory, a possible occurrence can be expected.

***Davallietum mariesii* Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 4, relevé 4
NK Scattered in the southern part of North Korea in the Sujang-san and Chonma-san (the surroundings of Kaesong city) and around Lake Sohungho (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK The association was found at many localities in the Gaya-san, Sobaek-san, Jiri-san, Deogyu-san, Juwang-san, by road from Worak-san to Andong city, and also in the Kim Sat Gat Valley near of Yongwol city (Appendix 1).

***Amitostigmato gracilis-Sedetum polytrichoidis* Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 3, relevé 9
Subass. a) *spodiopogonetosum sibirici* Kolbek et al. 1997
Subass. b) *lepisoretosum ussuriensis* Kolbek et al. 1997
NK Relatively frequent in the Kumgang-san and Sujang-san (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK The community has been recorded in the Seorak-san, Worak-san, Odae-san, Duta-san, Jiri-san, Juwang-san, and Sobaek-san (Appendix 1).

***Sedetum sarmentoso-middendorffiani* Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 7, relevé 3
NK Frequent in the Myohyang-san, especially in the surroundings of old Buddhist temples (Hwayangam and Sangwonam) and rare in the Kumgang-san (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK The community was found in the vicinity of Andong city and in the Sobaek-san and Gaya-san (Appendix 1).

Pyrrosietum linearifolio-petiolosae ass. nova
NT Kolbek et al. (see this paper): Table 3, relevé 4
NK Not yet confirmed in North Korea.
SK It was found in the Sobaek-san and near Yeongwol town (Appendix 1).

Lepisoro ussuriensis-Selaginelletum tamariscinae **Kolbek et al. 1997 nom. corr. Kolbek et Jarolímek 2013**
Bas. *Lepisoro ussuriensis-Selaginelletum involventis* Kolbek, Jarolímek and Valachovič 1997
NT Kolbek et al. (1997): Table 5, relevé 3
NK Relatively frequent in the Myohyang-san, Kumgang-san and Ljongak-san (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK This community was relatively frequent in the Juwang-san and Am-san, in the surrounding of the town Andong (near Gounsa Temple), and in Mureung-Valley (Appendix 1).

Woodsio polystichoidis-Orostachyetum erubescentis **Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 6, relevé 5
NK Scattered in natural habitats in the Myohyang-san and also in artificial habitats in the surroundings of the temples of Sangwonam and Hwayangam, and in the ancient Confucian School at Kaesong city (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea.

Commelino communis-Sedetum sarmentosi Kolbek et Valachovič 1996
NT Kolbek and Valachovič (1996): Table 1, relevé 7
NK Relatively frequent in the territory of the Kumgang-san (Kolbek and Valachovič 1996; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea.

Parietario micranthae-Pileaetum peploidis **Kolbek et al. 1997**
NT Kolbek et al. (1997): Table 8, relevé 3
NK Scarcely in the Sujang-san, Myohyang-san and Kumgang-san (Kolbek et al. 1997; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea.

Woodsia manchuriensis community
NK Not yet confirmed in North Korea.
SK The community was found at various locations in the Gaya-san, Taebaek-san and Sobaek-san, and around of Andong and Donghae cities (Appendix 1).

Dennstaedtia hirsuta community
NK Not yet confirmed in North Korea.
SK This community occurs in the Jiri-san, Gaya-san and Worak-san, and near Andong-Taebaek road (Appendix 1).

Camptosorus sibiricus-Pilea peploides community sensu Kolbek and Valachovič (1996).
NK Rare on the Sujangsansong Ruins in the east part of the Sujang-san and at one locality near the Kuryongpopo Waterfall in the Kumgang-san (Kolbek and Valachovič 1996; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea.

Oxalis stricta-Microlepia pilosella community sensu Kolbek et Valachovič (1996)
NK Rare in the town of Hedju, in Manvolde, and on the walls of the royal tomb of Kongmin near the town of Kaesong (Kolbek and Valachovič 1996; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea.

ORDER 2 ***Saxifragetalia fortunaei*** **Kolbek et al. 1998**
Communities of semi-dry, moist to wet rocks in the colline and montane belts in Korea.
NT *Saxifragion fortunaei* Kolbek et al. 1998: 46.

ALLIANCE C ***Saxifragion fortunaei*** **Kolbek et al. 1998**
Communities of shady or partialy shady moist and wet rocks in the colline and montane belts in Korea.
NT *Mukdenio rossii-Selaginelletum rossii* Kolbek et al. 1998: 46.

Astilbo chinensis-Chrysosplenietum flagelliferi ass. nova
NT Kolbek et al. (see this paper): Table 7, relevé 6
NK Not yet confirmed in North Korea.
SK The association was found so far in the southern part of the Korean Peninsula in the Jiri-san, Juwang-san, Sobaek-san, and Odae-san (Appendix 1).

