

PHYTOSOCIOLOGICAL ANALYSIS OF COMMUNITIES WITH *ADIANTUM CAPILLUS-VENERIS* IN THE FOOTHILLS OF THE JULIAN ALPS (WESTERN SLOVENIA)

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Abstract

We conducted a phytosociological study of the communities hosting the rare and endangered fern *Adiantum capillus-veneris* in the foothills of the Julian Alps, in Karst and in Istria. Based on a comparison with similar communities elsewhere in the southern Alps (northern Italy) we classified most of the recorded stands into the syntaxa *Eucladio-Adiantetum eucladietosum* and *-cratoneuretosum commutati*. Relevés from the southern Julian Alps, located in comparatively slightly colder and moister local climate and the dolomite bedrock are classified into the new subassociation *-hymenostylietosum recurvirostri* subass. nova. Stands with the abundant occurrence of the liverwort *Conocephalum conicum*, are classified in to the new subassociation *-conocephaletosum conici* subass. nova. Stands in conglomerate rock shelters along the Soča at Solkan are classified into the new association *Phyteumato columnae-Adiantetum* ass. nova, a community of transitional character between the classes *Adiantetea capilli-veneris* and *Asplenietea trichomanis*.

Key words: phytosociology, synsystematics, bryophytes, *Adiantetea*, *Eucladio-Adiantetum*, Natura 2000, Julian Alps, Soča Valley, Istria.

Izveček

Fitocenološko smo raziskali združbe, v katerih v prigorju Julijskih Alp, na Krasu in v Istri uspeva redka in ogrožena praprotna *Adiantum capillus-veneris*. Na podlagi primerjav s podobnimi združbami drugod v južnih Alpah (severna Italija) smo večino popisanih sestojev uvrstili v sintaksona *Eucladio-Adiantetum eucladietosum* in *-cratoneuretosum commutati*. Popise iz južnih Julijskih Alp, ki smo jih naredili v nekoliko hladnejšem in bolj vlažnem krajevnem podnebju in na dolomitni podlagi uvrščamo v novo subasociacijo *-hymenostylietosum recurvirostri* subass. nova. Sestoje, kjer je obilno uspeval jetrenjak *Conocephalum conicum*, smo uvrstili v novo subasociacijo *-conocephaletosum conici* subass. nova. Sestoje v konglomeratnih spodmolih ob Soči pri Solkanu uvrščamo v novo asociacijo *Phyteumato columnae-Adiantetum* ass. nova, saj kažejo na stik združb dveh razredov *Adiantetea capilli-veneris* in *Asplenietea trichomanis*.

Ključne besede: fitocenologija, sinsistematika, mahovi, *Adiantetea*, *Eucladio-Adiantetum*, Natura 2000, Julijske Alpe, Posočje, Istra.

1. INTRODUCTION

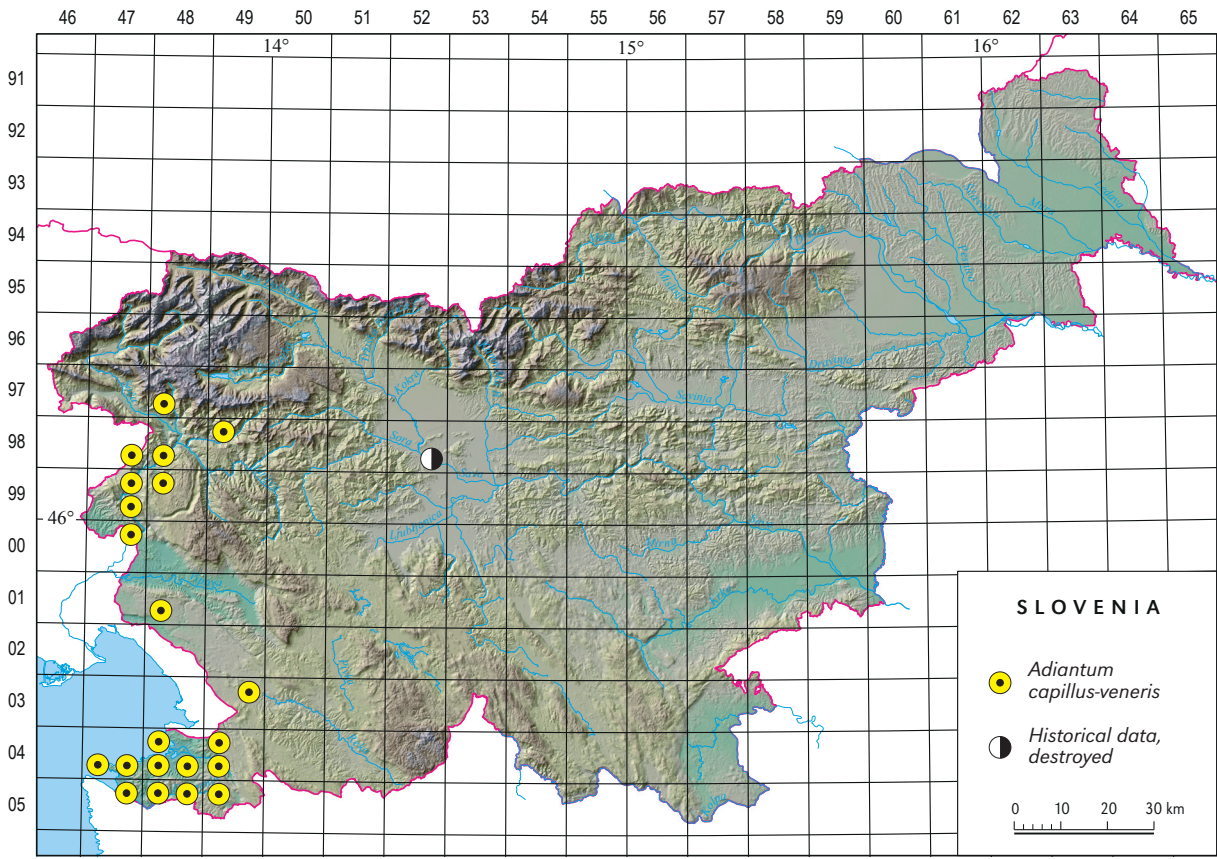
Adiantum capillus-veneris is a paleotemperate, subtropical and Mediterranean fern, a character species of the alliance *Adiantion* (Aeschmann et al. 2004: 66). Its sites are moist rock crevices, rock

shelters and overhangs (half-caves) that are usually wet with spray water and where tufa is frequently formed. It requires sufficient moisture and warmth. It is a protected species in Slovenia and classified as vulnerable in the Red List (Anon. 2002, Skoberne 2007). Its sites, petrifying springs

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Kartografija: Iztok Sajko, BIJH ZRC SAZU

Figure 1: Distribution of *Adiantum capillus-veneris* in Slovenia
Slika 1: Razširjenost vrste *Adiantum capillus-veneris* v Sloveniji

with tufa formation (tufa-forming spring-heads), are of Community interest – Natura 2000 habitat type code 7220 and Physis code 54.12 – Leskovar & Jogan (2004: 410), Poldini (2009: 686). A review of its localities known in Slovenia was published by T. Wraber (1986) and T. Wraber & Skoberne (1989: 42–43), and its distribution map by Jogan et al. (2001: 20). New localities of this rare fern were reported by Rojšek (1994, 2014), Žigon (1998), Dakskobler (2003), Glasnović (2009), Lužnik (2009) and Kocjan (2014) – Figure 1. Most of its known localities are situated in Istria; the only localities in Karst are in the Škocjan Caves (Schmidl Hall) and at Vojščica, others are in the Soča Valley, along the Soča and its tributaries between Ročinj and Solkan (there also in the Sopot gorge near Plave – 9947/4, new find of Katja Kogej and D. Rojšek, 26. 1. 2014, see also Rojšek 2014), two also in its Alpine region (Grahovo ob Bači – Mikuletič 1970 and the Mrzlica gorge under the village Krn – Rojšek 2003, published on the website <http://dar.zrsvn.si/>, 2014). The only inland locality in Slovenia was identified near Pirniče, where this species

had been growing in a rock shelter by a spring of a hot well. Population on this locality was destroyed in 1956 and the last to have picked this fern here was T. Wraber in 1953 (T. Wraber 1986: 262).

Although we have relatively good knowledge of the localities and ecology of some of its sites (Martinčič 1973: 124–125) and habitat types (Kaligarič & Otopal 2007: 33), we have not yet conducted phytosociological research nor have we published our relevés. One of the authors, Andrej Martinčič, gave a phytosociological description of the site of *Adiantum capillus-veneris* in the Schmidl Hall on 27 August 1980. Somewhat similar communities that are also classified into the alliance *Adiantion* had been studied in the Škocjan Caves even earlier, by Morton in 1935 and Tomažič in 1946. Even in our vicinity (Croatia, northern Italy) there are very few published relevés. These were contributed for Croatia by Horvatić (1934: 198–200: one published relevé of the association *Eucladio-Adiantetum*; 1939: 11: phytosociological table of the association *Eucladio-Phyllititetum* with six relevés; 1962: 11–12: list of diagnostic

species of both associations); these communities are studied also by Lovrić and Rac, but we have no knowledge of their publications other than general conspectuses that are available online, without tabular data. In northern Italy, a table of the association *Eucladio-Adiantetum* with five relevés was published by Sutter (1969: 361) and this phytosociological material is the most comparable to our conditions. Also from the Alpine region of northern Italy is the material published by Giacomini (1951), but his phytosociological tables comprise only moss species, with vascular plants mentioned only in the accompanying text. Poldini (1989: 55, 2009: 665) mentioned the association *Eucladio-Adiantetum*, but did not publish a corresponding phytosociological table. Giovagnoli & Tassinazzo (2012) published a description of the new association *Hymenostylio-Pinguiculetum poldinii* in the Venetian Prealps. Sporadically, *Adiantum capillus-veneris* also occurs within its stands and these two authors classify the new association into the alliance *Adiantion*. As a whole, its floristic composition differs considerably from that of our communities.

