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Cover photo: Proteus anguinus parkelj Sket & Arntzen 1994. Photo: D. Dalessi, 2012, Speleological laboratory at Department of Biology, BF, University of Ljubljana.

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RAZPRAVE / ESSAYS

Grb, ki ga je imela ACADEMIA OPEROSORUM LABACENSIUM (delovala je v letih 1693-1725), predhodnica Slovenske akademije znanosti in umetnosti. V ospredju grba so čebele in čebelnjak, ki simbolizirajo marljivost. Med, tudi ajdov med, je bil takrat ena najpomembnejših izvoznih dobrin slovenskih dežel.

Emblem of ACADEMIA OPEROSORUM LABACENSIUM (active in the years 1693-1725), a forerunner of the Slovenian Academy of Sciences and Arts. In foreground of the emblem are bee hive and honney-bees, symbol of diligence. Honey, including buckwheat honey, was in the time one of important export comodities of Slovenian countries.

HISTORY AND BIOLOGY OF THE «BLACK PROTEUS« (*PROTEUS ANGUINUS PARKELJ* SKET & ARNTZEN 1994; AMPHIBIA: PROTEIDAE): A REVIEW

Lilijana Bizjak Mali & Boris Sket[1]

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ABSTRACT

History and biology of the «black proteus« (*Proteus anguinus parkelj* Sket & Arntzen 1994; Amphibia: Proteidae): a review

Proteus anguinus parkelj Sket & Arntzen 1994 is a black pigmented with developed eyes, non-troglomorphic, but yet troglobiotic subspecies of *P. anguinus* Laurenti 1786. It is endemic to the karst of Bela krajina in southeast Slovenia. As a probable mimic of the epigean ancestor it is very informative regarding adaptation to subterranean environment. Since it was discovered only in 1986, relatively little is known about its biology. The purpose of this review paper is to summarize the published data about the circumstances of its discovery, its distribution, phylogeny, taxonomy and its biology, including environmental threats, conservation status, and actions that are being taken to ensure its survival. The exceedingly limited distribution of the black proteus makes it particularly vulnerable. It is endangered by environmental pollution as well as by various potential pathogens that are of global concern to amphibians. Populations of the black proteus are in dire need of protection if they are to survive in their own natural habitat.

Key words: Proteus anguinus parkelj, discovery, distribution, phylogeny, morphology, threats

IZVLEČEK

Zgodovina in biologija črnega močerila (*Proteus anguinus parkelj* Sket & Arntzen 1994; Amphibia: Proteidae): pregledni članek

Črni močeril *Proteus anguinus parkelj* Sket & Arntzen 1994 je temno pigmentirana podvrsta človeške ribice *P. anguinus* Laurenti 1786. Ni troglomorf, ima razvite oči, vendar je troglobiont. Je endemit belokranjskega krasa v JV Sloveniji in verjetno spominja na površinskega prednika. Zato je zelo informativen pri raziskavah adaptacij na življenje v podzemlju. Ker je bil odkrit šele leta 1986, je o njegovi biologiji znanega relativno malo. Namen tega preglednega članka je povzeti objavljene podatke o okoliščinah njegovega odkritja, geografski razširjenosti, filogeniji, taksonomiji in biologiji, vključno z okoljskimi grožnjami, varstvenim statusom in ukrepi za zagotovljanje njegovega preživetja. Zaradi izredno omejene razširjenosti je črni proteus še posebej ranljiva rasa. Ogroža ga onesnaževanje okolja, kot tudi različni potencialni patogeni, ki ogrožajo dvoživke po vsem svetu. Črni proteus potrebuje zaščito in varstveni status, če ga želimo ohraniti v njegovem naravnem habitatu.

Ključne besede: Proteus anguinus parkelj, odkritje, razširjenost, filogenija, morfologija, ogroženost

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INTRODUCTION

The purpose of this review paper is to summarize what we know from studies of the mysterious "black proteus", *Proteus anguinus parkelj* Sket et Arntzen 1994, endemic to underground waters of the karst of Bela krajina in southeast Slovenia. The researches were mainly conducted by two research groups at the Department of Biology of the Biotechnical Faculty, University of Ljubljana, with their collaborators from different institutions, including graduate students involved in the research work over many years. The group for Zoology and Speleobiology is focused on taxonomy, evolution and biogeography of *Proteus*. The group for Functional Morphology of Vertebrates is focused on the functional morphological adaptations of *Proteus* to its habitat in the context of vulnerability to toxic chemical and organic pollution with the long-term goal of understanding the factors that can affect its survival in its natural environment. The private Cave Laboratory Tular has also contributed to studies of proteus, and has also made numerous contributions to public outreach and dissemination of the information.

BACKGROUND

The species *Proteus anguinus* Laurenti 1786 was first mentioned by Valvasor in 1689, although he did not recognize its taxonomic affiliation, let alone its biological uniqueness and scientific importance. The species (also known as *človeška ribica*, proteus, the European blind cave salamander, or german *Olm*, among other common names) was first formally described by Laurenti (1786) based on a specimen that was thought to be from the karst lake Cerkniško jezero, in present-day Slovenia, although some researchers are doubtful about the exact locality (Sket 2007). *Proteus anguinus* was the first troglobiont ever to be scientifically described and is also one of the largest ones.