Dryopterido saxifragae-Saxifragetum fortunaei **Kolbek et al. 1998**
NT Kolbek et al. (1998): Table 3, relevé 7
Subass. a) ***caricetosum siderostictae*** subass. nova
Subass. b) ***hydrangeetosum acuminatae*** subass. nova
NK Frequently found in the Myohyang-san, Kumgang-san, Sujang-san, and Chonma-san (Kolbek et al. 1998; Kolbek and Jarolímek 2013).
SK Stands of the association were found in the Taebaek-san, Odae-san, Daegyu-san, Gaya-san, and Jiri-san (Appendix 1). Their distribution is probably wider in other mountains of South Korea and probably throughout the Korean Peninsula.

Mukdenio rossii-Selaginelletum rossii **Kolbek et al. 1998**
NT Kolbek et al. (1998): Table 2, relevé 2
Subass. a) ***typicum*** **Kolbek et al. 1998**
Subass. b) ***androsacetosum cortusaefoliae*** **Kolbek et al. 1998**
NK Frequent in the Myohyang-san, Chonma-san and Kumgang-san (Kolbek et al. 1998; Kolbek and Jarolímek 2013).
SK This community was found quite often, e.g. in the Tabaek-san, Duta-san, Sobaek-san, Juwang-san, Gaya-san, Worak-san, Odae-san, Seorak-san, rocks near Jeongseon town and in the Baekcheon Valley (Appendix 1).

Patrinio saniculaefoliae-Mukdenietum rossii **Kolbek et al. 1998**
NT Kolbek et al. (1998): Table 1, relevé 6

NK A widespread community in the Kumgang-san (Kolbek et al. 1998; Kolbek and Jarolímek 2013).
SK The largest stands were recorded in the Seorak-san. Several relevés were also recorded in the Gaya-san (Appendix 1).

Saxifraga fortunaei-Boehmeria spicata community sensu Kolbek and Valachovič (1996)
NK Rare near the Pagion Waterfall in the Chonma-san (Kolbek and Valachovič 1996; Kolbek and Jarolímek 2013).
SK Not yet confirmed in South Korea. In the northern part of the territory, a possible occurrence can be expected.

ORDER 3 *Selaginello stauntonianae-Buxetalia koreanae* ordo nova hoc loco
Communities of limestone rocks of the Korean Peninsula.
NT *Selaginello stauntonianae-Buxion koreanae*, holotypus.
Characteristic (ch) and differential (d) species of the order: *Anomodon integerrimus* (d) *A. viticulosus* (ch), *Artemisia gmelinii* (ch), *Asplenium ruta-muraria* (ch), *Aster pekinensis* (ch), *Buxus koreana* (d), *Lilium amabile* (d), *Patrinia rupestris* (d), *Selaginella stauntoniana* (d), *Spiraea pubescens* (ch), *Weissia controversa* (ch).
Plant communities of semi-dry and dry limestone (dolomite, schistose dolomite, calcareous cliffs) rocks in the colline and montane belts of the Korean Peninsula. The floristic differences against the alliances *Potentillion dickinsii*, *Selaginellion tamariscini* and *Selaginellion tamariscini* are first of all the presence of limestone (or strictly calcicolous) species and absence of significantly acidophilous species (e.g. *Rhododendron* spec. Div., *Selaginella rossii*, *S. tamariscina*, *Astilbe chinensis*, *Woodsia manchuriensis*, *Saxifraga fortunaei*, *Dryopteris saxifraga*, etc.). The important species represent endemic shrub *Buxus koreana* and fern *Selaginella stauntoniana* which do not occur in the territory on the granite, granodiorite and acidic schistose rocks. The communities of this order and alliance are therefore distinguished primarily by the geological bedrock of the habitat.

ALLIANCE D *Selaginello stauntonianae-Buxion koreanae* all. nova hoc loco
Communities of of semi-dry limestone rocks in the colline and montane belts of the Korean Peninsula.
NT *Meehanio urticifoliae-Selaginelletum stauntonianae*, holotypus
Characteristic (ch) and differential (d) species of the alliance: identical with order species
To this alliance belong the following associations described here:

Patrinio rupestris-Mukdenietum rossii ass. nova
NT Kolbek et al. (see this paper): Table 10, relevé 6
NK Not yet confirmed in North Korea.
SK The association was recorded in the vicinity of towns Yeongwol and Jeongseon, and around In-gye-cheon, Yong-gye-cheon, and Dongang Rivers (Appendix 1).

Junipero rigidae-Buxetum koreanae ass. nova
NT Kolbek et al. (see this paper): Table 11, relevé 1
NK Not yet confirmed in North Korea.
SK It is located at Gangneung, Taebaek, Yeongwol, and Jeongseon (Appendix 1).

Meehanio urticifoliae-Selaginelletum stauntonianae ass. nova
NT Kolbek et al. (see this paper): Table 11, relevé 9
NK One relevé was recorded near the Ponghari Monument above the Taedonggang River southwest of Pyongyang (Kolbek et al. 1998; Kolbek and Jarolímek 2013). This community was then classified as ***Selaginella stauntoniana*** community.
SK The community occurs in the wider neighborhood of Yeongwol town near Namhangang River (Appendix 1).