A number of authors have discussed the problem of synsystematic classification of communities with dominant *Adiantum capillus-veneris* in the south-Alpine, north-Adriatic and (or) Mediterranean region: Horvatić (1934, 1939), Horvat et al. (1974: 144–146), Zechmeister (1993), Zechmeister & Mucina (1994) and others, but it was addressed in most detail by Deil (1996, 1998). Deil also published a synthetic table with 105 columns, in which he included the communities from the class *Adiantetea* in the Mediterranean. From the regions in our vicinity he included the relevés published by Horvatić, Sutter and Giacomini; he mentioned also Lovrić's research from the east-Adriatic coastal region, but did not have access to the relevés from this area. Although Zechmeister (1993) and Zechmeister & Mucina (1994) classified the alliance *Adiantion* Br.-Bl. ex Horvatić 1934 into the order *Montio-Cardaminetalia* and class *Montio-Cardaminetea*, most phytosociologists, including the authors of this paper, classify this alliance into the independent order *Adiantetalia capilli-veneris* Br.-Bl. ex Horvatić 1934 and into the class *Adiantetea* Br.-Bl. 1948 (Deil 1996, Poldini 2009: 665, Šilc & Čarni 2012: 132). Our intention was to use relevés to determine the communities in which this rare fern occurs in Slovenia and to classify them, based on analyses and comparisons, within the syntaxonomic system. The centre of our field

research was in the Soča Valley. Among many localities in Istria we selected only a few for which we conducted a phytosociological inventory; in addition, we included two relevés from Škocjan Caves in the analytic table.

2. METHODS

Vegetation on the localities of *Adiantum capillus-veneris* was researched applying the standard Central-European method (Braun-Blanquet 1964). A total of 39 relevés were made. On most of the plots we collected mosses and liverworts, which one of the authors, Andrej Martinčič, determined in the laboratory. All relevés were entered into the FloVegSi database (Seliškar et al. 2003). Combined cover-abundance values were transformed into numerical values 1–9 (van der Maarel 1979). Programme packages SYN-TAX (Podani 2001) and R (R Core Team 2013) were used in numerical comparisons. The relevés were mutually compared by means of hierarchical classification. We applied the (unweighted) pair group method with arithmetic mean (UPGMA), minimum increase of sum of squares (MISSQ) and the principal coordinates analysis (PCoA). Wishart's similarity ratio was applied as a measure of dissimilarity. These comparisons formed the basis for the analytical table (Table 1). In the determination of lower syntaxonomic units of the association *Eucladio-Adiantetum* we consulted the synthetic table published by Deil (1996). Comparison of site conditions in nine communities with dominant *Adiantum capillus-veneris* in the Alps was conducted using Ellenberg's (Ellenberg et al. 1991) and Landolt's (Landolt et al. 2010) indicator values. In these communities we determined average conditions in terms of temperature (T), continentality (K), light conditions (L), moisture (F), soil reaction (R), nutrients (N), humus content (H) and aeration (A). The fourth roots of species coverage in percentage were used in our calculations.

The nomenclature source for the names of vascular plants is the Mala flora Slovenije (Martinčič & al. 2007). Schumacker & Váňa (2005) are the nomenclature source for the names of liverworts and Hill et al. (2006) for the names of mosses. The nomenclature sources for the names of syntaxa are Theurillat (2004) and Šilc & Čarni (2012). Data on geological bedrock were found in Buser (1986, 1987, 2009) and climatic data in Zupančič (1995) and Mekinda-Majaron (1995).

3. RESULTS AND DISCUSSION

3.1 CONSPECTUS OF DETERMINED AND DESCRIBED SYNTAXA

Adiantetea capilli-veneris Br.-Bl. 1948

Adiantetalia capilli-veneris Br.-Bl. ex Horvatić 1934

Adiantion capilli-veneris Br.-Bl. ex Horvatić 1934

Eucladio-Adiantetum Br.-Bl. 1931

-*eucladietosum* Br.-Bl. 1931

-*hymenostylietosum recurvirostri* subass. nova

-*cratoneuretosum commutati* (Pritivera & Lo Guidice) Deil 1996

-*conocephalotosum conici* subass. nova

Phyteumato columnae-Adiantetum capilli-veneris ass. nova

-*trichostomotosum crispulae* subass. nova

-*cinclidotosum riparii* subass. nova

Adianto-Molinietum arundinaceae ass. prov.

Asplenieta trichomanis (Br.-Bl. in Meier & Br.-Bl. 1934) Oberd. 1977

Potentilletalia caulescentis Br.-Bl. in Br.-Bl. et Jenny 1926

Phyteumato-Saxifragion petraeae Mucina in Mucina et al. 2011

Phyteumato-Paederotetum luteae ass. prov.

3.2 DESCRIPTION OF COMMUNITIES WITH DOMINANT *ADIANTUM CAPILLUS-VENERIS* IN WESTERN AND SOUTHWESTERN SLOVENIA

3.2.1 Ecological conditions on researched plots

A total of 39 relevés were arranged into Table 1. The relevés were made at the elevation of 57 m to 500 m; geological bedrock is composed of tufa (most frequently), conglomerate, dolomite and very rarely also of breccia, limestone, flysch and sandstone. General climatic conditions differ considerably across sample plots, although these macroclimatic data of precipitation and temperature are of very restricted value concerning the ecology of the cliffs and half cave habitats. Mean annual precipitation in the south-Alpine valleys of Mrzlica (Mrzli potok) and Bača is between 2000 mm and 2700 mm (data for the stations Grahovo ob Bači, 270 m a.s.l., and Krn, 910 m a.s.l., in the

period 1961–1990). Mean annual precipitation in the Central Soča Valley is slightly lower at 1500 mm to 2000 mm (data for the stations Solkan, 88 m a.s.l., and Plave, 100 m a.s.l., for the same period). The precipitation level is even lower in Istria, where it reaches on average 1250 mm (data for the station Kubed, 262 m a.s.l., in the same period). The difference in the mean annual temperature across the sample plots is also considerable. The Krn station records a mean annual temperature of 7.6 °C (period 1961–1990); comparable data for the Central Soča Valley are from the Vedrijan station (258 m a.s.l.) – 12.5 °C, and Kubed for Istria with 11.5 °C (all in the same period).

3.2.2 Floristic composition of researched stands

In addition to *Adiantum capillus-veneris*, vascular plants with slightly higher frequency on the sample plots (more than 20%) include *Molinia caerulea* subsp. *arundinacea*, *Hedera helix*, *Clematis vitalba*, *Calamagrostis varia*, *Brachypodium sylvaticum* and *Asplenium trichomanes*. Along with the dominant *Eucladium verticillatum*, *Hymenostylium recurvirostrum*, *Palustriella commutata* and *Conocephalum conicum* the more frequent moss species (with constancy exceeding 20%) include also *Pellia endiviifolia*, *Oxyrrhynchium hians*, *Oxyrrhynchium schleicheri* and *Plagiomnium rostratum*. Both vascular plants and mosses comprise many species that were recorded only in a few relevés, but some of them still have a diagnostic value.

3.2.3 Classification of relevés and description of the ascertained syntaxa

In terms of floristic similarity, the relevés formed several groups (Figures 2 and 3). Our classification of communities with dominant *Adiantum capillus-veneris* into the syntaxonomic system mainly follows the scheme published by Deil (1996: 42). Relevés No. 1 to 6 are classified into the subassociation *Eucladio-Adiantetum eucladietosum* (typical form of this association), where we differentiate both the typical variant (var. *typica*) and the variant with the taxon *Molinia caerulea* subsp. *arundinacea* (relevés 5 and 6 in Table 1) that indicates the contact (syndynamic connection) with spring grasslands with the dominant tall moor grass. Relevé No. 7 is a special form of

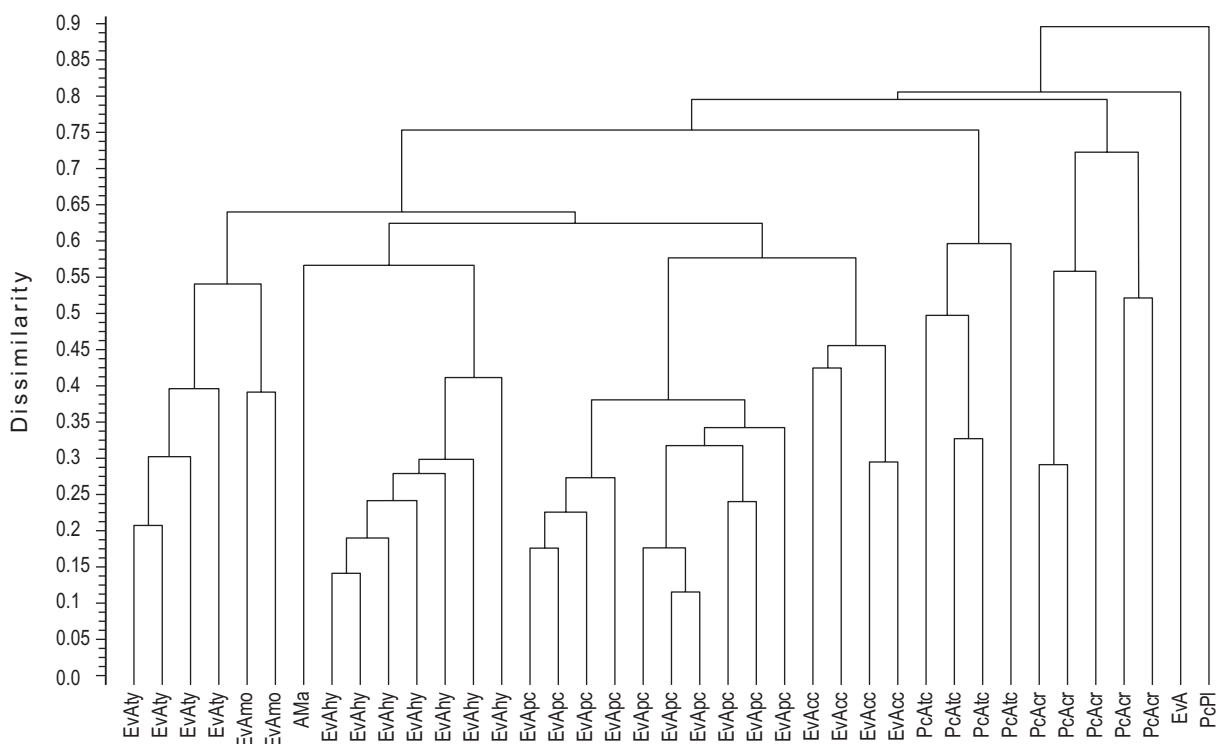


Figure 2: Dendrogram of relevés with *Adiantum capillus-veneris* in western and south-western Slovenia (UPGMA, similarity ratio).

Slika 2: Dendrogram popisov z vrsto *Adiantum capillus-veneris* v zahodni in jugozahodni Sloveniji (UPGMA, similarity ratio).

