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THE ASSOCIATION *SALICETUM INCANO-PURPUREAE* SILLINGER 1933
ON THE GRAVEL BARS OF THE NADIŽA RIVER (NORTHWESTERN SLOVENIA)

*L'ASSOCIAZIONE SALICETUM INCANO-PURPUREAE SILLINGER 1933
DEL GRETO DEL FIUME NATISONE (SLOVENIA NORD-OCCIDENTALE)*

Abstract - In this study the association *Salicetum incano-purpureae* Sillinger 1933 on the gravel bars of the Nadiža river, in northwestern Slovenia, is described. The community is of a similar composition to cognate communities in Central Europe, with the characteristic species being *Salix eleagnos*. Its differential species are: *Cirsium oleraceum*, *Chaerophyllum hirsutum*, *Geranium robertianum*, *Aegopodium podagraria*, *Angelica sylvestris*, *Mentha longifolia*, *Senecio ovatus* and *Stachys sylvatica*. We classify the community into a new geographical variant *Salicetum incano-purpureae* var. geogr. *Knautia drymeia* subsp. *drymeia* var. geogr. nova. This is due to, firstly, the geographical position of the community on the border of the Illyrian and Central European regions and secondly, the presence of the Illyrian species. These species are: *Knautia drymeia* subsp. *drymeia*, *Lamium orvala*, *Omphalodes verna*, *Primula vulgaris*, *Cyclamen purpurascens*, *Laburnum alpinum*, *Anemone trifolia*, all of which indicate the distribution in the Illyrian province. In addition, we have also differentiated the new geographical subvariant with species *Asperula taurina*. The differential species *Asperula taurina* is in Slovenia only found at Breginjski kot and in the Soča Valley. Two variants of the community are also described: the initial with the species *Petasites paradoxus* and a variant with the species *Rubus caesius*, growing on deeper and more developed soil.

Key words: *Salicetum incano-purpureae*, Phytosociology, Nadiža River, NW Slovenia.

Riassunto breve - In questo lavoro viene descritta l'associazione *Salicetum incano-purpureae* Sillinger 1933 del greto del F. Natisone, Slovenia nord-occidentale. L'associazione è stata descritta sulla base di una analoga associazione dell'Europa centrale, che ha come specie caratteristica *Salix eleagnos*. Le specie che la differenziano sono invece: *Cirsium oleraceum*, *Chaerophyllum hirsutum*, *Geranium robertianum*, *Aegopodium podagraria*, *Angelica sylvestris*, *Mentha longifolia*, *Senecio ovatus* e *Stachys sylvatica*. L'associazione viene inquadrata in *Salicetum incano-purpureae* var. geogr. *Knautia drymeia* subsp. *drymeia* var. geogr. nova. Il motivo principale di questa differenziazione sta nella posizione geografica dell'associazione ai bordi delle regioni europee illirica e centrale e secondariamente per la presenza di specie illiriche. Queste specie sono: *Knautia drymeia* subsp. *drymeia*, *Lamium orvala*, *Omphalodes verna*, *Primula vulgaris*, *Cyclamen purpurascens*, *Laburnum alpinum*, *Anemone trifolia*, tutte a gravitazione illirica. La nuova subvariante geografica si differenzia, inoltre, per la presenza della specie *Asperula taurina*. *Asperula taurina* è stata trovata in Slovenia solamente a Breginjski kot e nella Valle dell'Isonzo. Sono state, inoltre, descritte due altre varianti dell'associazione: la prima a *Petasites paradoxus* ed un'altra a *Rubus caesius*, che cresce su suolo più profondo e più sviluppato.

Parole chiave: *Salicetum incano-purpureae*, Fitosociologia, F. Natisone, Slovenia Nord-occidentale.

Introduction

Despite a long and rich tradition of phytosociological research in Slovenia (ZUPANČIČ, 1997), willow communities and willow carrs have been quite neglected in research. The researchers have merely mentioned them in their studies, emphasizing that these communities are not sufficiently well-known and elaborated (M. WRABER, 1960; ZUPANČIČ, 1996). In addition, they have been of little economic significance for forestry (SMOLE, 1989).

While examining willow communities, Slovene researchers classified them within the alliance *Salicion albae* Soó 1930, which groups often flooded riverside woods (PISKERNIK, 1975; MARINČEK & SELIŠKAR, 1984; ČARNI, 1995). The communities of the alliance *Salicion eleagno-daphnoidis* (Moor 1958) Grass 1993, which include montane shrub willow communities, have not been examined yet.

Among Slovene authors, most of the work in this field has been done by TOMAŽIČ (1949) who thoroughly examined the development of vegetation on bare gravel, sand and mud on the terraces of the river Sava near Ljubljana. He precisely described the ecological conditions on alluvial sites and the factors which cause alterations in the zoning of the communities or the succession series. Unfortunately, these communities were not presented in a table form, but only the stages *Salicetum mixtum* and *Salicetum triandro-purpureae* were mentioned. These stages can be interpreted as independent communities. In particular Dovolilová-Novotná (1961) mentions *Salicetum mixtum* Klika 1936 as a synonym for *Salicetum incano-purpureae* Sillinger 1933, from which we may conclude that TOMAŽIČ had been researching stands of the Hoary willow (*Salix eleagnos*) by the river Sava near Ljubljana. This community was found on gravel bars of the Soča river near Bovec by T. WRABER (1965).

This riverside vegetation on gravel had also been researched on our territory by PETKOVŠEK (1966) who described the association *Calystegio-Salicetum purpureae*.

When we mention our territory and the vegetation from the alliance *Salicion eleagno-daphnoidis*, we must mention AICHINGER (1933) who examined the riverside vegetation of Alpine streams in the Karavanke Mountains.

Researches into willow stands in the immediate vicinity of Slovenia, were also done by TRINAJSTIĆ (1969, 1992, 1994) on the river Drava.

Following researches have been done in Friuli-Venezia Giulia (Furlanija-Juljska krajina); POLDINI & VIDALI (1995) mention the association *Salicetum eleagni* Hag. 16 ex Jenik 55 but only in manuscript (ex schedis).