Unclassified communities

Parthenocissus tricuspidata comunity (Table 12)
NK The widespread but not detailed studied community in North Korea.
SK The community is very common across the whole Korean Peninsula, e.g. Yeongwol, Jeongseon, Uiseong, Samcheok, Bonghwa, and Seorak-san (Appendix 1).

Discussion

Rock habitats are specific to their ecology, significantly influencing the selection of species able to survive there. Rock habitats are generally similar throughout the world and are characteristic of a lack of soil substrate and bedrock geology (Lee 1987), in which most plants take root. The particularities of individual habitats lie mainly in the geological composition of rocks (Hong et al. 2012) and microclimate. The climate has a large impact on the creation of Korean rock vegetation, bringing long and rich summer rainfall (Shin 1970; Ahn 2001). This is the main difference from the rocky vegetation of the lower to middle mountains in Europe. Summer rainfall and temperatures between 18 and 30 degrees have a positive effect on rock vegetation and the development of species that need enough water to grow. However, most of this vegetation can be described as semithermophilous. For this reason, we find a higher abundance of bryophytes in this habitat, while spring therophytes (ephemeral plants) are hardly represented. However, increased rainfall results in permanent soil erosion, with just a thin layer of soil that is maintained by tussock-forming species, deep-rooted

herbs and plants forming cushions. Most rainfall comes just in summer. Winter rainfall does not have to be kept on the rocks, and the habitats are directly exposed to low winter temperatures and needle ice. Needle ice has a profound effect on the seedlings of trees that can germinate due to rain, but during the winter they are "pulled out" of the primitive soil and dry in the spring. Thus, there are no obvious differences in habitat orientation as we know from landscapes where summer rainfall is rather scarce (e.g., *Lepisoro ussuriensis-Selaginelletum tamariscinae*, *Astilbo chinensis-Chrysosplenietum flagelliferi*, *Patrinio rupestris-Mukdenietum rossii*, *Meehanio urticifoliae-Selaginelletum stauntonianae*, and *Woodsia manchuriensis* community). Thus, there are fewer communities that prefer some habitat exposure (e.g. *Davallietum mariesii*, *Amitostigmato gracilis-Sedetum polytrichoidis*, *Sedetum sarmentoso-middendorffianii*, *Dryopterido saxifragae-Saxifragetum fortunaei*, *Mukdenio rossii-Selaginelletum rossii*, *Patrinio saniculaefoliae-Mukdenietum rossii* and *Dennstaedtia hirsuta* community). However, the preference may vary with latitude. The summer monsoon also has a limiting effect on sun exposure (cf. Deil 2019) and thus reduces the differences in temperature between summer and winter and between day and night. Thus, in general, the climate is susceptible to suboceanic conditions and the "steppe effect" disappears. Climatic conditions and shallow soil thus have a major impact on the selection of surviving species (cf. Nowak et al. 2014, 2015; Polyakova and Valachovič 2019). Therefore, predominantly tussock-forming grasses (*Calamagrostis arundinacea*, *Arundinella hirta*, *Spodiopogon sibiricus*), sedges (*Carex lanceolata* agg., *C. ciliato-marginata*) (see also Oh 2006) and deep-rooted herbs (*Chrysanthemum zawadskii* agg., *Parthenocissus tricuspidata*, *Paraixeris chelidoniifolia*, *Buxus koreana*, *Juniperus rigida*, *Aster pekinensis*, *Artemisia gmelinii*, *Patrinia saniculaefolia*, and *P. rupestris*) are maintained at the stands (e.g., in associations *Davallietum mariesii*, *Amitostigmato gracilis-Sedetum polytrichoidis*, *Dryopterido saxifragae-Saxifragetum fortunaei*, *Patrinio rupestris-Mukdenietum rossii*, *Junipero rigidae-Buxetum koreanae*). Compared to European vegetation, there are still some fundamental visual differences due to climate: 1) there are no broad transitions between vegetation of rock fissures and margins, between fringes and forest, 2) accumulation of soil substrate in clusters and under plant tufts, 3) smaller floristic differences between rocky basiphilous vegetation of limestone and vegetation on silicate rocks (e.g. associations *Patrinio rupestris-Mukdenietum rossii* and *Patrinio saniculaefoliae-Mukdenietum rossii*), and 4) rich occurrence of bryophytes (partly also lichens, see Tables 2, 6, 8, 9). Moss cushions, in which a substantial majority of herbs and woody plants germinate, play a very important role. In addition to retaining the necessary nutrients, but this medium mainly maintains a sufficient supply of moisture. For many rocky plants, moss cushions are a lifelong substrate, just as for most other terrestrial plants soil cover.