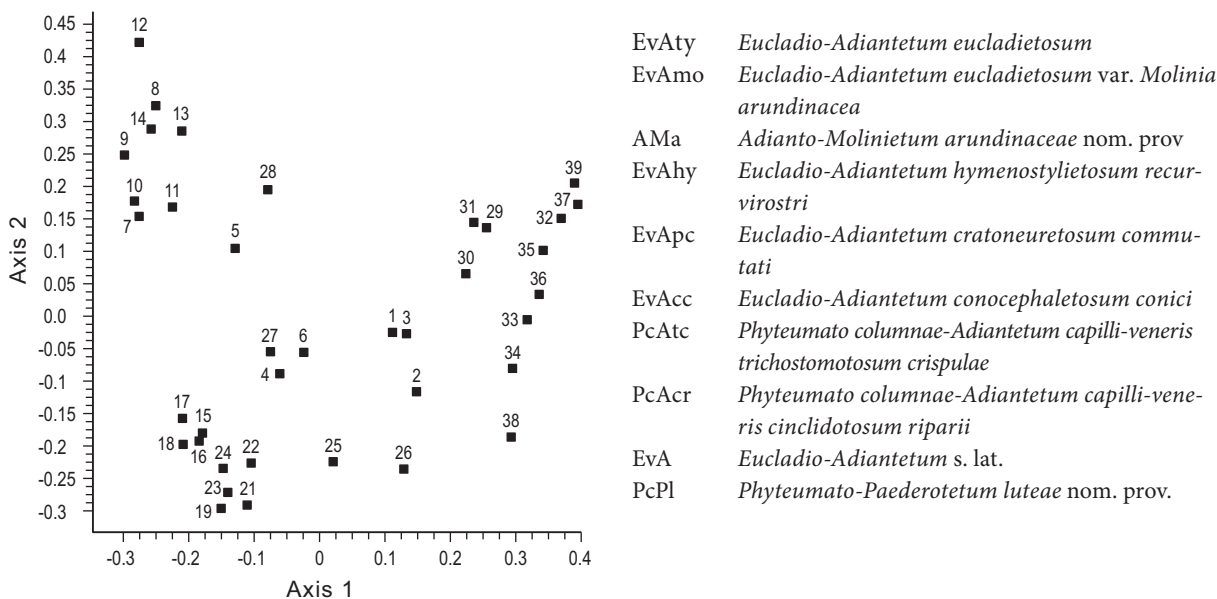


Figure 3: Two-dimensional scatter-diagram of relevés with *Adiantum capillus-veneris* in western and southwestern Slovenia (PCoA, similarity ratio). Numbers correspond with successive numbers in Table 1.

Slika 3: Dvorazsežni ordinacijski diagram popisov z vrsto *Adiantum capillus-veneris* v zahodni in jugozahodni Sloveniji (PCoA, similarity ratio). Številke se ujemajo z zaporedno številko popisov v tabeli 1.

such spring grassland and is temporarily considered as the syntaxon *Adianto-Molinietum arundinaceae* nom. prov. that is still classified into the alliance *Adiantion*.

Relevés No. 8 to 14 are classified into the new subassociation *Eucladio-Adiantetum hymenostylietosum recurvirostri* subass. nova. Its nomenclature type is relevé No. 10 in Table 1, *holotypus* hoc loco. The differential species of the subassociation is *Hymenostylium recurvirostrum*, mainly because of its abundance (it is dominant in the moss layer; *Eucladium verticillatum* occurs individually and with very small coverage); vascular plants with some diagnostic value are also *Sesleria caerulea* subsp. *calcaria*, *Tofieldia calyculata* and *Petasites paradoxus*. Except for one stand, the stands of this subassociation were recorded in the Alpine valleys of Bača and Mrzlica (Mrzli potok), at the elevations between 360 m and 500 m. *Hymenostylium recurvirostrum* is a boreal-temperate taxon that is distributed in Central Europe mainly in the Alps (Frahm & Frey 1992: 286). Its main distribution area is in the upper montane and subalpine belt (Düll 1991: 195), but all known localities in Slovenia, with the exception of three, are situated at the elevation of under 1000 m. Although Landolt et al. (2010) mark the taxon with *x* as regards temperature conditions (wide range of occurrence, poor indicator), its ecological requirements for warmth are slightly different from the generally more thermophilous taxon *Eucladium verticillatum*, which is a Mediterranean-Submediterranean-Atlantic species. In Central-European macroclimatic conditions, the latter is associated mainly with the colline belt. Both moss species occur on very similar sites and are frequently found together. Stands of the subassociation *Eucladio-Adiantetum hymenostylietosum recurvirostri* mainly occur in comparatively slightly colder and moister local climate than the stands of the typical subassociation and the dolomite bedrock probably plays a significant role.

Relevés No. 15 to 24 are classified into the subassociation *Eucladio-Adiantetum cratoneuretosum commutati* (Pritivera & Lo Guidice 1986) Deil 1996. Its stands most frequently overgrow tufa-forming waterfalls. The differential species include a moss *Palustriella commutata* (= *Cratoneuron commutatum*) and *Brachypodium sylvaticum* and *Galeobdolon flavidum* among the vascular plants. We differentiate the variant with *Conocephalum conicum* which connects the stands of this subassociation with the stands of floristically similar

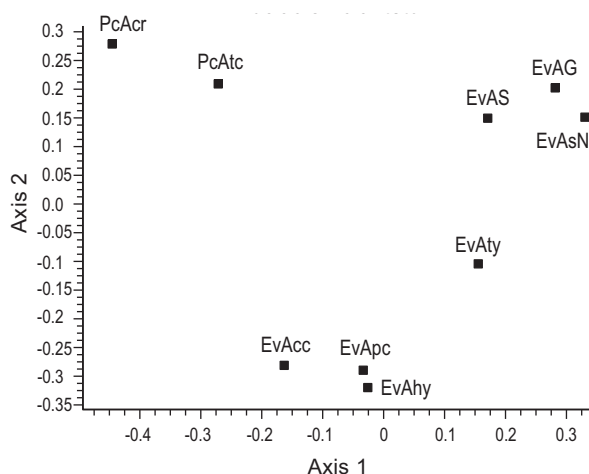
new subassociation *Eucladio-Adiantetum conocephalotosum conici* subass. nova hoc loco. (relevés No. 25 to 28). Its nomenclature type is relevé No. 26 in Table 1, *holotypus* hoc loco. Stands of this subassociation differ from others mainly with the abundant occurrence of the liverwort *Conocephalum conicum*, which is the dominant species in the moss layer, while *Eucladium verticillatum*, *Palustriella commutata* and *Hymenostylium recurvirostrum* are absent or less abundant. Their sites are slightly drier in comparison to sites of other subassociations, parent material is often conglomerate.

Relevés No. 29 to 37 are classified into the new association *Phyteumato columnae-Adiantetum capilli-veneris*. Its nomenclature type is relevé No. 30 in Table 1, *holotypus* hoc loco. Characteristically, the stands of the new association occur in conglomerate cliffs immediately above the River Soča and are periodically flooded. Their moss layer is no longer so dominant and the typical species from the alliance *Adiantion* are relatively poorly represented. In terms of species composition, these stands represent a transition towards the communities of the class *Asplenietea trichomanis*. Diagnostic taxa of the new association are *Asplenium trichomanes*, *Phyteuma scheuchzeri* subsp. *columnae*, *Paederota lutea* and *Leontodon hispidus* subsp. *brumatii*. We differentiate two subassociations, *-trichostomotosum crispulae* subass. nova hoc loco, the nomenclature type is relevé No. 30 in Table 1, *holotypus* hoc loco, the differential species are *Trichostomum crispulum* and *Didymodon fallax* on slightly drier sites, and *-cinclidotosum riparii* subass. nova hoc loco in more frequently flooded rock shelters – its nomenclature type is relevé 33 in Table 1, *holotypus* hoc loco. The differential species are *Cinclidotus riparius*, *Cinclidotus fontinaloides*, *Lunularia cruciata*, *Hygrohypnum luridum* and *Phyllitis scolopendrium*. *Lunularia cruciata* is a Mediterranean-Submediterranean-Atlantic element that is synanthropically distributed outside its natural distribution area. In Slovenia, it was found by F. Dolšak in 1920 and 1938 “in hortis urbis Ljubljana”. The next time it was found in Slovenia was not before 2010, when it was spotted in the rockery in the Botanical Garden in Ljubljana (leg. Janja Makše). The new locality on the bank of the Soča at Solkan, in the Submediterranean phytogeographical region (leg. I. Dakskobler & D. Rojšek), allows for the assumption that it is an autochthonous locality, especially in view of the fact that Dierßen (2001) classifies it as an element of the alliance *Adiantion*. Relevé No. 38 character-

ises what is probably a secondary occurrence of *Adiantum capillus-veneris* on the floor in Schmidl's Hall in the Škocjan Caves, along the wall on the right, in the belt of ferns and mosses. The relevé indicates a certain similarity with the stands of the association *Eucladietum verticillati* Allorge ex Braun 1968, but is temporarily still treated in the framework of the association *Eucladio-Adiantetum* s. lat. Relevé No. 39 belongs to the class *Asplenietea trichomanis*, order *Potentilletalia caulescentis* and to the alliance *Phyteumato-Saxifragion petraeae* (Šilc & Čarni 2012) or suballiance *Physoplexido-Potentillenion caulescentis* (Theurillat 2004). It is temporarily considered as the syntaxon *Phyteumato-Paederotetum luteae* nom. prov.

3.2.4 Comparison of communities with dominant *Adiantum capillus-veneris* in the southern and southeastern Alps

In a synthetic comparison we considered, in addition to the listed communities, also the relevés from the southern Alps (Giacomini 1951, Sutter 1969). We created a synthetic table with nine columns (Table 2). Sutter's relevés have some similarities with stands of the subassociation *Eucladio-Adinetetum hymenostylietosum* in the southern Julian Alps, except that in our study area *Hymenostylium recurvirostrum* is the dominant species in the moss layer, whereas in the relevés from northern Italy the moss layer is still dominated by *Eucladium verticillatum*. Its stands can therefore still be treated as a special variant with *Potentilla caulescens* within the typical subassociation *-eucladietosum*. Giacomini's relevés (Giacomini 1951) can also be classified into this subassociation.



Its subassociation *-southbyetosum stillicidiorum*, whose differential species include *Schoenus nigricans*, stands out in terms of floristics and ecology. Even when our comparison included other author's relevés from the southern Alps it demonstrated a distinct difference between the stands of the association *Eucladio-Adiantetum* and *Phyteumato columnae-Adiantetum* (Figures 4 and 5).