Synsystematic classification of willow carrs has been treated very differently by several authors in Europe (SEIBERT & CONRAD, 1992; GRASS, 1993).

SEIBERT & CONRAD (1992) classify the associations *Myricarietum* (Rübel 12) Jenik 55 and *Salicetum eleagni* Jenik 1955 within the alliance *Salicion eleagni* Aich. 1933. As a synonym of the latter, they consider *Salicetum eleagno-daphnoidis* Moor 1958. According

to them, the only characteristic species are *Salix eleagnos* and *Salix daphnoides*. They divide this association into two subassociations: *euphorbietosum* and *phalaridetosum*. The first of these subassociations is found on rather dry sites. As differential species of the subassociation *euphorbietosum* they chose the following species: *Euphorbia cyparissias*, *Pinus sylvestris*, *Cirsium arvense*, *Carex flacca*, *Myricaria germanica*, *Melilotus alba*, *Calamagrostis epigejos* and *Leontodon hispidus* subsp. *hispidus*. Within the subassociation *euphorbietosum* they differentiate the race with the species *Hippophaë rhamnoides*.

The second subassociation is found on rather humid sites and represents a stage of succession towards the association *Alnetum incanae*. The differential species of the subassociation *phalaridetosum* are: *Phalaris arundinacea*, *Rubus caesius*, *Angelica sylvestris*, *Urtica dioica*, *Symphytum officinale*, *Aegopodium podagraria*, *Cirsium oleraceum*, *Filipendula ulmaria* and *Galium aparine*. Within this subassociation, they also differentiate the phase with the species *Stachys sylvatica*.

GRASS (1993) revised the alliance *Salicion eleagni* Aich. 1933 and named it *Salicion eleagno-daphnoidis* (Moor 1958) Grass 1993. She indicates the association *Salici-Myricarietum* as the most initial, similar to SEIBERT & CONRAD (1992). She divided the association *Salicetum eleagni* into two associations, a more initial *Salici incanae-Hippophaetum* Br.-Bl. in Volk 1939 (syntaxonomical synonym *Salicetum eleagno-daphnoidis* Moor 1958) and a more developed *Salicetum incano-purpureae* Sillinger 1933 (syntaxonomical synonym *Salicetum eleagni* Jenik 1955). According to SEIBERT & CONRAD (1992) the initial association corresponds to the subassociation *euphorbietosum*. The differential species of the subassociation *phalaridetosum* are treated by GRASS as the differential species of the association *Salicetum incano-purpureae* Sillinger 1933.

A significant difference among the authors is the indicatory evaluation of the species *Hippophaë rhamnoides*. SEIBERT & CONRAD (1992) treat it only as a geographical differential species, whereas GRASS (1993) treats it as a characteristic species of the association *Salici incanae-Hippophaetum*.

The area of research

The research was carried out on the gravel bars of the river Nadiža at Breginjski kot. The examined community was observed along the river from the border crossing at Most na Nadiži to Brischis (Brišče) in Italy (fig. 1). From here downstream the Nadiža does not produce any gravel bars worthy of note.

The area of research is classified, in accordance with M. WRABER (1969), into the Alpine phytogeographical area of Slovenia. ZUPANČIČ et al. (1987), in their detailed study, classify it into the Submediterranean pre-Alpine district of the pre-Alpine region of the Illyrian floral

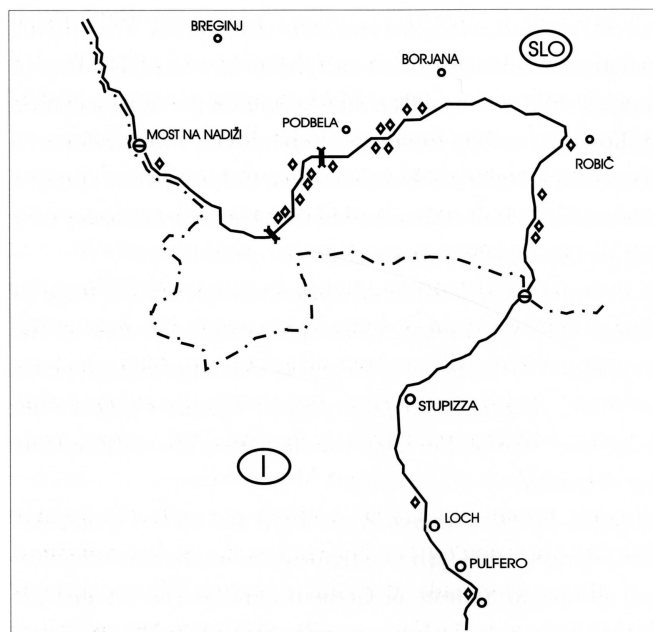


Fig. 1 - Locations of relevés.
- Ubicazione dei rilievi.

province. According to international criteria (after Köppen) Breginjski kot has a boreal climate, represented by the variant Cfb (a temperate warm-humid climate with warm summers). This climate is characteristic of the whole Slovene area apart from the coast of The Gulf of Trieste which is variant Cfa. According to OGRIN's classification (1996), Breginjski kot is in an area with a temperate continental climate, in a sub-type of the climate typical of western and southern Slovenia. In this sub-type the average temperatures in October are typically higher than those in April. There is Submediterranean precipitation regime with an average annual rain fall of 1300-2800 mm. The data collected from the weather station at Breginj indicates that the area is most humid. Between 1931-1960 the annual precipitation was on average 2725 mm, but between 1980-1990 slightly less (2593 mm). The oscillation in annual precipitation indicates two maximums, a less distinctive one in spring (in April and May) and a more distinctive one in autumn (in October and November) with a slight annual depression in July. We do not have any data about temperature regime at Breginjski kot. However, temperatures can be inferred from the data collected from two nearby weather stations, in Montemaggiore (Matajur) (954 m) and Vedronza (Njivice) (320 m), both in Italy. The average annual temperature at Montemaggiore (Matajur) was 9,2 °C, and at Vedronza (Njivice) 10,1 °C. From this temperature data we can conclude that the Mediterranean influence prevails over the Alpine one (LOVRENČAK & PLUT, 1978).