For the study of rock vegetation of the Korean Peninsula and East Asia, there is currently little comparative literature. Miyawaki et al. (1981, 1984); (Miyawaki 1986, 1987) described in their books on Japanese vegetation a total of 25 plant communities of rocks and classified them within the class *Asplenietea trichomanis*. For example, Miyawaki et al. (1981) give *Crypsinus hastatus* comm., Miyawaki et al. (1984) *Polysticho craspedosori-Tanakaeetum radicantis*, *Astilbo-Filipenduletum multijugae* and *Astilbe simplicifolia-Primula reinii* comm., and Miyawaki (1987) *Crypsinus hastatus-Conandron ramondioides* Ass. Ohba (1973a) described the order *Juncetalia maximowiczii* as shaded and moist rock communities of subalpine and alpine belts. Such communities were not found by us in Korea. However, it is possible that they may occur, for example, in the northern border mountains. However, the communities of the order *Potentilletalia dickinsii* described by the same author are found in Korea. The community of this order and alliance *Potentillion dickinsii* described by the same author is present in Korea in the association *Rhododendro mucronulati-Potentilletum dickinsii*. Some Korean rock plant communities contain a number of species common to the Japanese, and therefore, this order is a link between the rock communities of both countries. Many such species are used as diagnostic species of the class.

Based on our previous published works (Kolbek et al. 1997, 1998), we have relatively eligible comparison territories of the North and South parts of the Korean Peninsula. In the territory of South Korea, we have not observed the communities of the *Potentillion dickinsii* alliance with the only one known to date *Rhododendro mucronulatae-Potentilletum dickinsii* association described from the territory of North Korea (Kolbek et al. 1997). The community was analysed there in the Suyang-san, Kumgang-san and Chonma-san. The last two mountain ranges are located near the border with South Korea. The probability of occurrence of these units in South Korea is therefore very high, especially for the north lying rocky areas (e.g., Seorak-san and Odae-san). Similarly, we did not find any stands in South Korea that could be assigned to the *Artemisio keiskeanae-Chrysanthemetum coreani* association from the *Selaginellion tamariscini* alliance. However, its occurrence in this territory can also be assumed because we recorded it in North Korea scattered from the Myohyang-san to the Kumgang-san.

The association *Davallietum mariesii* is a very expressive and unmistakable unit in the field, because it's dominant taxon that is conspicuous on boulders, even very steep, but rarely on fallen tree trunks. Dominant fern also penetrates into the forest community *Davallio-Pinetum densiflorae*. In the text, the author of this association writes "on exposed rocks, some

epilithic vascular plants such as *Davallia mariesii* and *Dendrobium moniliforme* grow, ...” (Toyohara 1979). It is obvious, therefore, that this fern is predominantly a type of rock, but has wider ecological amplitude.

The 43 phytocoenological relevés of the *Dryopterido-Saxifragetum* association, described from North Korea (Kolbek et al. 1998), only belong to the subassociation of *Dryopterido-Saxifragetum caricetosum sierostictae*. In this article, the newly described *Dryopterido-Saxifragetum hydrangeetosum acuminatae* subassociation was not recorded in North Korea and represents the wetter subunit of the association.

In South Korea, we have recently confirmed a greater incidence the occurrence of distinctly basiphilous communities of calcareous rocks (dolomite, schistose dolomite) that we have not found (visited) in North Korea. Except for one exception (1 relevé), we did not visit such areas in North Korea. The presence of the newly described three associations (*Junipero rigidae-Buxetum koreanae*, *Meehanio urticifoliae-Selaginelletum stauntonianae* and *Patrinio rupestris-Mukdenietum rossii*) on these substrates is thus only rightly documented from the territory of South Korea. The occurrence of at least some of these associations and the relevant *Selaginello stauntonianae-Buxion koreanae* alliance, also in the northern part of the Korean Peninsula is more than likely. Different substrate ecology and the resulting different species composition give the possibility to classify these communities in the newly described order *Selaginello stauntonianae-Buxetalia koreanae*. It is highly likely that this group of communities also occurs in the northern part of the Korean Peninsula. On the territory of the Korean Peninsula is not as strict boundary on vegetation and differences between limestone and silicate rocks as in Europe. The substrate, although calcareous, may have the upper horizons in many places totally decalcified or only slightly calcareous.

Completely new units described from South Korea and from the whole Korean Peninsula are *Pyrrosietum linearifolio-petiolosae*, *Astilbo chinensis-Chrysosplenietum flagelliferi*, *Dennstadtia hirsuta* community, *Woodsia manchuriensis* community, and mention of a very widespread but extremely variable community with the *Parthenocissus tricuspidata*. The first community was found on the mossy rock walls most often in areas with increased humidity in the valleys of streams and rivers. The second community accompanies moist to wet rocks, with its occurrence on shaded boulders in the immediate vicinity of rivulets, brooks and smaller rivers. Their occurrence in the northern part of the Peninsula is also likely. Other units are merely a reminder of other, currently not classified, communities that may occur in various variations throughout the territory.

Because we did not have the opportunity to study all rock sites, it is possible that some communities found in North Korea were not captured in South Korea. This opposite also applies, so that the newly described communities in the southern part could be found in the north. This can also be valid for entirely new communities found in the future in both parts of the country. For a more precise classification of these and similar communities, a larger number of phytocoenological relevés from a wider area would be needed.