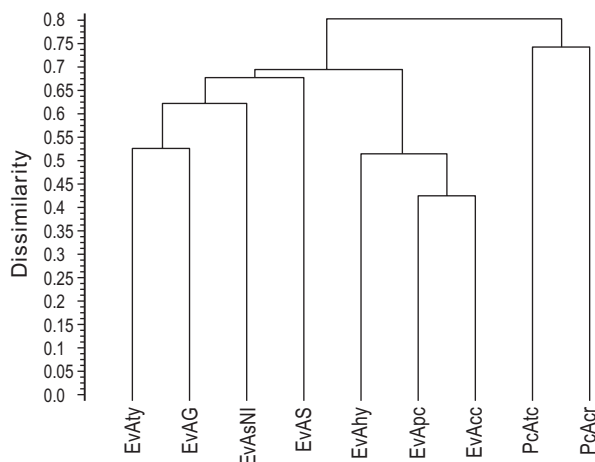


Figure 4: Dendrogram of communities with *Adiantum capillus-veneris* in the southern and southeastern Alps (UPGMA, similarity ratio).

Slika 4: Dendrogram popisov z vrsto *Adiantum capillus-veneris* v južnih in jugovzhodnih Alpah (UPGMA, similarity ratio).

EvAty	<i>Eucladio-Adiantetum eucladietosum</i> – Slovenia
EvAG	<i>Eucladio-Adiantetum eucladietosum</i> – N Italy, Giacomini (1951)
EvAsNI	<i>Eucladio-Adiantetum southbyetosum stillicidiorum</i> – N Italy, Giacomini (1951)
EvAS	<i>Eucladio-Adiantetum eucladietosum</i> var. <i>Potentilla caulescens</i> – N Italy, Sutter (1969)
EvAhy	<i>Eucladio-Adiantetum hymenostylietosum recurvirostri</i>
EvApc	<i>Eucladio-Adiantetum cratoneuretum commutati</i>
EvAcc	<i>Eucladio-Adiantetum conocephalotosum conici</i>
PcAtc	<i>Phyteumato columnae-Adiantetum capilli-veneris trichostomotosum crispulae</i>
PcAcr	<i>Phyteumato columnae-Adiantetum capilli-veneris cinclidotosum riparii</i>

Figure 5: Two-dimensional scatter-diagram of communities with *Adiantum capillus-veneris* in the southern and southeastern Alps (PCoA, similarity ratio).

Slika 5: Dvoragezni ordinacijski diagram združb z vrsto *Adiantum capillus-veneris* v južnih in jugovzhodnih Alpah (PCoA, similarity ratio).

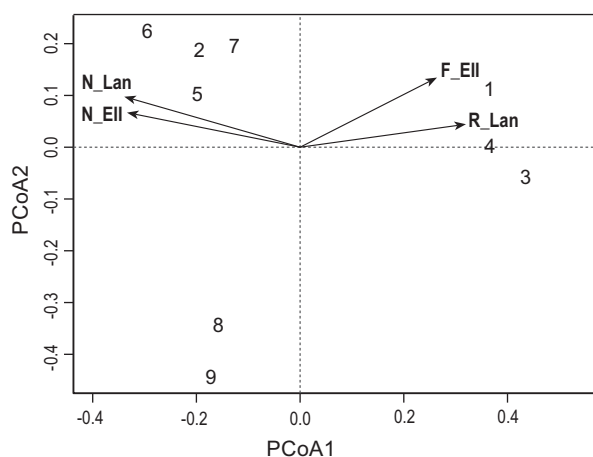


Figure 6: Two-dimensional scatter-diagram of communities with *Adiantum capillus-veneris* in the southern and southeastern Alps (PCoA, similarity ratio). Arrows represent Landolt's and Ellenberg's characteristic indicator values for moisture (F), soil reaction (R) and nutrients (N). The numbers correspond with the numbers of syntaxa in Table 2.

Slika 6: Dvorazsežni ordinacijski diagram združb z vrsto *Adiantum capillus-veneris* v južnih in jugovzhodnih Alpah (PCoA, similarity ratio). Puščice označujejo Landoltove in Ellenbergove značilne indikacijske vrednosti za vlažnost (F), reakcijo tal (R) in hranila v tleh (N). Številke ustrezajo številkam sintaksonov v tabeli 2.

Calculations of phytoindication gave similar results (Table 3 and Figure 6). Differences occur primarily in indicator values for soil moisture (F), soil reaction (R) and soil nutrients (N). Ellenberg's phytoindicator values indicate the moistest sites of the phytocoenoses of the association *Eucladio-Adiantetum* from northern Italy. According to Landolt's indicator values these phytocoenoses also indicate the least acidic or the most alkaline soil reaction. Stands of the association *Eucladio-Adiantetum* from Slovenia occur on nutrient poor sites. Compared to other communities, the sites of the stands from the association *Phyteumato-Adiantetum* do not stand out with any ecological factor. On the whole, their species composition indicates warm, sub-oceanic, half-shady, medium moist sites with nutrient-poor, neutral to alkaline soil.

4. CONCLUSIONS

Phytosociological research of the sites of the rare and endangered species *Adiantum capillus-veneris* in western and southwestern Slovenia determined that the moss layer plays the key role in the systematic classification and ecological differen-

tiation of its communities. These communities most often develop on the tufa and the moss layer is dominated by *Eucladium verticillatum*. Such stands are classified into the association *Eucladio-Adiantetum*, which is the central association of the alliance *Adiantion*. The moss layer in some of the relevés, especially those made on the highest-lying and the most Alpine sites of *Adiantum capillus-veneris* in Slovenia, above the Bača Valley at Grahovo and in the riverbeds of the Mrzlica under the village Krn (mainly on dolomite bedrock), is dominated by *Hymenostylium recurvirostrum*. This moss has similar ecological requirements as *Eucladium verticillatum*, but occurs also in the montane and subalpine belt, on locations with a relatively cold climate. In our case, the subassociation *Eucladio-Adiantetum hymenostylietosum recurvirostri* (with the exception of one relevé) in fact denominates sites of *Adiantum capillus-veneris* in the Alpine phytogeographical region and on predominantly dolomite bedrock, which are very rare in Slovenia. If the moss layer of the association *Eucladio-Adiantetum* is dominated by *Palustriella commutata* (= *Cratoneuron commutatum*) and (or) *Conocephalum conicum*, these stands can be classified into the subassociation *-cratoneuretosum commutati* (Pritivera & Lo Guidice 1986) Deil 1996 and into the subassociation *-conocephaletosum conici*. In the first case, the sites consist mainly of larger or smaller tufa-forming waterfalls and in the second case of conglomerate rock shelters. Stands with the dominant *Adiantum capillus-veneris*, where *Eucladium verticillatum* still occurs in the moss layer, usually with a low abundance, where *Hymenostylium recurvirostrum* is very rare and *Palustriella commutata* completely absent, and where the geological bedrock is not tufa but conglomerate, can be classified into the association *Eucladio-Adiantetum* only with reservation. In such stands, which were recorded on both banks of the Soča at Solkan, some other vascular plants also occur with high coverage, especially *Asplenium trichomanes*, *Phyllitis scolopendrium*, *Paederota lutea* and *Phyteuma scheuchzeri* subsp. *columnnae*; moss species include *Trichostomum crispulum*, as well as *Cinclidotus riparius*, *Cinclidotus fontinaloides* and *Lunularia cruciata*, which mainly occur in rock shelters that are periodically flooded. On one location in drier conglomerate rocks we recorded *Adiantum capillus-veneris* in a typical community of more or less dry rock crevices from the class *Asplenieta trichomanis* and order *Potentilletalia caulescentis*. However, it remains to be seen whether this hygrophilous fern will persist in this

community for a longer period. Conglomerate rocks along the Soča at Solkan (and perhaps also near Ročinj) are subject to syndynamic processes associated with water level fluctuations (partly related to the operation of the hydroelectric power plants Doblar, Plave and Solkan) and in turn phytocoenoses indicate a contact of communities of two classes, *Adiantetea* and *Asplenietea trichomanis*. Some of our relevés very clearly demonstrate this transition and their classification into the new association *Phyteumato columnae-Adiantetum* is therefore sensible. It is still classified into the alliance *Adiantion*, but its denomination after a typical resident of rock crevices, flowering plant *Phyteuma scheuchzeri* subsp. *columnae*, indicates the relationship of this community with the communities of the order *Potentilletalia caulescentis*, alliance *Phyteumato-Saxifragion petraeae* or suballiance *Physoplexido-Potentillenion caulescentis*. In view of the immediate vicinity of the river and human impact on its course the stands of the newly described association *Phyteumato-Adiantetum* are considered as a habitat type that is the most threatened among the studied stands. On the other hand, *Adiantum capillus-veneris* demonstrates substantial adaptability and is not subject to deterioration due to periodically flooded sites. It is therefore relatively safe in rock shelters, but less so in vertical rocks, where it may suffer from a lack of moisture.

5. POVZETEK

Fitocenološka analiza združb z vrsto *Adiantum capillus-veneris* v prigorju Julijskih Alp (zahodna Slovenija)