The source of the Nadiža river is on the southern slopes of the Stol mountain chains,

between Veliki Muzec and Punta di Montemaggiore (Breški Jalovec, Breška gora). Numerous steep mountain streams run from here. The largest quantities of water are in Črni potok, Beli potok, Plazi potok and Globotnik. Over a distance of less than a kilometre, at Most na Nadiži, after the confluence of Črni potok and Beli potok, the water course is called the Nadiža. At the foot of the village Logje, the river turns sharply and runs eastwards for a few kilometres. At Robič it turns southwards again and soon crosses the Italian border. The valley of the river Nadiža is narrow and canyon-like in the upper course. It widens slightly below Most na Nadiži, where gravel bars are abundant. The valley opens again just upstream of Podbela and is very wide as far as Korita at Kred. It narrows again between Korita and Robič, because the left bank of the river is strengthened by gabion walls, and the steep slopes of Mija which are on the right side. The riverbed widens a little for a second time between Robič and the Italian border. The abundance of gravel bars is here also seen. In Italy the Nadiža flows into Torre (Ter) at Manzano, before joining the Soča (Isonzo) just above Monfalcone.

The Nadiža is a river with many torrent-like features, which are indicated by high oscillations between low, medium and high waters. The Nadiža has the Alpine rain-snow regime, like all water courses of altimontane and submontane regions. This regime is characterized by two maxima and two minima. The primary maximum begins in late spring, generally in May or sometimes in June. The November increase, although quite pronounced, does not reach this level. The primary minimum occurs in winter and lasts from December until March. The lowest point is in January or February and is lower than the low waters in summer (KOLBEZEN & PRISTOV, 1998).

Methods

The riverside vegetation was investigated in accordance with the standard Central European method (BRAUN-BLANQUET, 1964; WESTHOFF & VAN DER MAAREL, 1973). The sample plots were defined in spring; phytosociological relevés were done at the end of July 1998. In order to determine the species which were not flowering at the time the relevé was made, we revisited the area in autumn. High waters in autumn destroyed some stands and therefore caused some difficulties.

The dendrogram of the relevés was taken using the statistical computer package Syntax 5.0 (PODANI, 1994). We applied the methods of hierarchical clustering, on the basis of complete linkage. The measure of dissimilarity was complement of the coefficient "similarity ratio". When dividing the association into lower units, we applied the principle of multidimensional division of vegetation units (MATUSZKIEWICZ & MATUSZKIEWICZ, 1981).

For syntaxonomical nomenclature we refer to GRASS (1993). For the nomenclature of plant species we refer to VREŠ & TRPIN (1995).

The results and the discussion

Stratification of the community

The community is stratified into two layers: a shrub layer and a herb layer. In the shrub layer of the association *Salicetum incano-purpureae* the Hoary willow (*Salix eleagnos*), and the Purple willow (*Salix purpurea*), which has a smaller cover, can be found. The species *Salix purpurea* is mostly found on the margins of the stands. This species usually grows in better lit places (MOOR, 1958). *Frangula alnus* is very frequent. In the shrub layer are also found the species of the order *Prunetalia spinosae* R. Tx. 1952, although they are more frequent in the herb layer. In addition to these, *Alnus incana* is also occasionally found, mostly in the upper part of the researched area. We decided not to divide the shrub layer into two layers, because the shrubs appearing in the herb layer were mainly saplings and smaller plants.

The shrub layer does not exceed 5 metres in height. Similar structures in southern Germany do not exceed 2-3 m, whereas trees in forests can be 12-16 m high (SEIBERT & CONRAD, 1992), under the influence of underground water. NEUMANN (1981) noticed 15 metres to be the maximum height of the species *Salix eleagnos* on gravel bars. This species grows lower when the sites remain dry for a longer period.

The herb layer is relatively abundant and reaches at least 50% cover. At this point the cover is seldom less than that, usually in structures on the margins where the community of the Nadiža appears.

The cover of the herb layer changes in accordance with the structure's location. In the upper, faster course of the river where gravel sediments are concentrated and their surface area is smaller, the cover is smaller (about 50%) than in the lower course. In the lower course of the river, which is slower and where the river deposits gravel sediments and sand, the cover is large (about 80%), mostly due to the species of the classes *Artemisetea* Lohmeyer et al. in R.Tx. 1950 and *Galio-Urticetea* Passarge ex Kopecky 1969.

Sociological structure

According to GRASS (1993) the differential species of the association, found in stands are: *Cirsium oleraceum*, *Chaerophyllum hirsutum*, *Geranium robertianum*, *Aegopodium podagraria*, *Angelica sylvestris*, *Mentha longifolia*, *Senecio ovatus* and *Stachys sylvatica*. However, the characteristic combination is partly impoverished, in contrast with the one presented by GRASS (1993). For example, the species *Lamium maculatum*, *Primula elatior*, *Valeriana officinalis* agg. are completely absent.

From the group of differential species proposed by GRASS (1993), only two of them were found in the stands in Friuli-Venezia Giulia. Therefore those communities can be classified as less developed (POLDINI, personal communication).

There are few typical species of the higher synsystematical units. The characteristic species of the alliance *Salicion eleagno-daphnoidis* is the species *Salix eleagnos*, giving the stands a typical appearance. *Salix purpurea* and *Populus nigra* are characteristic species of the class *Salicetea purpureae* Moor 1958, yet the poplar was only noticed in a single relevé in the lower course in Italy.

The species of the class *Artemisetea* and *Galio-Urticetea* thrive on ruderal and nitrogen rich sites. Their appearance and cover are mainly characteristic in the lower level of the observed course, where gravel deposits widen, and the soil is more abundant with fine grained sand. Most of the species belonging to the class *Artemisetea* are characteristic of the alliance *Dauco-Melilotion* Görs 1966, the alliance of slightly nitrogen rich communities of two-year herbs, mainly thermo and xerothermophilous species (MUCINA, 1993).