It will surely be the aim of further research to complete phytocoenological system and specify the ecological characteristics presented in this article.

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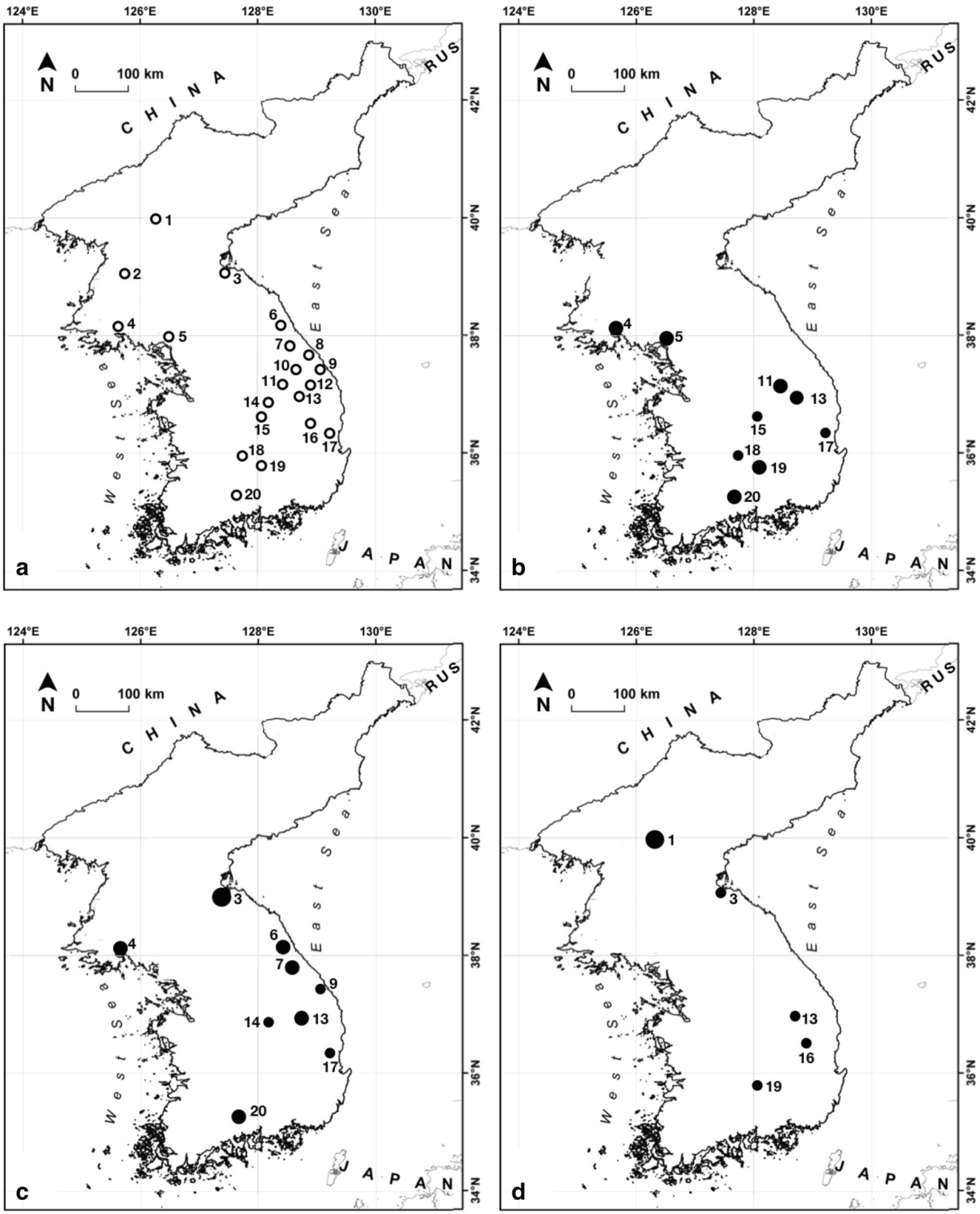
Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix

Full names of the infra-specific taxa given in the nomenclatural sources:

Appendix 1 Distribution of rock vegetation relevés in Korea. **a** Localities North Korea (1 – 5): 1 – Myohyang-san; 2 – Lyongak-san; 3 – Kumgang-san; 4 – Suyang-san; 5 – Chonma-san; Localities South Korea (6 – 20): 6 – Seorak-san; 7 – Odae-san; 8 – Gangneung; 9 – Duta-san + Donghae, Mureung Valley + Samcheok, Singi-myeon; 10 – Jeongseon; 11 – Yeongwol; 12 – Taebaek-san; 13 – Sobaek-san + Bonghwa, Baekcheon Valley; 14 – Worak-san; 15 – Mungyeong; 16 – Andong + Uiseong, Gounsa Temple; 17 – Juwang-san; 18 – Deogyu-san; 19 – Gaya-san; 20 – Jirisan. Explanations: Small dot = 1 relevé, medium dot = 2 – 5 relevés, big dot = ≥ 6 relevés. Plant communities: **b** *Davallietum mariesii* (localities 4, 5, 11, 13, 15, 17, 18, 19, 20). **c** *Amitostigmato gracilis-Sedetum polytrichoidis* (3, 4, 6, 7, 9, 13, 14, 17, 20). **d** *Sedetum sarmentoso-middendorfiani* (1, 3, 13, 16, 19). **e** *Pyrrosietum linearifolio-petiolosae* (11, 13). **f** *Lepisoro ussuriensis-Selaginelletum tamariscinae* (1, 2, 3, 9, 16, 17). **g** *Woodsia