S fitocenološkimi raziskavami rastišč redke in ogrožene vrste *Adiantum capillus-veneris* v zahodni in jugozahodni Sloveniji smo ugotovili, da je za sinsistematsko razvrstitev njenih združb odločilna mahovna plast. Največkrat so te združbe razvite na lehnjaku in v mahovni plasti prevladuje vrsta *Eucladium verticillatum*. Take sestoje uvrščamo v asociacijo *Eucladio-Adiantetum*, ki je osrednja asociacija zveze *Adiantion*. V nekaterih popisih, predvsem v tistih, ki smo jih naredili na najvišje ležečih in najbolj alpskih rastiščih venerinih laskov v Sloveniji, nad dolino Bače pri Grahovem in v koritih Mrzlice pod vasjo Krn in v glavnem na dolomitni podlagi, je v mahovni plasti prevladujoča vrsta *Hymenostylium recurvirostrum*. Ta mah ima zelo podobne ekološke potrebe in rastišča kot mah *Eucladium verticillatum*, le da uspeva tudi v montanskem in subalpinskem pasu, v krajih z razme-

roma hladnim podnebjem. Nova subasociacija *Eucladio-Adiantetum hymenostylietosum recurvirostri* v našem primeru (z izjemo enega popisa) dejansko označuje rastišča venerinih laskov v alpskem fitogeografskem območju in na prevladujoči dolomitni podlagi, ki so v Sloveniji velika redkost. Če v mahovni plasti asociacije *Eucladio-Adiantetum* prevladujeta vrsti *Palustriella commutata* (= *Cratoneuron commutatum*) in (ali) *Conocephalum conicum*, lahko take sestoje uvrščamo v subasociaciji *-cratoneuretosum commutati* (Pritivera & Lo Guidice 1986) Deil 1996 in *-conocephalotosum conici*. V prvem primeru prevladujejo večja ali manjša lehnjakotvorna slapišča, v drugem primeru konglomeratni spodmoli. Sestoje z dominantno vrsto *Adiantum capillus-veneris*, kjer je v mahovni plasti vrsta *Eucladium verticillatum* ponekod še prisotna, a navadno z majhno pokrovnostjo, vrsta *Hymenostylium recurvirostrum* zelo redka, vrsta *Palustriella commutata* pa sploh odsotna in geološka podlaga ni lehnjak pač pa konglomerat, le s pridržkom še lahko uvrščamo v asociacijo *Eucladio-Adiantetum*. V takšnih sestojih, popisali smo jih na obeh bregovih Soče pri Solkanu, imajo vsaj ponekod večjo pokrovnost tudi nekatere druge cevnice, predvsem vrste *Asplenium trichomanes*, *Phyllitis scolopendrium*, *Paederota lutea* in *Phyteuma scheuchzeri* subsp. *columnae*, med mahovi pa nekatere druge vrste kot so *Trichostomum crispulum* in predvsem v spodmolih, ki so občasno poplavljeni, vrste *Cinclidotus riparius*, *Cinclidotus fontinaloides* in *Lunularia cruciata*. V bolj suhem konglomeratnem skalovju smo na enem mestu popisali vrsto *Adiantum capillus-veneris* v tipični združbi bolj ali manj suhih skalnih razpok iz razreda *Asplenietea trichomanis* in reda *Potentilletalia caulescentis*. Vprašanje je, ali se bo ta vlagoljubna praprota v njej obdržala dlje časa. Očitno se v konglomeratnem skalovju ob Soči pri Solkanu (in morda tudi pri Ročinju) v povezavi z nihanjem gladine reke (ki je deloma povezano z delovanjem hidroelektrarn Doblar, Plave in Solkan) dogajajo sindinamski procesi in se posledično v fitocenozah kaže stik združb dveh razredov, *Adiantetea* in *Asplenietea trichomanis*. Nekateri naši popisi na ta prehod kažejo precej očitno in zato je smiselna njihova uvrstitev v novo asociacijo *Phyteumato columnae-Adiantetum*. Še vedno jo uvrščamo v zvezo *Adiantion*, a z njenim poimenovanjem po cvetnici, tipični prebivalki skalnih razpok, *Phyteuma scheuchzeri* subsp. *columnae*, nakazujemo povezavo te združbe z združbami reda *Potentilletalia caulescentis*, zveze *Phyteumato-Saxifragion petraeae* oz. podzveze *Physoplexido-Potentillenion caulescentis*. Prav zaradi neposredne bližine reke in človekovega vpliva na njen tek so sestoji novo opisane asociacije *Phyteumato-Adiantetum* kot habitatni tip med vsemi preučeni najbolj ogroženi. Res pa je, da vrsta *Adiantum capillus-veneris* kaže na veliko prilagodljivost in ji občasno poplavljenost rastišča ne škodijo. V spodmolih je torej razmeroma varna, manj pa v navpičnem skalovju, kjer je zanjo lahko usodno pomanjkanje vlage.

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Table 1: Analytical table of the communities with dominant *Adiantum capillus-veneris* in western and southwestern Slovenia.

Number of relevé (Zaporedna številka popisa)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Database number of relevé (Delovna številka popisa)	247653	249161	249634	247809	247658	249162	245263	245261	245264	245262	247815	245266	245260	249922
Elevation in m (Nadmorska višina v m)	126	157	334	200	150	150	365	360	360	360	180	370	395	500
Aspect (Lega)	SE	SW	E	SE	SW	SW	S	SE	S	SW	SW	SE	SE	SE
Slope in degrees (Nagib v stopinjah)	100	180	180	100	80	45	50	100	100	100	90	90	100	90
Parent material (Matična podlaga)	Co	Sa	L	L, F	Tu	Tu	D	D	D	D	Tu	D	B	Tu
Cover of shrub layer in % (Zastiranje grmovne plasti v %)	E2	.	.	.	.	3	.	.	.	.	.	.	.	.
Cover of herb layer in % (Zastiranje zeliščne plasti v %)	E1	79	35	70	70	70	80	70	70	80	70	40	70	20
Cover of moss layer in % (Zastiranje mahovne plasti v %)	E0	70	30	20	40	60	50	20	60	60	40	90	70	100
Number of species (Število vrst)		18	2	3	17	9	21	16	9	9	12	12	10	14
Relevé area (Velikost popisne ploskve)	m ²	5	10	3	3	3	2	6	5	4	5	2	6	4
Date of taking relevé (Datum popisa)		3/22/2013	7/15/2013	8/27/1980	4/10/2013	3/22/2013	7/15/2013	10/24/2012	10/24/2012	10/24/2012	10/24/2012	4/11/2013	10/24/2012	10/24/2012
Locality (Nahajališče)		Ročinj-Toplice	Koštabona - Supot	Škocjanske jame	Britof-Idrija	Trebež	Koštabona-Supot	Grahovo - Brezna grapa	Grahovo - Brezna grapa	Grahovo - Brezna grapa	Grahovo - Brezna grapa	Avče	Grahovo - Brezna grapa	Grahovo - Brezna grapa
Quadrant (Kvadrant)		9848/3	0548/1	0349/2	9847/4	9947/2	0548/1	9849/1	9849/1	9849/1	9849/1	9948/1	9849/1	9849/1
Coordinate GK Y (D-48)	m	398405	402145	421743	390827	391703	402145	412770	412764	412768	412764	398588	412756	412714
Coordinate GK X (D-48)	m	5107863	5038996	5058442	5107245	5102350	5038991	5113560	5113542	5113566	5113552	5106944	5113536	5113572

Diagnostic species of the syntaxa (Diagnostične vrste sintaksonov)

AD <i>Adiantum capillus-veneris</i>	E1	4	3	4	4	4	3	2	4	4	5	4	2	4	1
AD <i>Eucladium verticillatum</i>	E0	4	3	1	3	4	3	.	.	.	+	+	.	.	+
EP <i>Molinia caerulea</i> subsp. <i>arundinacea</i>	E1	.	.	.	.	3	4	5	1	+	+	+	+	1	r
AD <i>Hymenostylium recurvirostrum</i>	E0	+	.	.	+	2	.	1	4	4	3	4	4	3	5
ES <i>Sesleria caerulea</i> subsp. <i>calcaria</i>	E1	.	.	.	.	.	.	1	+	.	+	.	+	.	.
TR <i>Petasites paradoxus</i>	E1	.	.	.	.	.	.	+	+	+	1	.	.	.	.
SCF <i>Tofieldia calyculata</i>	E1	.	.	.	.	.	.	r	.	+	.	.	+	r	.
MC <i>Palustriella commutata</i>	E0	.	.	.	1	+	+	3	1	2	2	1	1	+	1
MC <i>Conocephalum conicum</i>	E0	.	.	.	.	.	.	.	.	.	.	+	.	.	+
FS <i>Brachypodium sylvaticum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+
FS <i>Galeobdolon flavidum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+
AT <i>Asplenium trichomanes</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.	.
PC <i>Phyteuma scheuchzeri</i> subsp. <i>columnae</i>	E1	r	.	.	.	.	.	.	.	.	.	.	r	.	.
PC <i>Paederota lutea</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.
AT <i>Leontodon hispidus</i> subsp. <i>brumatii</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MC <i>Trichostomum crispulum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MC <i>Didymodon fallax</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Tabela 1: Analitska tabela združb z dominantno vrsto *Adiantum capillus-veneris* v zahodni in jugozahodni Sloveniji.

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Pr.	Fr.																									
247660	249164	249163	249160	247661	247813	247814	247808	250036	248229	247654	247659	247817	247819	250409	250526	250816	250818	249927	250410	250408	250412	250413	249635	250415																											
180	140	150	145	224	180	180	200	200	170	133	160	120	120	65	70	64	62	57	64	59	78	78	334	59																											
SEE	NEE	W	NE	SE	SW	SW	SE	SE	SW	NE	SE	SSW	SW	W	SE	SE	SE	N	SE	SWW	SE	NE	0	SW																											
80	70	30	35	60	90	80	100	95	70	20	80	100	90	95	95	100	95	90	95	90-95	90	90	0	90																											
Tu	Tu	Tu	Tu	Tu	Tu	Tu	Tu	Tu	Tu	Co	Tu	Co	Co	Co	Co	Co	Co	Co	Co	Co	L	L	L	Co																											
.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	5	2	.	.	5	10	10	.	.	.																
70	70	80	70	50	70	70	70	80	50	60	60	50	60	80	40	30	20	80	70	50	40	20	30	25																											
60	80	90	85	60	100	80	90	80	90	80	70	60	70	10	15	40	50	30	80	70	50	30	40	5																											
7	10	10	16	13	11	16	23	16	11	16	8	10	11	8	11	17	21	14	16	23	13	12	7	15																											
1	3	1	5	4	3	1,5	2	2	4	1	1	1	2	2	2	3	2	4	4	4	1	1	3	4																											
3/22/2013	7/15/2013	7/15/2013	7/15/2013	3/22/2013	4/11/2013	4/11/2013	4/10/2013	9/23/2013	5/9/2013	3/22/2013	3/22/2013	4/11/2013	4/11/2013	10/5/2013	10/5/2013	10/23/2013	10/23/2013	7/9/2007	10/5/2013	10/5/2013	10/5/2013	10/5/2013	8/27/1980	10/5/2013																											
Trebež	Koštabona-Supot	Koštabona-Supot	Koštabona-Supot	Trebež	Avče	Avče	Britof-Idrinja	Britof-Idrinja	Avče	Ročinj - Toplice	Trebež	Ročinj-Ajba	Ročinj-Ajba	Solkani-Soča	Sabotin-Soča	Solkanski most	Solkanski most	Sabotin-Soča	Solkani-Soča	Solkani-Soča	Mrzlek -Soča	Mrzlek-Soča	Škojanske jame	Solkani-Soča																											
9947/2	0548/1	0548/1	0548/1	9947/2	9948/1	9948/1	9847/4	9847/4	9948/1	9848/3	9947/2	9847/4	9847/4	0047/2	0047/2	0047/2	0047/2	0047/2	0047/2	0047/2	0047/2	0047/2	0349/2	0047/2																											
5102390	391637	5038954	402136	5038990	402145	5038972	402135	5102497	391571	5106918	398614	5106928	398606	5107249	390836	5107257	390852	5106930	398612	5107851	398387	5102377	391657	5107809	396596	5107796	396806	5094114	396219	5093624	395870	5093629	395880	5093628	395880	5093570	395816	5093613	395863	5094115	396219	5095303	394992	5095291	394998	5058439	421741	5094047	396210		
4	4	4	4	3	4	4	4	4	4	5	3	4	3	4	4	3	3	1	4	3	3	3	+	+	+	39	100																								
1	+	.	+	1	1	1	4	2	1	+	2	.	.	.	+	+	+	.	.	.	1	.	2	.	25	64																									
r	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	31					
.	.	.	.	.	.	.	+	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	15	38				
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	18	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	10	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	10	
4	4	4	5	4	4	3	3	4	4	1	.	+	.	.	.	.	.	.	.	.	.	.	.	23	59															
.	.	.	.	3	2	3	1	+	+	2	4	3	2	.	.	.	.	.	.	.	.	.	.	15	38																
.	.	.	r	.	+	r	r	r	r	2	.	.	.	.	.	.	.	.	1	3	.	.	.	8	21																		
.	.	.	.	+	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	7	18															
.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	10	26					
.	2	+	+	1	+	1	+	7	18																								
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	5	13					
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	8	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	10	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	8	