The species of the class *Festuco-Brometea* Br.-Bl. et R. Tx. ex Klika et Hadač 1944 indicate that a period of dry weather appears in summer, because gravel and sand are not able to hold moisture. Their number and cover are relatively small.

The species which grow better in shady and humid places, such as *Angelica sylvestris*, *Eupatorium cannabinum*, *Deschampsia cespitosa*, *Brachypodium sylvaticum* have a greater presence and above all a greater cover value.

The species from the class *Molino-Arrhenatheretea* R. Tx 1937 em. R. Tx. 1970 are relatively numerous in the relevés. The only one with a greater cover is *Deschampsia cespitosa*.

The species of the class *Quercu-Fagetea* Br.-Bl. et Vlieger and Vlieger 1937 and its lower syntaxonomical units are frequent.

The species of the class *Thalaspisetea rotundifolii* Br.-Bl. 1948: *Achnatherum calamagrostis* and *Petasites paradoxus* are not separately considered in the table I, although they are indicative of the initial sites.

Ecological circumstances

The described community thrives along Alpine and pre-Alpine rivers and streams mostly in the upper courses. It is found on gravel and sand (fig. 2 shows a characteristic zonation on a slope), often on islands in mid water course. The dominant species *Salix eleagnos* is able to survive in such harsh circumstances due to its strong vertical root system (JURKO, 1964).

The community is periodically inundated. The soil is relatively abundant in humus and fine grained sand (GRASS, 1993). JOVANOVIĆ & TUCOVIĆ (1965) found about 75% sand at a depth of 5-10 cm. A layer of gravel mixed with rare layers of sand was mostly obtained at deeper levels.

The community does not continue downriver into the submontane zone. It is replaced downriver by the association *Salicetum triandrae* Malcuit ex Noirfalise and Lebrun et al. 1955. The water-holding capability of soil is particularly altered (ELLENBERG, 1988; 1996) when

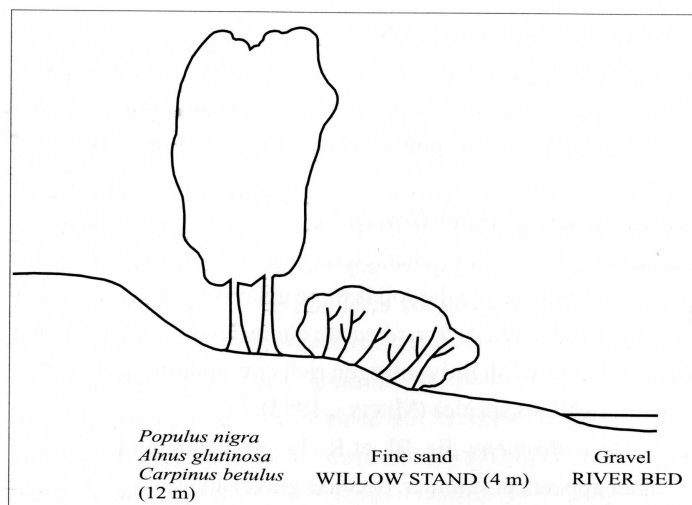


Fig. 2 - Zonation of plant communities on gravel bars of river Nadiža. Stand at Loch (Italy).
- Zonazione dell'associazione vegetale del greto del F. Natisone a Loch (Italia).

the course of the river becomes slower and therefore able to deposit fine grained sand and mud.

The maximum water capacity of the soil is about half that of the willow communities of the alliance *Salicion albae* and about a third that of the alliance *Salicion cinereae* T. Müller et Görs. The maximum water capacity (vol. %) of the soil is about 45% (ŠILC, unpublished). Thick gravel may lack the capillary strength which causes the appearance of species typical of dry sites (TOMAŽIČ, 1949).

JOVANOVIĆ & TUCOVIĆ (1965) describe the species *Salix eleagnos*, which is dominant in the community, as a basophilous one (pH over 8). It is found in fast mountainous rivers on rough alluvium consisting of gravel and sand. Its characteristic is a wide ecological amplitude, being a species tolerant of drought. It grows on thick gravel as well as on constantly humid alluvial deposits (KARL et al., 1998).

The dynamics of the community were not specially observed. It can be seen from the table I, that the variant with the species *Petasites paradoxus* is more initial than the variant with the species *Rubus caesius*.

T. WRABER (1965) links into the succession series the associations *Leontodonti berinii-Chondrilletum* T. Wraber 1965 and *Salicetum eleagni-purpureae* prov. The species *Myricaria germanica* is rare in willow stands at Soča near Bovec, while *Hippophaë rhamnoides* is absent.

These species and therefore the stands of the association *Salici-Myricarietum* and *Salici incanae-Hippophaetum* have not been found yet on the banks of the Nadiža river. We can see that the dynamics of the gravel bars in the Nadiža differ from the dynamics of the communities on gravel bars in neighbouring countries.

The succession series of the stands is often slowed down or even stopped by the river due to permanently deposited material. When the waters are extremely high (for example in autumn 1998), the destructive power of the river increases to such an extent that it can take away entire stands.

The influence of the oscillation in the river level and the frequency of inundation have changed due to human interference. When there are civil engineering works and power stations building, the oscillation of the level of the river goes down. In Switzerland they have discovered a decrease in the number of natural carrs, and only 20% preserved their alluvial character (GALLANDAT et al., 1993). This is compared to the situation in 1958, when MOOR researched the riverside vegetation. However, there has not been a great human interference on the Nadiža yet, apart from at Robič where the slope has been strengthened. Steep mountain streams and tributaries (PAULIČ, 1995) were systematically regulated in the main. Therefore we can assert that the natural current of the Nadiža has been relatively well preserved.

Synsystematics of the association

Syntaxonomical division proposed by GRASS (1993) was used in our study above all because the geographical proximity made it appropriate.