manchuriensis* community (9, 12, 13, 16, 19). **h** *Dennstaedtia hirsuta* community (14, 16, 19, 20). **i** *Astilbo chinensis-Chrysosplenietum flagelliferi* (7, 13, 17, 20). **j** *Dryopterido saxifragae-Saxifragetum fortunaei* (1, 3, 4, 5, 7, 13, 18, 19, 20). **k** *Mukdenio rossii-Selaginelletum rossii* (1, 3, 5, 6, 7, 9, 10, 12, 13, 14, 17, 19). **l** *Patrinio saniculaefoliae-Mukdenietum rossii* (3, 6, 19). **m** *Patrinio rupestris-Mukdenietum rossii* (10, 11). **n** *Junipero rigidae-Buxetum koreanae* (8, 10, 11, 12). **o** *Meehanio urticifoliae-Selaginelletum stauntonianae* (2, 11). **p** *Parthenocissus tricuspidata* community (6, 10, 11, 13, 16)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128°E
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40°N
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J A P A N
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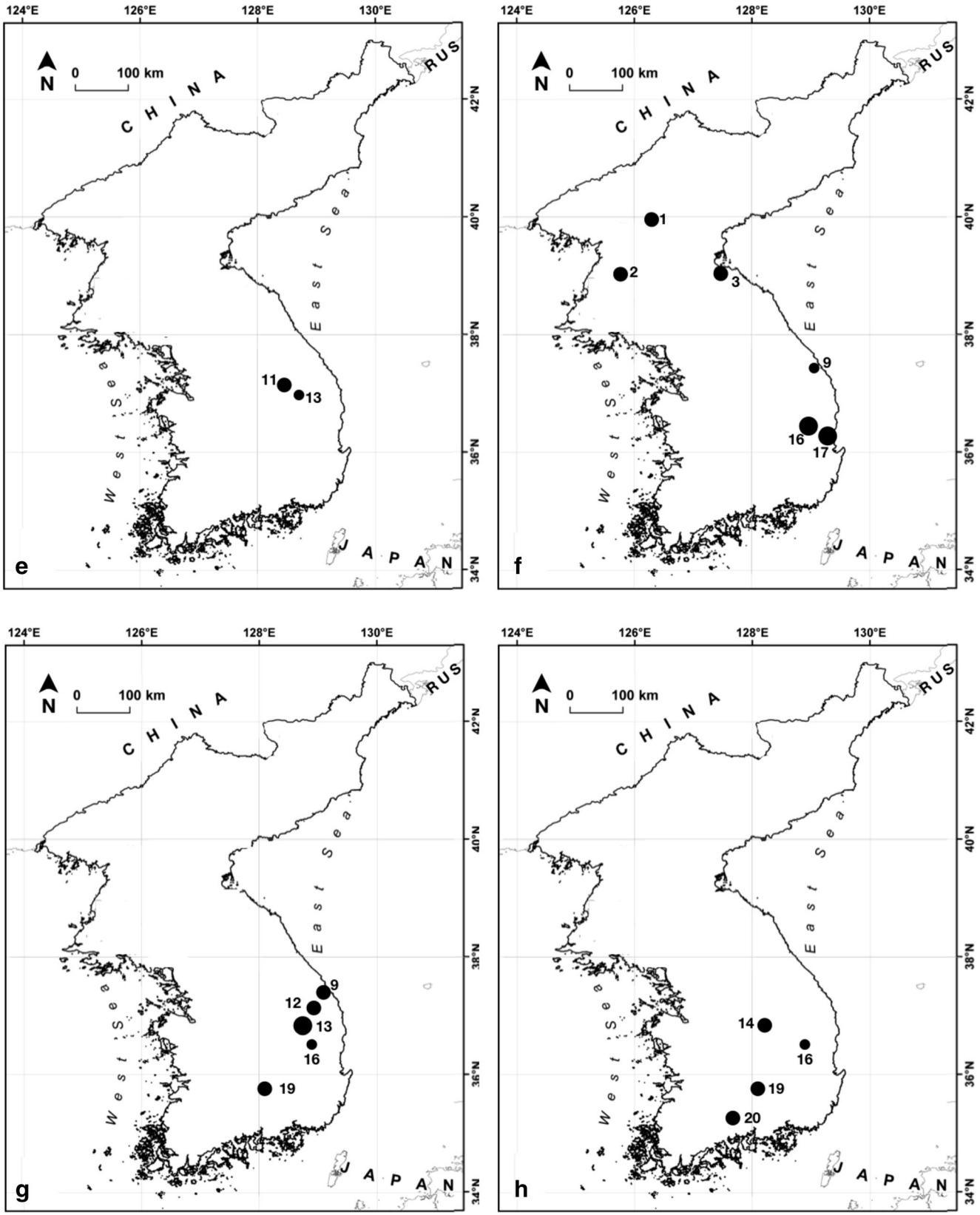
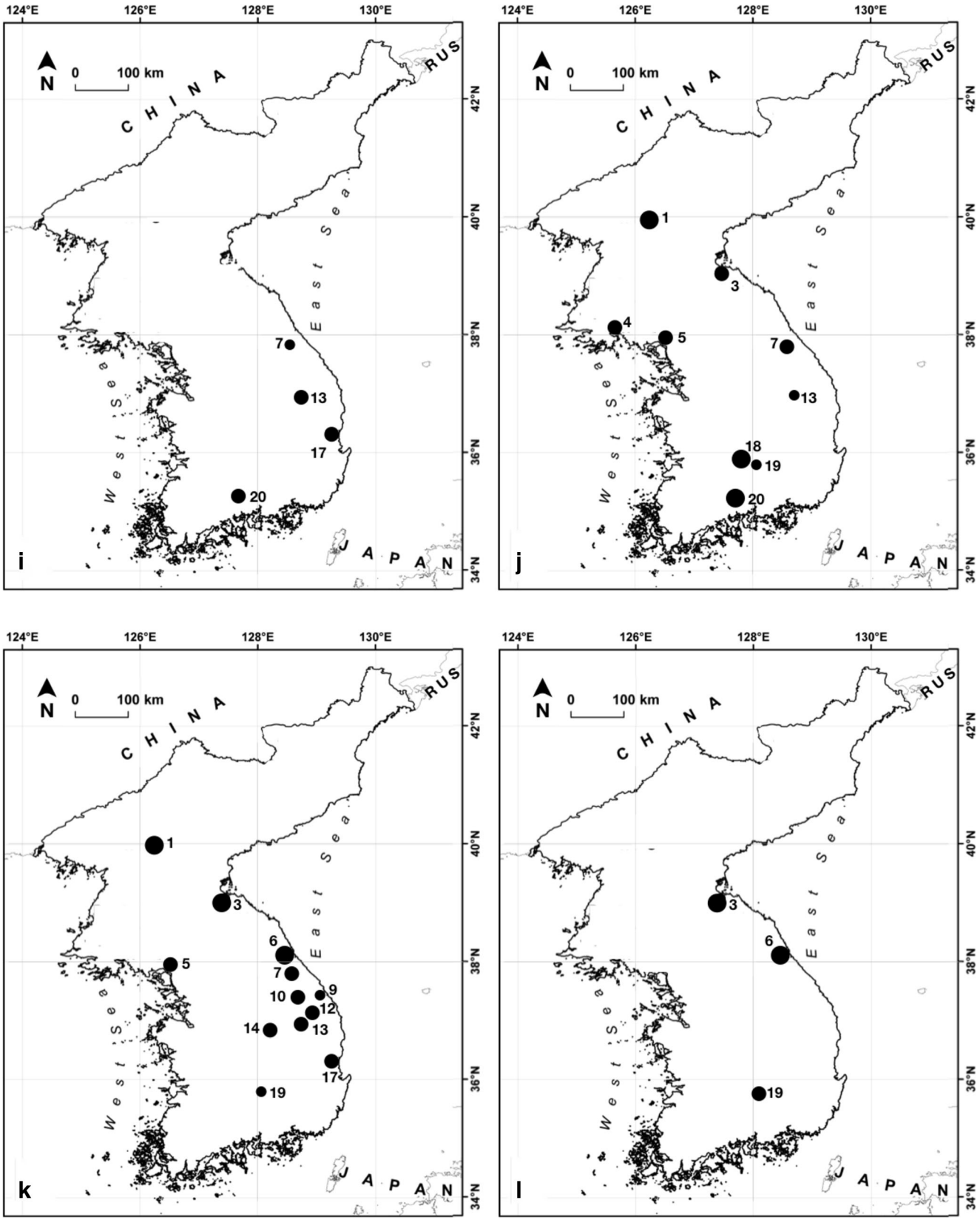
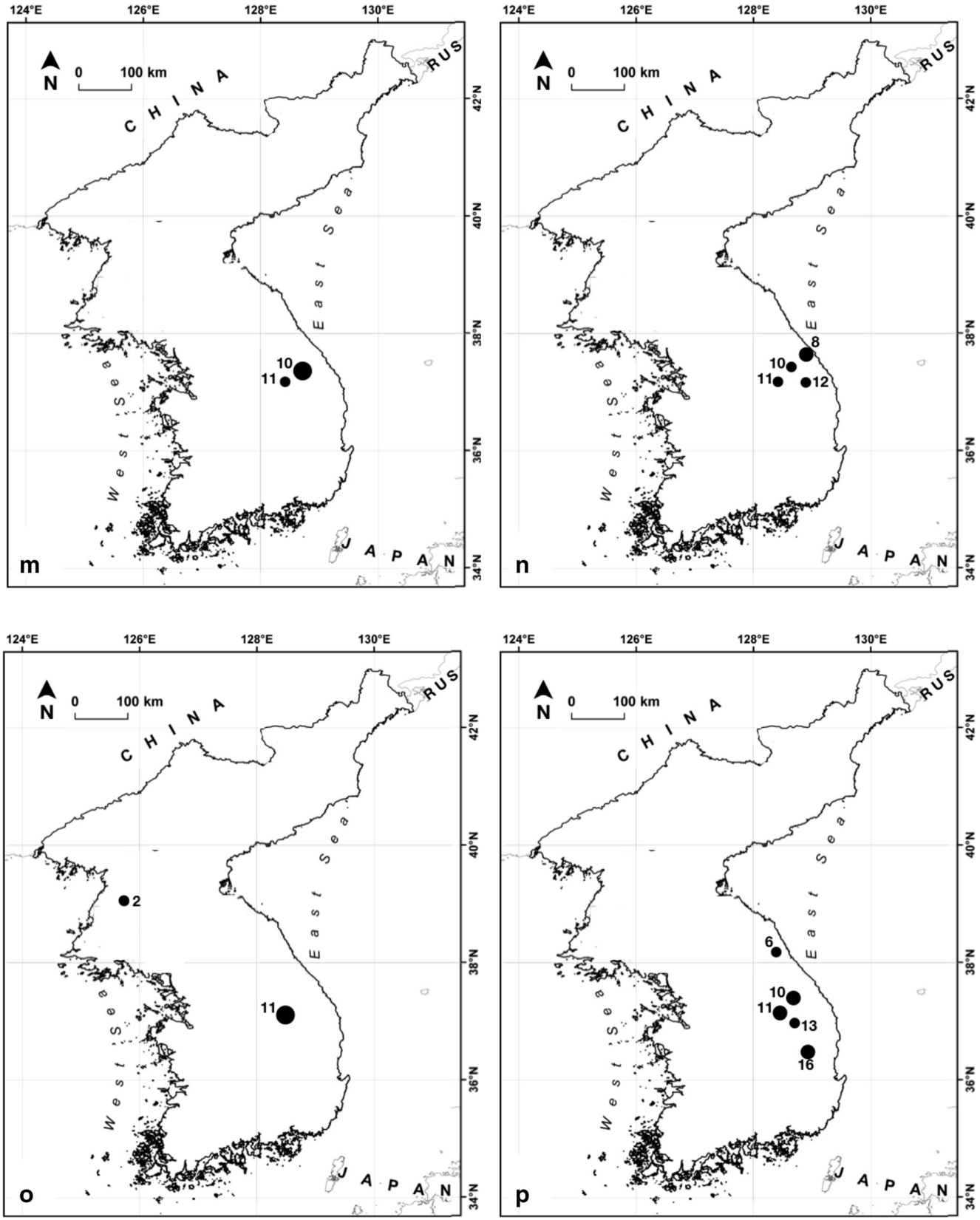