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	
FS	<i>Phyllitis scolopendrium</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	r	
MC	<i>Cinclidotus riparius</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.
MC	<i>Cinclidotus fontinaloides</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.
MC	<i>Lunularia cruciata</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.
MC	<i>Hygrohypnum luridum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.
AD	Adiantion, Adiantetea															
	<i>Pellia endiviifolia</i>	E0	.	.	.	+	.	+	.	.	.	+	1	.	1	+
	<i>Didymodon tophaceus</i>	E0	.	.	.	.	.	+	.	.	.	.	.	.	.	.
	<i>Calliergonella cuspidata</i>	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
MC	Montio-Cardaminetea															
	<i>Bryum pseudotriquetrum</i>	E0	.	.	.	.	.	+	.	.	.	+	.	.	.	.
	<i>Cratoneuron filicinum</i>	E0	.	.	.	.	.	+	.	.	.	.	.	.	.	.
	<i>Philonotis fontana</i>	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	<i>Didymodon spadiceus</i>	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	<i>Gymnostomum aeruginosum</i>	E0	.	.	.	.	.	.	.	+	.	.	.	.	.	.
CF	Cystopteridion fragilis															
	<i>Orthothecium rufescens</i>	E0	.	.	.	.	.	.	+	.	.	+	.	.	+	.
	<i>Jungermannia atrovirens</i>	E0	.	.	.	.	.	.	.	.	+	.	.	.	.	.
	<i>Cystopteris fragilis</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
PJ	Parietaria judaicae															
	<i>Parietaria judaica</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Cymbalaria muralis</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AT	Asplenietea trichomanis															
	<i>Cardaminopsis arenosa</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Asplenium viride</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Asplenium ruta-muraria</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TR	Thlaspietea rotundifolii															
	<i>Hieracium bifidum</i>	E1	.	.	.	.	r	.	.	.	.	.	.	.	.	.
ES	Elyno-Seslerietea															
	<i>Aster bellidiastrum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FB	Festuco-Brometea															
	<i>Globularia punctata</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.
	<i>Scabiosa graminifolia</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TG	Trifolio-Geranietea															
	<i>Campanula rapunculoides</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Laserpitium latifolium</i>	E1	.	.	.	.	.	.	r	.	.	.	.	.	.	.
MA	Molinion, Molinio-Arrhenatheretea															
	<i>Angelica sylvestris</i>	E1	.	.	.	.	.	.	r	.	.	.	.	.	+	.
	<i>Deschampsia cespitosa</i>	E1	.	.	.	r	.	.	.	.	.	.	.	.	.	.
	<i>Caltha palustris</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Galium mollugo</i>	E1	.	.	.	.	.	l	.	.	.	.	.	.	.	.
	<i>Taraxacum officinale</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Pulicaria dysenterica</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.
MuA	Mulgedio-Aconitetea, Betulo-Adenostyletea															
	<i>Salix appendiculata</i>	E2a	.	.	.	.	.	.	r	.	.	.	.	.	.	.
	<i>Senecio ovatus</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	r
FC	Filipendulo-Convulvetea															
	<i>Filipendula ulmaria</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EA	Epilobietea angustifolii															
	<i>Eupatorium cannabinum</i>	E1	.	.	.	r	.	.	l	.	.	.	.	.	.	.
SM	Stellarietea mediae															
	<i>Cardamine hirsuta</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Stellaria media</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Erigeron annuus</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Pr.	Fr.
.	+	3	2	r	.	.	1	.	6	15
.	+	+	+	2	2	.	+	6	15
.	r	.	.	.	.	.	.	.	.	.	.	1	2	4	1	.	.	.	5	13
.	1	1	2	.	.	.	.	3	8
.	+	+	+	.	.	3	8
.	+	1	+	+	1	1	+	+	.	2	.	1	+	.	.	.	.	.	.	.	.	.	.	.	17	44
.	+	2	5
.	1	3
.	.	+	3	8
.	+	+	3	8
.	+	2	5
.	1	3
.	1	3
.	3	8
.	1	3
.	+	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2	5
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	+	.	.	+	2	5
.	r	.	.	.	.	.	1	3
.	+	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	+	3	8
.	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	3	8
.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	1	3
.	r	.	.	.	.	.	.	1	3
.	1	3
.	1	3
.	r	.	.	.	.	1	3
.	.	.	+	.	.	.	r	r	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	6	15
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	1	3

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
GU	Galio-Urticetea														
	<i>Petasites hybridus</i>	E1	.	.	.	r	.	.	.	.	.	.	.	.	.
	<i>Aegopodium podagraria</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Viola odorata</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Equisetum arvense</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
RP	Rhamno-Prunetea														
	<i>Ligustrum vulgare</i>	E1	.	.	.	.	.	.	.	.	r	.	.	.	.
	<i>Rubus macrophyllus</i>	E2a	.	.	.	.	.	+	.	.	.	.	.	.	.
EP	Erico-Pinetea														
	<i>Calamagrostis varia</i>	E1	.	.	.	l	.	.	+	.	.	r	.	+	+
	<i>Buphthalmum salicifolium</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
VP	Vaccinio-Piceetea														
	<i>Veronica urticifolia</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	r
	<i>Oxalis acetosella</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
AF	Aremonio-Fagion														
	<i>Lamium orvala</i>	E1	.	.	.	r	.	.	.	.	.	.	.	.	.
	<i>Cyclamen purpurascens</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Anemone trifolia</i>	E1	.	.	.	.	.	.	.	.	.	.	.	r	.
	<i>Cardamine trifolia</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
FS	Fagetalia sylvaticae														
	<i>Mycelis muralis</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	r
	<i>Geranium robertianum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	r
	<i>Salvia glutinosa</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Viola reichenbachiana</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Fagus sylvatica</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Pulmonaria officinalis</i>	E1	.	.	.	.	.	.	.	.	.	r	.	.	.
	<i>Sambucus nigra</i>	E1	.	.	.	.	.	.	.	.	.	.	r	.	.
	<i>Aruncus dioicus</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	r
	<i>Euphorbia amygdaloides</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Symphytum tuberosum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Asarum europaeum</i> subsp. <i>caucasicum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Ranunculus lanuginosus</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Tilia cordata</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.
QP	Quercetalia pubescentis														
	<i>Ruscus aculeatus</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Ostrya carpinifolia</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Fraxinus ornus</i>	E2a	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Viola alba</i> subsp. <i>scotophylla</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Asparagus acutifolius</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Sesleria autumnalis</i>	E1	.	.	.	.	.	r	.	.	.	.	.	.	.
	<i>Carex flacca</i>	E1	.	.	.	.	.	.	r	.	.	.	+	.	.
	<i>Tamus communis</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Celtis australis</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Quercus pubescens</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Clematis recta</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
QF	Quercu-Fagetea														
	<i>Hedera helix</i>	E1	r	.	.	.	.	+	r	+	+	.	+	.	+
	<i>Clematis vitalba</i>	E2a	.	.	.	.	.	+	r	.	.	.	.	.	.
	<i>Primula vulgaris</i>	E1	.	.	.	r	.	.	.	.	.	.	+	.	.
	<i>Viola riviniana</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Vinca minor</i>	E1	+	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Lonicera caprifolium</i>	E2a	.	.	.	.	.	+	.	.	.	.	.	.	.
	<i>Corylus avellana</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Ficaria verna</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	<i>Alnus incana</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Pr.	Fr.	
.	2	5
r	.	.	.	+	2	5
.	+	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	.	.	l	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	8
.	1	3
.	+	+	.	r	r	.	.	.	.	.	.	.	.	.	.	10	26
.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	4	10
.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	.	.	.	r	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	1	3
.	1	3
.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	1	3
.	4	10
.	.	.	.	+	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	4	10
.	+	+	+	4	10
.	.	.	+	l	r	.	.	.	.	.	.	4	10
.	+	2	5
.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	2	5
.	+	.	+	2	5
.	1	3
.	1	3
.	r	.	.	.	1	3
.	+	r	+	+	+	+	.	.	+	2	l	+	+	.	l	r	.	+	l	.	.	.	.	.	22	56	
.	r	.	.	.	.	.	+	+	r	.	.	+	.	.	+	.	+	.	9	23
.	+	.	r	.	.	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	15
.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	8
.	2	5
.	.	.	l	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5
.	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	1	3
.	+	.	.	.	1	3

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
<i>Ilex aquifolium</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hieracium racemosum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
O Other species (Druge vrste)															
<i>Festuca</i> sp.	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Thuja orientalis</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Veronica</i> sp.	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Deutzia scabra</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ficus carica</i>	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Galium palustre</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Buddleja davidii</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
M Mosses (Mahovi)															
<i>Oxyrrhynchium hians</i>	E0	.	.	.	.	.	.	.	.	.	.	l	.	.	.
<i>Oxyrrhynchium schleicheri</i>	E0	.	.	.	.	+	.	.	.	+	.	r	.	.	.
<i>Plagiomnium rostratum</i>	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Fissidens taxifolius</i> subsp. <i>taxifolius</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	+	.
<i>Lophozia</i> sp.	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Jungermannia</i> sp.	E0	.	.	.	.	.	+	.	.	.	.	.	.	+	.
<i>Pedinophyllum interruptum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	r
<i>Brachythecium rutabulum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Barbula unguiculata</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Barbula convoluta</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Oxystegus tenuirostris</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Platyhypnidium riparioides</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Neckera besseri</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Plasteurhynchium striatulum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Jungermannia hyalina</i>	E0	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Tortella</i> sp.	E0	.	.	+	.	.	.	.	.	.	.	.	.	.	.
<i>Didymodon ferrugineus</i>	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Ctenidium molluscum</i>	E0	.	.	.	.	.	.	+	.	.	.	.	.	.	.
<i>Seligeria trifaria</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	+	.
<i>Fissidens adianthoides</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Amblystegium serpens</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Brachythecium starkei</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Rhynchostegium murale</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Philonotis marchica</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Fissidens dubius</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Jungermannia gracillima</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Mnium marginatum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Rhynchostegiella tenella</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Thamnobryum alopecurum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Didymodon acutus</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Mnium</i> sp.	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.