Thus, in accordance with GRASS (1993) the synsystematical position is the following:

Salicetea purpureae Moor 1958

Salicetalia purpureae Moor 1958

Salicion eleagno-daphnoidis (Moor 1958) Grass 1993

Salicetum incano-purpureae Sillinger 1933

The division of the community into lower units

The extent of the association *Salicetum incano-purpureae* in Europe is only roughly known. Although the association was described among the first (ELLENBERG, 1988), due to its characteristic appearance, the synthetic studies about its extent have not been found yet. We can reach certain conclusions about the extents of the dominant species *Salix eleagnos*, from its areal. This shows it to be widespread in Central and southern Europe, the Mediterranean, Alpine and pre-Alpine regions up to the Danube river (SCHIECHTL, 1992).

The *Salix eleagnos*-dominated communities were described on the Balkan peninsula in Croatia (JOVANOVIĆ et al., 1986; TRINAJSTIĆ, 1992, 1994), Serbia (JOVANOVIĆ & TUCOVIĆ, 1965), Macedonia (RIZOVSKI & DŽEKOV, 1990) and Albania (KÁRPÁTI, 1962).

The extent of the community in Slovenia is still not very well researched. The known habitats are: the upper course of the river Sava (ČARNI et al., 1999) and lower down near Ljubljana (TOMAŽIČ, 1949), near Bistrica (the tributary of the river Mirna) (ŠILC, unpublished),

Table I - The association *Salicetum incano-purpureae* Sillinger 1933 on the gravel bars of the Nadiža river (northwestern Slovenia).
- *L'associazione Salicetum incano-purpureae Sillinger 1933 del greto del F. Natisone (Slovenia nord-occidentale)*.

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Altitude (m)	380	300	300	290	290	290	290	290	270	270	270	270	270	270	240	240	240	240	200	180
Relevé area (m ²)	80	60	40	60	50	70	40	80	60	45	50	50	30	60	70	40	80	60	80	60
Aspect	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	plato	E plato	
Slope (degrees)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
Cover shrub layer (%)	90	90	70	90	90	90	80	80	80	80	80	80	80	70	80	80	90	90	60	60
Cover herb layer (%)	60	30	50	50	60	40	40	50	80	60	80	80	90	50	100	60	90	80	60	20
Number of species	47	41	38	43	47	41	37	57	64	43	66	60	53	39	41	38	49	47	42	43
CHARACTERISTIC AND DIFFERENTIAL SPECIES OF ASSOCIATION <i>Salicetum incano-purpureae</i> Sillinger 1933																				
MA	Cirsium oleraceum	+	+	+	+	1	+	+	+	+	+	1	+	+	+	+	+	+	+	+
MA	Chaerophyllum hirsutum	+	1	+	+	1	+	+	1	1	1	+	1	+	+	+	1	+	+	+
GU	Geranium robertianum	+	1	+	+	3	+	+	1	1	+	2	+	1	1	+	1	+	1	+
GU	Aegopodium podagraria	+	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
MA	Angelica sylvestris	+	1	1	1	1	+	+	2	1	1	2	1	1	+	+	+	+	+	+
MA	Mentha longifolia	+					+	+							+	+	+	+	+	+
QF	Senecio ovatus					+		+	+	+	+	+	+	+	+	+	+	+	+	+
QF	Stachys sylvatica																			
DIFFERENTIAL SPECIES OF GEOGR. VARIANT <i>Knaulia drymeia</i> subsp. <i>drymeia</i> var. <i>geogr. nova</i>																				
F	<i>Knaulia drymeia</i> subsp. <i>drymeia</i>	+	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	+
F	<i>Lamium orvala</i>	+																		
F	<i>Omphalodes verna</i>	+					r													
AF	<i>Primula vulgaris</i>	r																		
AF	<i>Cyclamen purpurascens</i>	r																		
AF	<i>Laburnum alpinum</i>	B	+																	
QF	<i>Anemone trifolia</i>	C						r												
DIFFERENTIAL SPECIES OF GEOGR. SUBVARIANT <i>Asperula taurina</i> var. <i>geogr. nova</i>																				
F	<i>Asperula taurina</i>	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
DIFFERENTIAL SPECIES OF VARIANT WITH SPECIES <i>Petasites paradoxus</i>																				
Pet. par.	<i>Petasites paradoxus</i>	+	2	2	3	2	2	2	2	1	2	1	1	+	1	+	2	+	1	1
AU	<i>Alnus incana</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
AU	<i>Alnus incana</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
DIFFERENTIAL SPECIES OF VARIANT WITH SPECIES <i>Rubus caesius</i>																				
C	<i>Rubus caesius</i>	2	+	+	+	+	+	+	+	+	3	2	1	1	2	1	4	1	1	1
GU	<i>Urtica dioica</i>										+	+	+	+	+	+	+	+	+	+

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CHARACTERISTIC SPECIES OF <i>Salicetum elegagno-daphnoides</i> , <i>Salicetalia purpureae</i> , <i>Salicetia purpureae</i>																				
A	<i>Salix elegans</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B	<i>Salix elegans</i>	4	5	4	4	5	4	4	5	4	4	5	4	4	4	5	4	4	4	4
C	<i>Salix elegans</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B	<i>Salix purpurea</i>	+	2	1	2	1	1	1	1	2	2	2	2	2	1	2	1	3	2	2
B	<i>Populus nigra</i>																			
C	<i>Populus nigra</i>																			
ARTEMISETEA																				
DM	<i>Artemisia vulgaris</i>																			
DM	<i>Erigeron annuus</i>																			
DM	<i>Echium vulgare</i>																			
DM	<i>Saponaria officinalis</i>																			
DM	<i>Daucus carota</i>																			
DM	<i>Silene vulgaris</i> subsp. <i>vulgaris</i>																			
DM	<i>Melilotus alba</i>																			
DM	<i>Melandrym album</i>																			
DM	<i>Diplotaxis tenuifolia</i>																			
GALIO-URTICETEA																				
C	<i>Eupatorium cannabinum</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
G	<i>Petasites hybridus</i>	+	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C	<i>Helianthus tuberosus</i>																			
G	<i>Impatiens parviflora</i>																			
C	<i>Solanum dulcamara</i>																			
C	<i>Solanum dulcamara</i>																			
C	<i>Solidago gigantea</i>																			
G	<i>Glechoma hederacea</i>																			
C	<i>Calystegia sepium</i>																			
C	<i>Calystegia sepium</i>																			
G	<i>Alitaria petiolata</i>																			
G	<i>Geum urbanum</i>																			
C	<i>Impatiens glandulifera</i>																			
FESTUCO-BROMETEA																				
	<i>Euphorbia cyparissias</i>	+																		
	<i>Medicago lupulina</i>																			
	<i>Buphthalmum salicifolium</i>	+																		
	<i>Galium lucidum</i>																			
MOLINIO-ARRHENATHERETEA																				
	<i>Deschampsia cespitosa</i>	+	1	+	1	+	+	+	1	1	3	2	2	1	1	2	1	2	+	+