Appendix 1 (continued)



Appendix 1 (continued)



Appendix 1 (continued)

Agropyron tsukushiense var. *transiens*
Gollania neckerella var. *coreensis*
Hydrangea serrata var. *acuminata*
Marsupella emarginata ssp. *tubulosa*
Polygonatum odoratum var. *pluriflorum*
Prunus serrulata var. *spontanea*
Rhizomnium punctatum var. *elatum*
Sasamorpha purpurascens var. *borealis*
Solidago virgaurea var. *asiatica*

Aggregate species (agg.) and their content:

Astilbe chinensis agg. – rare includes also *A. chinensis* (Maxim.) Franchet & Savatier var. *chinensis* and mostly *A. chinensis* Maxim ex Franch. & Sav. var. *davidii* Franch. (Anonymous 1972–1976, Lee T. B. 1999, Lee Y. N. 1999, 2006).

Carex lanceolata agg. – includes *C. lanceolata* Bott ex A. Grey and *Carex humilis* Leyss. var. *nana* (H. Lév & Vaniot) Ohwi. The last species is known also as *C. lanceolata* var. *nana* Lév & Van., *C. nanella* Ohwi, *C. lanceolata* Franch, and *C. humilis* ssp. *lanceolata* (Anonymous 1972–1976, Lee Y. N. 2006, Oh 2006).

Chrysanthemum zawadskii agg. – includes difficult to distinguish varieties of the species *Chrysanthemum zawadskii* Herbich as *Ch. zawadskii* var. *alpinum* (Nakai) Kitamura, *Ch. zawadskii* var. *latilobum* (Maxim.) Kitamura and *Ch. zawadskii* var. *lucidum* (Nakai) T. Lee.

Rubia cordifolia agg. – includes mostly *R. cordifolia* var. *pratensis* Maxim.

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