- Pr. Presence – prezenca
 Fr. Frequency – frekvenca
 Co Conglomerate – konglomerat
 Sa Sandstone – peščenjak
 L Limestone – apnenec
 F Flysch – fliš
 Tu Tufa – lehnjak
 D Dolomite – dolomit
 B Breccia – breča

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Pr.	Fr.	
.	+	.	.	.	1	3	
.	r	1	3
.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	.	.	.	.	1	3
.	r	.	.	.	.	1	3
.	+	.	.	.	1	3
.	+	.	.	.	1	3
.	r	.	1	3
.	.	.	.	+	+	l	l	+	.	+	.	.	+	.	+	+	+	+	+	+	+	+	.	.	16	41	
+	.	+	.	+	+	+	8	21
.	l	.	.	+	+	.	+	+	+	+	8	21
r	+	+	+	+	.	.	6	15
.	.	+	+	3	8
.	.	+	3	8
.	+	.	.	+	3	8
.	r	l	.	.	.	+	+	3	8
.	+	+	+	.	.	3	8
.	+	+	2	5
.	+	+	.	.	2	5
.	+	1	.	.	2	5
.	+	+	.	.	2	5
.	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	.	+	1	3
.	1	3
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.	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	1	3
.	1	3

Table 2: Synoptic table of the communities with dominant *Adiantum capillus-veneris* in the southern and south-eastern Alps.

Tabela 2: Sintezna tabela združb z dominantno vrsto *Adiantum capillus-veneris* v južnih in jugovzhodnih Alpah.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8	9
Number of relevés (Število popisov)		4	5	6	5	7	10	4	4	5
Sign for syntaxa (Oznaka sintaksonov)		EvAsNI	EvAty	EvAG	EvAS	EvAhy	EvApc	EvAcc	PcAtc	PcAcr
AD	<i>Adiantion, Adiantetea</i>									
	<i>Adiantum capillus-veneris</i>	E1	100	100	100	100	100	100	100	100
	<i>Eucladium verticillatum</i>	E0	100	100	100	100	43	90	50	75
	<i>Preissia quadrata</i>	E0	50	.	.	40	.	.	.	.
	<i>Hymenostylium recurvirostrum</i>	E0	.	50	.	100	100	10	50	25
	<i>Pellia endiviifolia</i>	E0	.	33	33	60	57	80	75	.
	<i>Didymodon tophaceus</i>	E0	.	17	.	.	.	10	.	.
	<i>Calliergonella cuspidata</i>	E0	.	17	.	.	.	.	.	.
MC	<i>Montio-Cardaminetea</i>									
	<i>Palustriella commutata</i>	E0	50	50	.	.	100	100	50	.
	<i>Cratoneuron filicinum</i>	E0	50	17	.	.	.	20	.	.
	<i>Bryum pseudotriquetrum</i>	E0	.	17	.	.	14	10	.	.
	<i>Philonotis fontana</i>	E0	.	17	.	.	.	10	.	.
	<i>Didymodon spadiceus</i>	E0	.	17	.	.	.	.	.	.
	<i>Conocephalum conicum</i>	E0	.	.	.	.	29	60	100	.
	<i>Gymnostomum aeruginosum</i>	E0	.	.	.	.	14	.	.	.
	<i>Cinclidotus fontinaloides</i>	E0	.	.	.	.	.	10	.	80
	<i>Trichostomum crispulum</i>	E0	.	.	.	.	.	.	100	.
	<i>Didymodon fallax</i>	E0	.	.	.	.	.	.	75	.
	<i>Cinclidotus riparius</i>	E0	.	.	.	.	.	.	.	100
	<i>Lunularia cruciata</i>	E0	.	.	.	.	.	.	.	60
	<i>Hygrohypnum luridum</i>	E0	.	.	.	.	.	.	.	60
CF	<i>Cystopteridion fragilis</i>									
	<i>Jungermannia atrovirens</i>	E0	.	.	.	40	14	.	.	.
	<i>Orthothecium rufescens</i>	E0	.	.	.	.	29	.	.	.
	<i>Cystopteris fragilis</i>	E1	.	.	.	.	.	.	.	20
PC	<i>Potentilletalia caulescentis</i>									
	<i>Phyteuma scheuchzeri</i> subsp. <i>columnae</i>	E1	.	17	.	.	14	.	.	75
	<i>Paederota lutea</i>	E1	.	17	.	.	.	.	50	20
	<i>Potentilla caulescens</i>	E1	.	.	17	100	.	.	.	.
	<i>Moehringia bavarica</i>	E1	.	.	.	40	.	.	.	.
PJ	<i>Parietaria judaicae</i>									
	<i>Parietaria judaica</i>	E1	.	.	.	20	.	.	25	.
	<i>Cymbalaria muralis</i>	E1	.	.	.	.	.	10	.	.
AT	<i>Asplenieta trichomanis</i>									
	<i>Asplenium trichomanes</i>	E1	.	17	33	100	.	.	25	25
	<i>Asplenium ruta-muraria</i>	E1	.	.	.	40	.	.	.	.
	<i>Cardaminopsis arenosa</i>	E1	.	.	.	.	.	20	.	.
	<i>Leontodon hispidus</i> subsp. <i>brumatii</i>	E1	.	.	.	.	.	.	.	25
	<i>Asplenium viride</i>	E1	.	.	.	.	.	.	.	20
TR	<i>Thlaspietea rotundifolii</i>									
	<i>Hieracium bifidum</i>	E1	.	17	.	.	.	.	.	.
	<i>Petasites paradoxus</i>	E1	.	.	.	.	43	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8	9
SCF	Scheuchzerio-Caricetea fuscae									
	<i>Schoenus nigricans</i>	E1	100	.	.	.	.	.	.	.
	<i>Tofieldia calyculata</i>	E1	.	.	60	43	.	.	.	.
	<i>Pinguicula alpina</i>	E1	.	.	40	.	.	.	.	.
ES	Elyno-Seslerietea									
	<i>Sesleria caerulea</i> subsp. <i>calcaria</i>	E1	.	.	.	43	.	.	75	.
	<i>Aster bellidifolium</i>	E1	.	.	.	.	.	.	25	20
FB	Festuco-Brometea									
	<i>Globularia punctata</i>	E1	.	17	.	.	.	.	.	.
	<i>Blackstonia perfoliata</i>	E1	.	.	.	60	.	.	.	.
TG	Trifolio-Geranietea									
	<i>Campanula rapunculoides</i>	E1	.	17	.	.	.	.	.	.
MA	Molinion, Molinio-Arrhenatheretea									
	<i>Deschampsia cespitosa</i>	E1	.	17	.	.	10	.	.	20
	<i>Galium mollugo</i>	E1	.	17	.	.	.	.	.	.
	<i>Pulicaria dysenterica</i>	E1	.	17	.	.	.	.	.	.
	<i>Angelica sylvestris</i>	E1	.	.	.	.	14	.	.	20
	<i>Caltha palustris</i>	E1	.	.	.	.	20	.	.	.
	<i>Taraxacum officinale</i>	E1	.	.	.	.	.	.	25	.
FC	Filipendulo-Convulvetea									
	<i>Filipendula ulmaria</i>	E1	.	.	.	.	.	.	.	20
MuA	Mulgedio-Aconitetea									
	<i>Senecio ovatus</i>	E1	.	.	.	14	.	.	.	.
EA	Epilobietea angustifolii									
	<i>Eupatorium cannabinum</i>	E1	.	17	.	.	30	.	25	.
SM	Stellarietea mediae									
	<i>Cardamine hirsuta</i>	E1	.	.	.	.	10	.	.	.
	<i>Stellaria media</i>	E1	.	.	.	.	10	.	.	.
GU	Galio-Urticetea									
	<i>Petasites hybridus</i>	E1	.	17	.	.	.	.	.	20
	<i>Aegopodium podagraria</i>	E1	.	.	.	.	20	.	.	.
	<i>Viola odorata</i>	E1	.	.	.	.	10	.	.	.
	<i>Equisetum arvense</i>	E1	.	.	.	.	10	.	.	.
RP	Rhamno-Prunetea									
	<i>Rubus macrophyllus</i>	E2a	.	17	.	.	.	.	.	.
	<i>Ligustrum vulgare</i>	E1	.	.	.	14	10	25	.	.
EP	Erico-Pinetea									
	<i>Molinia caerulea</i> subsp. <i>arundinacea</i>	E1	.	33	.	86	30	.	.	.
	<i>Calamagrostis varia</i>	E1	.	17	.	57	10	25	50	.
	<i>Bupthalmum salicifolium</i>	E1	.	17	.	.	.	.	.	.
VP	Vaccinio-Piceetea									
	<i>Veronica urticifolia</i>	E1	.	.	.	14	10	.	.	40
	<i>Oxalis acetosella</i>	E1	.	.	.	.	.	50	.	.
AF	Aremonio-Fagion									
	<i>Lamium orvala</i>	E1	.	17	.	.	.	25	.	.
	<i>Anemone trifolia</i>	E1	.	.	.	14	.	.	.	.
	<i>Cyclamen purpurascens</i>	E1	.	.	.	.	10	25	.	.
	<i>Cardamine trifolia</i>	E1	.	.	.	.	10	.	.	.
FS	Fagetalia sylvaticae									
	<i>Salvia glutinosa</i>	E1	.	17	.	.	10	.	.	.
	<i>Viola reichenbachiana</i>	E1	.	17	.	.	.	25	.	.
	<i>Fagus sylvatica</i>	E1	.	17	.	.	.	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8	9
	<i>Brachypodium sylvaticum</i>	E1	.	.	.	14	60	.	.	20
	<i>Galeobdolon flavidum</i>	E1	.	.	.	14	40	50	.	.
	<i>Mycelis muralis</i>	E1	.	.	.	14	30	.	25	.
	<i>Geranium robertianum</i>	E1	.	.	.	14	30	.	.	.
	<i>Aruncus dioicus</i>	E1	.	.	.	14	.	.	.	.
	<i>Phyllitis scolopendrium</i>	E1	.	.	.	14	.	.	25	60
	<i>Pulmonaria officinalis</i>	E1	.	.	.	14	.	.	.	.
	<i>Sambucus nigra</i>	E1	.	.	.	14	.	.	.	.
	<i>Euphorbia amygdaloides</i>	E1	.	.	.	.	10	.	.	.
	<i>Symphytum tuberosum</i>	E1	.	.	.	.	10	.	.	.
	<i>Asarum europaeum</i> subsp. <i>caucasicum</i>	E1	.	.	.	.	.	25	.	.
	<i>Ranunculus lanuginosus</i>	E1	.	.	.	.	.	25	.	.
	<i>Tilia cordata</i>	E2a	.	.	.	.	.	.	.	20
QP	<i>Quercetalia pubescentis</i>		.	.	.	.	.	.	.	.
	<i>Asparagus acutifolius</i>	E1	.	17	.	.	10	.	.	.
	<i>Celtis australis</i>	E1	.	17	.	.	.	.	.	.
	<i>Fraxinus ornus</i>	E2a	.	17	.	.	10	.	.	40
	<i>Ostrya carpinifolia</i>	E1	.	17	.	.	.	.	75	.
	<i>Quercus pubescens</i>	E1	.	17	.	.	.	.	.	.
	<i>Ruscus aculeatus</i>	E1	.	17	.	.	10	50	.	.
	<i>Sesleria autumnalis</i>	E1	.	17	.	.	10	.	.	.
	<i>Viola alba</i> subsp. <i>scotophylla</i>	E1	.	17	.	.	10	.	.	.
	<i>Carex flacca</i>	E1	.	.	.	29	.	.	.	.
	<i>Tamus communis</i>	E1	.	.	.	.	20	.	.	.
	<i>Clematis recta</i>	E1	.	.	.	.	.	.	.	20
QF	<i>Quercus-Fagetea</i>		.	.	.	.	.	.	.	.
	<i>Hedera helix</i>	E1	.	33	.	57	70	100	50	40
	<i>Vinca minor</i>	E1	.	33	.	.	.	.	.	.
	<i>Clematis vitalba</i>	E2a	.	17	.	.	10	.	75	40
	<i>Primula vulgaris</i>	E1	.	17	.	14	30	25	.	.
	<i>Viola riviniana</i>	E1	.	17	.	.	20	.	.	.
	<i>Lonicera caprifolium</i>	E2a	.	17	.	.	10	.	.	.
	<i>Corylus avellana</i>	E1	.	17	.	.	.	.	.	.
	<i>Ficaria verna</i>	E1	.	.	.	.	10	.	.	.
	<i>Ilex aquifolium</i>	E2a	.	.	.	.	.	.	.	20
	<i>Alnus incana</i>	E2a	.	.	.	.	.	.	.	20
O	Other species (Druge vrste)		.	.	.	.	.	.	.	.
	<i>Ficus carica</i>	E2a	.	.	20	.	.	.	.	20
	<i>Festuca</i> sp.	E1	.	.	.	.	.	25	.	.
	<i>Thuja orientalis</i>	E2a	.	.	.	.	.	.	25	.
	<i>Veronica</i> sp.	E1	.	.	.	.	.	.	25	.
	<i>Deutzia scabra</i>	E2a	.	.	.	.	.	.	.	20
	<i>Galium palustre</i>	E1	.	.	.	.	.	.	.	20
M	Mosses (Mahovi)		.	.	.	.	.	.	.	.
	<i>Southbya tophacea</i>	E0	75	.	.	.	.	.	.	.
	<i>Riccardia</i> sp.	E0	50	.	.	.	.	.	.	.
	<i>Oxyrrhynchium schleicheri</i>	E0	.	17	.	29	30	25	25	.
	<i>Plagiomnium rostratum</i>	E0	.	17	.	.	10	75	.	60
	<i>Jungermannia</i> sp.	E0	.	17	.	14	10	.	.	.
	<i>Lophozia</i> sp.	E0	.	17	.	.	20	.	.	.
	<i>Didymodon ferrugineus</i>	E0	.	17	.	.	.	.	.	.
	<i>Jungermannia hyalina</i>	E0	.	17	.	.	.	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8	9
<i>Tortella</i> sp.	E0	.	17	.	.	.	.	.	.	.
<i>Jungermannia gracillima</i>	E0	.	.	50	.	.	.	.	25	.
<i>Trichostomum brachyodontium</i> var. <i>cuspidatum</i>	E0	.	.	17	.	.	.	.	.	.
<i>Wessia</i> sp.	E0	.	.	17	.	.	.	.	.	.
<i>Seligeria trifaria</i>	E0	.	.	.	20	14	.	.	.	.
<i>Oxyrrhynchium hians</i>	E0	.	.	.	.	14	50	50	75	100
<i>Fissidens taxifolius</i> subsp. <i>taxifolius</i>	E0	.	.	.	.	14	20	.	25	40
<i>Pedinophyllum interruptum</i>	E0	.	.	.	.	14	.	.	25	20
<i>Brachythecium rutabulum</i>	E0	.	.	.	.	.	10	25	25	.
<i>Brachythecium starkei</i>	E0	.	.	.	.	.	10	.	.	.
<i>Fissidens adianthoides</i>	E0	.	.	.	.	.	10	.	.	.
<i>Philonotis marchica</i>	E0	.	.	.	.	.	10	.	.	.
<i>Rhynchostegium murale</i>	E0	.	.	.	.	.	10	.	.	.
<i>Barbula unguiculata</i>	E0	.	.	.	.	.	.	.	50	.
<i>Barbula convoluta</i>	E0	.	.	.	.	.	.	.	25	40
<i>Oxystegus tenuirostris</i>	E0	.	.	.	.	.	.	.	25	.
<i>Mnium marginatum</i>	E0	.	.	.	.	.	.	.	25	.
<i>Rhynchostegiella tenella</i>	E0	.	.	.	.	.	.	.	25	.
<i>Thamnobryum alopecurum</i>	E0	.	.	.	.	.	.	.	25	.
<i>Neckera bessi</i>	E0	.	.	.	.	.	.	.	.	40
<i>Plasteurhynchium striatulum</i>	E0	.	.	.	.	.	.	.	.	40
<i>Platyhypnidium riparioides</i>	E0	.	.	.	.	.	.	.	.	40
<i>Amblystegium serpens</i>	E0	.	.	.	.	.	.	.	.	20
<i>Didymodon acutus</i>	E0	.	.	.	.	.	.	.	.	20