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
<i>Taraxacum officinale</i>	r	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	1	+	17	
<i>Centaurea carniolica</i>	+	+	+	1	+	+	+	+	+	+	+	1	+		+	+	+	+	+	16	
<i>Galium mollugo</i>					+		+	+	+	+	+	+	+	+	+	+	+	+	+	15	
<i>Molinia arundinacea</i>	+		+	+		+	1	1	+		+	+	+	+		+	+			9	
<i>Pimpinella major</i> subsp. <i>major</i>									+	+	+	+	+	+		+				7	
<i>Barbarea vulgaris</i>				+							+	r	+	+	+	+	+	+	+	6	
<i>Dactylis glomerata</i>											+	+	+							4	
<i>Heracleum sphondylium</i>											+	+	+		1					3	
<i>Thalictrum flavum</i>			+					r			+		+			+				2	
<i>Leucanthemum ircutianum</i>																				2	
<i>Prunella vulgaris</i>		+	+												+				+	2	
<i>Leontodon hispidus</i> subsp. <i>hispidus</i>							+	+												2	
PRUNETALIA																					
<i>Clematis vitalba</i>	B	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	+	4	
<i>Clematis vitalba</i>		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	19	
<i>Cornus sanguinea</i>	B	+	+	+	+	+	+	+	+	+	+	1	2	+	1	+	+	+	+	12	
<i>Cornus sanguinea</i>		+	+	+	1	2	+	+	+	+	+	+	+	+	+	+	+	+	+	11	
<i>Carpinus betulus</i>		+	+	+	+	+	+	+	+	+	+	+	+			+	+	+	+	4	
<i>Humulus lupulus</i>	B	+	+	+	+	+				r				1	2		+			2	
<i>Ligustrum vulgare</i>	B							+			+	+			+				+	3	
<i>Ligustrum vulgare</i>								r			+				+	+				3	
<i>Crataegus monogyna</i>																	+			2	
<i>Viburnum lantana</i>	r										r									2	
ALNO-ULMION																					
<i>Fraxinus excelsior</i>	B	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		2	
<i>Fraxinus excelsior</i>		1	1		1	+		+	+	+	+	+	+	+	+	+	+	+	+	13	
<i>Festuca gigantea</i>														+	+	+	+	+	+	11	
<i>Acer pseudoplatanus</i>	B	+		+	+	+		+	+	+	+	+	+		+	+	+	r	+	2	
<i>Acer pseudoplatanus</i>									+	+	+	+	+	+	+	+	+	+	+	9	
<i>Agropyron caninum</i>				+							+	+	+							5	
<i>Ulmus glabra</i>	B										r	+	+		+					2	
<i>Ulmus glabra</i>						r					+	+	+	+	+			1		3	
<i>Impatiens noli-tangere</i>												+		+						2	
FAGETALIA																					
<i>Ranunculus lanuginosus</i>			1	+	+	+	+	+	1	1	1	+	+	+	+	+	+	+	+	16	
<i>Salvia glutinosa</i>		+	+	+	1	+	+	+	1	+	+	+	+	+	+	+	+	+	+	16	
<i>Petasites albus</i>	r				+	+	1				+	+	+	+	+	+	+	+	+	10	
<i>Asarum europaeum</i> subsp. <i>caucasicum</i>		r	+			+	+	r	+	+	r	+	+	+	+	+		r	9	9	
<i>Galium laevigatum</i>	+				+	+	+	+	+	+	+	+	+	+	+	+			+		

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
<i>Scrophularia nodosa</i>											+	+	+	+				+			4
<i>Mycelis muralis</i>												+	+								3
<i>Campanula trachelium</i>											+	+	+								3
<i>Daphne mezereum</i>	+									+	+	+									3
<i>Veronica urticifolia</i>	+									+	+	+									3
<i>Galeobdolon flavidum</i>	+		+						+												2
<i>Fagus sylvatica</i>																					2
<i>Pulmonaria officinalis</i>																					2
<i>Prunus avium</i>				+	+	+															2
QUERCO-FAGETEA																					
<i>Frangula alnus</i>	B	+	+	+	1	1	2	1	1	1	1	1	1	1	+	+	1	1	+	1	19
<i>Frangula alnus</i>		+	+			1	+										+				6
<i>Brachypodium sylvaticum</i>		+	+	1	1	1	+	1	1	1	2	1	1	1	1	1	2	1	+	1	18
<i>Cerastium sylvaticum</i>		+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	14
<i>Hedera helix</i>		+	+	+	+			+	+	+	+	+	+	+	+	+		+			10
<i>Corylus avellana</i>									+				+								2
<i>Corylus avellana</i>					+	+	r	r	+	+	+	+	+			+	+		+	+	6
<i>Acer campestre</i>		+	+					+	r										+	+	5
<i>Carex digitata</i>	+							+	+	+											2
<i>Arabis turrita</i>						+			+												2
<i>Hieracium sylvaticum</i>								+									r				2
OTHER SPECIES																					
<i>Peucedanum verticillare</i>		+	+	+	+	+	1	1	2	1	1	+	1	+	+	1	1	+	+	+	18
<i>Galeopsis sp.</i>											+	+	+	1	+	+	+	1	+	+	11
<i>Galeopsis pubescens</i>																					1
<i>Galeopsis speciosa</i>							+											+			1
<i>Calamagrostis varia</i>			+	+	+	+		2		+	+	+	+		+	+		+			8
<i>Achnatherum calamagrostis</i>			+	+	+	+	+	+	+	+	+	+	+		+	+					8
<i>Astragalus glycyphyllos</i>			+	+	+	+				+	+	+	+							+	6
<i>Agrostis stolonifera</i>			+	+	+	+			+	+	+	+	+								5
<i>Aquilegia atrata</i>		r		1			1		+	+	+	+	+		+	+	1	+	+	+	5
<i>Oxalis fontana</i>				+						+	+	+	+	+	+						5
<i>Polygonum persicaria</i>										+	+	+	+	+	+			+	+	+	5
<i>Plantago major</i>			+							+	+	+	+			+					4
<i>Hypericum perforatum</i> subsp. <i>perforatum</i>									r	+		r				+					3
<i>Solidago virgaurea</i> subsp. <i>virgaurea</i>										+							+				2
<i>Rosa sp.</i>		+																			2
<i>Hieracium piloselloides</i>										+											2
<i>Campanula rapunculoides</i>							+		+												2
<i>Festuca arundinacea</i>					r				+							+	+	+			2

and near Soča (T. WRABER 1965). The appearance of the community on the gravel bars of the Drava river is still to be researched, but we can conclude from TRINAJSTIĆ's (1994) publications that the willow communities by the Drava are more initial (*Salici incanae-Hippophaetum*). The studied community at the upper course of the Nadiža is geographically characterized by some species from the alliance *Aremonio-Fagion* (Ht. 1938) Borhidi in Török et al. 1989, for example *Knautia drymeia* subsp. *drymeia*, *Lamium orvala*, *Omphalodes verna*, *Primula vulgaris*, *Cyclamen purpurascens*, *Laburnum alpinum*, *Anemone trifolia*. A new geographical variant could therefore be separated.

For the geographical variant we propose the name var. geogr. *Knautia drymeia* subsp. *drymeia* var. geogr. nova. This clearly restricts the area of this geographical variant's thriving to the Illyrian floral province, and separates the Illyrian (southeastern) geographical variant from the communities in Central Europe.

Knautia drymeia subsp. *drymeia* is a species which is distributed across southeastern Europe (PRAPROTNIK, 1987). The concentrated areal ranges from the southern and eastern Alps across the Balkan Peninsula (MEUSEL & JAEGER, 1992). SOÓ (1964) defines the species as an Alpine-Illyrian-Carpathian floristic element. The Illyrian species *Lamium orvala* and *Omphalodes verna* range from south-east with the areal extension extremity in the Karavanke Mountains and the Carnic Alps (MARINČEK, 1994).

The geographical distribution of the association could additionally be defined by the presence of the species *Asperula taurina*, which only thrives in Slovenia in the Soča Valley (DAKSKOBLER, 1996).

The species *Asperula taurina* is found across the western and southern Alps, in the Illyrian and Balkan mountainous regions, and the southern Carpathians (MEUSEL et al., 1992).

The association is geographically restricted by the extent of the Illyrian species, which reach their extreme northwestern areal limit here. The association is additionally defined by the species *Asperula taurina* which is only found in Slovenia in the researched area.

The nomenclatural type of the geographical variant and subvariant *Salicetum incano-purpureae* var. geogr. *Knautia drymeia* subsp. *drymeia* subvar. geogr. *Asperula taurina* is the relevé 11 in the Phytosociological Table I.

Numerous researchers divided the treated association into various subassociations. JOVANOVIĆ & TUCOVIĆ (1965) described the association *Salicetum incanae* prov., mentioning the subassociation *alnetosum*, which is supposed to be syndynamically linked to the association *Alnetum incanae* Lüdi 1921. They did not publish the table, nor did they mention the differential species of the association.

SMETTAN (1981) described the subassociation with the species *Salix appendiculata* as being the initial one, and also as being the single differential species.

LIPPERT et al. (1995) examined the river Tagliamento, which is a rarity among the Alpine

ivers, because it is still natural. They divided the association *Salicetum eleagni* Hag. 1916 ex Jenik 1955 into three subassociations: *typicum*, *alnetosum incanae* and *euphorbietosum*.

Our relevés were classified on the basis of LIPPERT et al. (1995), into the subassociation *typicum*, which can be divided into two variants evident in the dendrogram of the relevés (fig. 3).

The variant with the species Petasites paradoxus

This is found in the upper course of the river, which is faster and from where almost all the material is carried off by the river. Therefore the sites are oligotrophic. The differential species of the variant are *Petasites paradoxus* and *Alnus incana*. *Petasites paradoxus* is found in all relevés in the table I, but in this variant the cover value is greater. This is a typical species of gravel bars and screes. The cover of the herb layer is smaller than in the nitrogen rich variant. There are, on average, 44 species on each relevé area.

We found the appearance of the grey alder quite unusual as it is characteristic of the most developed subassociation *alnetosum*. This indicates the development of willow

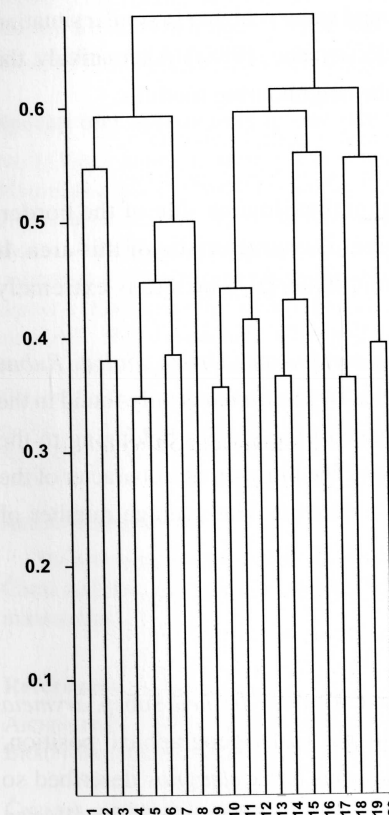


Fig. 3 - Dendrogram of relevés of the association. Numbers refer to number of relevé in Phytosociological Table I.