- 1 EVAsNI *Eucladio-Adiantetum southbyetosum stillicidiorum* – N Italy, Gicomini (1951)
- 2 EvAty *Eucladio-Adiantetum eucladietosum* – Slovenia
- 3 EvAG *Eucladio-Adiantetum eucladietosum* – N Italy, Gicomini (1951)
- 4 EvAS *Eucladio-Adiantetum eucladietosum* var. *Potentilla caulescens* – N Italy, Sutter (1969)
- 5 EvAhy *Eucladio-Adiantetum hymenostylietosum recurvirostri* – Slovenia
- 6 EvApc *Eucladio-Adiantetum cratoneuretosum commutati* – Slovenia
- 7 EvAcc *Eucladio-Adiantetum conocephaletosum conici* – Slovenia
- 8 PcAtc *Phyteumato columnae-Adiantetum capilli-veneris trichostomotosum crispulae* – Slovenia
- 9 PcAcr *Phyteumato columnae-Adiantetum capilli-veneris cinclidotosum riparii* – Slovenia

Table 3: Average Landolt's and Ellenberg's indicator values for communities with dominant *Adiantum capillus-veneris* in southern Alps and Slovenia

Tabela 3: Landoltove in Ellenbergove indikacijske vrednosti za združbe z dominantno vrsto *Adiantum capillus-veneris* v južnih Alpah in Sloveniji

	T_	K_	L_	F_	R_	N_	H_	D_	L_	T_	K_	F_	R_	N_
	Lan	Lan	Lan	Lan	Lan	Lan	Lan	Lan	Ell	Ell	Ell	Ell	Ell	Ell
<i>Eucladio-Adiantetum southbyetosum stillicidiorum</i> – N Italy, Gicomini (1951)	3.7	2.5	3.2	4.5	5.0	1.8	3.8	3.0	5.9	5.9	4.4	7.9	7.8	2.5
<i>Eucladio-Adiantetum eucladietosum</i> – Slovenia	3.8	2.9	2.9	3.0	4.0	2.8	2.9	2.9	5.8	5.7	4.1	5.5	6.7	4.6
<i>Eucladio-Adiantetum eucladietosum</i> – N Italy, Gicomini (1951)	3.2	2.8	2.8	2.8	4.8	1.7	1.3	5.0	5.1	5.5	4.2	6.7	6.7	3.0
<i>Eucladio-Adiantetum eucladietosum</i> var. <i>Potentilla</i> <i>caulescens</i> – N Italy, Sutter (1969)	3.3	2.9	3.5	2.5	4.7	2.1	1.6	4.5	6.1	5.0	4.1	6.3	7.8	3.0
<i>Eucladio-Adiantetum hymenostylietosum recurvirostri</i> – Slovenia	3.3	2.8	2.9	3.5	4.5	2.5	3.0	2.8	5.7	4.8	4.0	6.1	7.4	4.7
<i>Eucladio-Adiantetum cratoneuretosum commutati</i> – Slovenia	3.6	2.8	2.8	3.2	4.0	3.0	3.1	2.6	5.4	5.4	4.1	5.9	6.8	5.4
<i>Eucladio-Adiantetum conocephaletosum conici</i> – Slovenia	3.9	2.6	2.3	3.1	4.0	2.8	3.0	3.2	4.5	5.3	4.0	5.9	7.2	5.2
<i>Phyteumato columnae-Adiantetum capilli-veneris</i> <i>trichostomosum crispulae</i> – Slovenia	3.5	2.8	2.9	3.0	4.1	2.3	2.7	3.7	5.7	5.0	4.3	5.0	7.0	4.3
<i>Phyteumato columnae-Adiantetum capilli-veneris</i> <i>cinclidotosum riparii</i> – Slovenia	3.6	2.8	2.8	3.1	4.0	2.7	2.7	3.2	5.5	5.0	4.1	5.7	6.9	4.4