- Dendrogramma dei rilievi dell'associazione. La numerazione si riferisce ai numeri dei rilievi riportati nella tab. I.

communities into alder communities. The appearance of the grey alder in the upper course is not connected with the succession series, because the stands downstream are more developed. It is probably caused by the narrow current and gravel bars.

Grey alder (*Alnus incana*) is more susceptible to the oscillation of soil moisture than willows (ELLENBERG, 1988). In the upper course the gravel bars are narrower and more influenced by the river, which supplies the shallow roots of the alder with water. The gravel bars are rather dry in the lower course where the described stands appear. This causes a complete absence of alders.

The dryness in the lower course is indicated by the species of the alliance *Dauco-Melilotion*. Alders germinate better than willows (HELLER, 1969) at the courses with the summer maximum. When the water course is at its highest level in the upper course, the influence of the river is on the growth due to the narrowness of the gravel bars. Saplings of alders are often found in initial associations (*Petasitetum nivei* Beger 1921), where we would expect willows, not alders, to grow.

The stands of alders which usually appear lower down by the river, are mostly developed in ditches and depressed areas where the level of underground water is higher [a similar situation was also observed by WENDELBERGER-ZELINKA (1952, in ELLENBERG, 1988)]. Alternatively, the alders are supplied with water by streams running from the neighbouring foothills.

The variant with the species Rubus caesius

This is found in the upper course of the Nadiža on the Slovene side of the border, and also in Italy (2 relevés). A slower course of the river is characteristic of this area. It therefore deposits fine grained sand, waste and organic material. The site is extremely eutrophic.

The differential species of the variant are *Rubus caesius* and *Urtica dioica*. *Rubus caesius* is a differential species due to its cover. The species *Urtica dioica* is only found in the lower course. The variant is characterized by the presence of the species belonging to the class *Artemisetea*, mainly of the alliance *Dauco-Melilotion*. The nitrogen rich character of the site is also indicated by the cover of the class *Galio-Urticetea*. The average number of species is 49.

Conclusion

The syntaxon *Salicetum incano-purpureae* var. geogr. *Knautia drymeia* subsp. *drymeia* has a unique floristic composition. This is because of its particular geographical position, compared to the other communities dominated by the species *Salix eleagnos* described so far. The appearance of the *Aremonio-Fagion* species clearly classifies it into the Illyrian

province, while the species *Asperula taurina* is classified into the Submediterranean-pre-Alpine region of the province.

Further research, already in progress, will show the appropriateness of the division.

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Appendix

Locations of the relevés:

No.:1, Most na Nadiži (9746/3), left bank, 6.8.1998; No.: 2, "Napoleon's bridge" under Logje (9746/4), left bank, 20.7.1998; No.:3, "Napoleon's bridge" under Logje (9746/4), old riverbed, left bank, 20.7.1998; No.:4, Gabri at Podbela (9746/4), right bank, 20.7.1998; No.:5, Gabri at Podbela (9746/4), right bank, 20.7.1998; No.:6, Berjač at Podbela (9746/4), left bank, 20.7.1998; No.:7, under bridge at Podbela (9746/4), right bank, 20.7.1998; No.:8, Gabri at Podbela (9746/4), 24.7.1998; No.:9, Borjana (9746/4), under Debelo čelo, left bank, 21.7.1998; No.:10, Borjana (9746/4), under Debelo čelo, left bank, 21.7.1998; No.:11, Log at Podbela (9746/4), right bank, 21.7.1998; No.:12, Log at Podbela (9746/4), right bank, 21.7.1998; No.:13, by Mokar (9746/2), at confluence, left bank, 21.7.1998; No.:14, at Mokar (9746/2), left bank, 21.7.1998; No.:15, Robič (9747/3), below Počivalnik, left bank, 21.7.1998; No.:16, Robič (9747/3) Počivalnik, left bank, 21.7.1998; No.:17, Robič, Studenci (9747/3), right bank, 21.7.1998; No.:18, Robič (9747/3), 22.7.1998; No.:19, Loch di Pulfero (Italy) (9846/2), right bank, 22.7.1998; No.:20, Brischis (Italy) (9846/2), right bank, 22.7.1998.

Species that appear only in one relevé:

No.1: *Vinca minor* +, *Mercurialis perennis* +, *Equisetum arvense* +, *Trifolium montanum* +; No. 2: *Viburnum opulus* +; No.4: *Cichorium intybus* +, *Lapsana communis* +; No. 5: *Achillea millefolium* +, *Trifolium pratense* +; No. 6: *Arctium lappa* 1, *Melilotus officinalis* +; No. 7: *Carex flacca* +, *Euphrasia stricta* +, *Carduus crassifolius* +, *Agrostis capillaris* 1; No. 8: *Arctium tomentosum* r; No. 9: *Tilia cordata* B +, *Vincetoxicum hirundinaria* +, *Melica nutans*; No. 10: *Carpinus betulus* B r, *Ranunculus repens* +, *Epipactis atrorubens* r; No. 11: *Euphorbia amygdaloides* +, *Filipendula ulmaria* +, *Tanacetum vulgare* +, *Holcus lanatus* r, *Clinopodium vulgare* +; No. 12: *Melandryum rubrum* +, *Tilia cordata* +, *Picea abies* r, *Aruncus dioicus* r, *Dianthus sp.* +, *Allium ursinum* r, *Calamintha sylvatica* +; No. 13: *Phleum pratense* +, *Cirsium vulgare* r, *Bromus sterilis* r; No. 14: *Sambucus nigra* +, *Veronica chamaedrys* +; No. 16: *Carex alba* +; No.18: *Sanguisorba minor* +, *Rumex scutatus* +; No. 19: *Lunaria rediviva* +; No. 20: *Robinia pseudacacia* B +.

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