The taxonomical and biogeographical history of the species is highly problematic. Neither the exact location of the type specimen nor the identity of the author who described it are known for certain, and information about its basic biology and reproduction and even its taxonomic identity are still unclear, although most evidence places it with the North American genus *Necturus* in the Family Proteidae (Kezer et al. 1965; Sessions 1980; Trontelj & Gorički 2003). The putative species has been taxonomically split (Fitzinger 1850) and then fused again, and might be split once again into at least six species based on current molecular and biogeographical information (Gorički 2004, 2006; Gorički et al. 2006; Gorički & Trontelj 2006; Trontelj et al. 2009, 2017). Its current geographic distribution is thought to extend through an area characterized as holodinaric, from easternmost Italy through southern Slovenia, Croatia and along the eastern border of Hercegovina and Dalmacija (Sket 1997). Its presence in Montenegro is questionable. Some populations may be reproductively isolated.

Note that the names 'white proteus', 'white subspecies' or *'Proteus anguinus anguinus*' denote here any population of depigmented protei, presenting just momentarily and formally a subspecies. In fact, it is an assembly of morphologically and ecologically very similar populations which are genetically distinct and may present even several independent species.

DISCOVERY OF THE »BLACK PROTEUS«

Historically, the only known populations of *P. anguinus* over the entire known range of the species were depigmented, cave-adapted »white proteuses« with regressed eyes and other troglomorphic characteristics (Sket 2017) (Fig. 1). Occasional reports have been made of darkly pigmented specimens of *P. anguinus* (Aljančič et al. 1986, Aljančič 1988), either from natural populations or captive animals, but these were all troglomorphic white proteus individuals that, at least in the case of the captive animals, had been exposed to light for some time. The first dark pigmented, non-troglomorphic specimens of the »black proteus« (designated as the subspecies *P. a. parkelj*), complete with functional eyes (Fig. 1), were found in October 1986 (nearly 300 years after the white *Proteus* was first mentioned by Valvasor) by researchers of the Inštitut za raziskovanje krasa (from Postojna), during a pumping experiment for water supply of the

Dobličica spring near Črnomelj, in Bela krajina, SE Slovenia (Aljančič et al. 1986; Mihevc 1987; Sket & Arntzen 1994; Aljančič 2017). Following the discovery of the first specimens of the black proteus, searching in surface waters of Dobličica spring gave no positive results, even after a thorough inspection via scuba diving of the 40 m wide and 10 m deep limnocrene spring of Dobličica (Sket 1993c). But gradually, over time, short-term visits and observation of nearby Jelševnik spring resulted in the collection of about 15 individuals. Occasionally, after heavy rains, the animals can be observed penetrating from underground to approach the surface through a thin turf, covering the cracked rock that is characteristic of its type locality (Fig. 2A). The currently known geographic distribution of *P. a. parkelj* is highly restricted in SE Slovenia, southwest to west of Črnomelj where it is found only at spring outlets in an area that is less than 5 km^2 in size (Sket & Arntzen 1994; Gorički et al. 2017; Hudoklin & Aljančič 2017). Adjacent populations of *P. a. anguinus* (the white proteus) are located all around this area.

The first specimen of *P. a. parkelj* that was morphologically analyzed was a female with a total body length of 187 mm and body mass of 13.5 g and with immature ovaries. Detailed reports of the anatomical peculiarities of *P. a. parkelj* were first published by Istenič (1987) and later by Sket (1993b, c). All subsequent samples of *P. a. parkelj* exhibited a remarkable uniformity in external morphology, which allowed the formal description of the black proteus as a new taxon. The morphological description included detailed osteological data and was supplemented by allozyme analysis (Sket & Arntzen 1994). Superficially, many of the morphological characters of the black proteus appear to be plesiomorphies. In addition to dark pig-

Figure 1: Proteus anguinus Laurenti, the ‚first cave animal', described in 1786 from Slovenia as distributed along the almost whole Dinaric karst. Proteus anguinus parkelj Sket & Arntzen, a non-troglomorphic subspecies of P. anguinus, found 1986 and described 1994 as a surprising discovery. It is a troglobiont, but not adaptively morphologically transformed as a ‚fully' cave-adapted troglomorph. It is endemic to several kilometres in the SE corner of Slovenia. Scale bar: 2 cm. Photos: D. Dalessi, Speleological laboratory at Department of Biology, BF, University of Ljubljana.
Slika 1: Proteus anguinus Laurenti, ‚prva jamska žival'. Opisana 1786 iz Slovenije, razširjena je vzdolž skoraj vsega Dinarskega krasa. Proteus anguinus parkelj Sket & Arntzen 1994, ne troglomorfna rasa in veliko odkritje iz leta 1986. Je endemit le nekaj kilometrov velikega območja v JV kotu Slovenije. Je troglobiont, vendar ni adaptivno morfološko preoblikovan. Merilo: 2 cm. Fotografiji: D. Dalessi, Speleološki laboratorij na Oddelku za biologijo, BF, Univerza v Ljubljani.

mentation and fully developed (and presumably functional) eyes, the black proteus lacks conspicuous snout elongation, has differently shaped skull bones, lower teeth number, shorter legs, shorter tail, and a longer trunk with a higher number of trunk vertebrae compared with the white proteus. The differences between the two subspecies were later confirmed by detailed analysis of the skull and whole skeleton by micro-CT scanning (Centrih-Genov 2011; Ivanović et al. 2013).

The existence of a population of non-troglomorphic *Proteus* inhabiting the underground waters in the low karst of Bela krajina is an important biological puzzle. First, it suggests lower selection pressure for troglomorphy in this area, or possibly selection against troglomorphism. This conclusion is supported by the existence in the same area of the only Dinaric cave shrimp *Troglocaris* race that has non-troglomorphic traits such as pigmented eye rudiments (*Troglocaris anophthalmus ocellata,* Jugovic et al. 2012; Sket 1993a). Some epigean and even terrestrial animals (Diplopoda, Chilopoda) drift out of the springs (Sket 1993c, d), which indicates a relatively good food supply and weaker selection pressure compared to the »typical« cave environments inhabited by populations of white proteus.

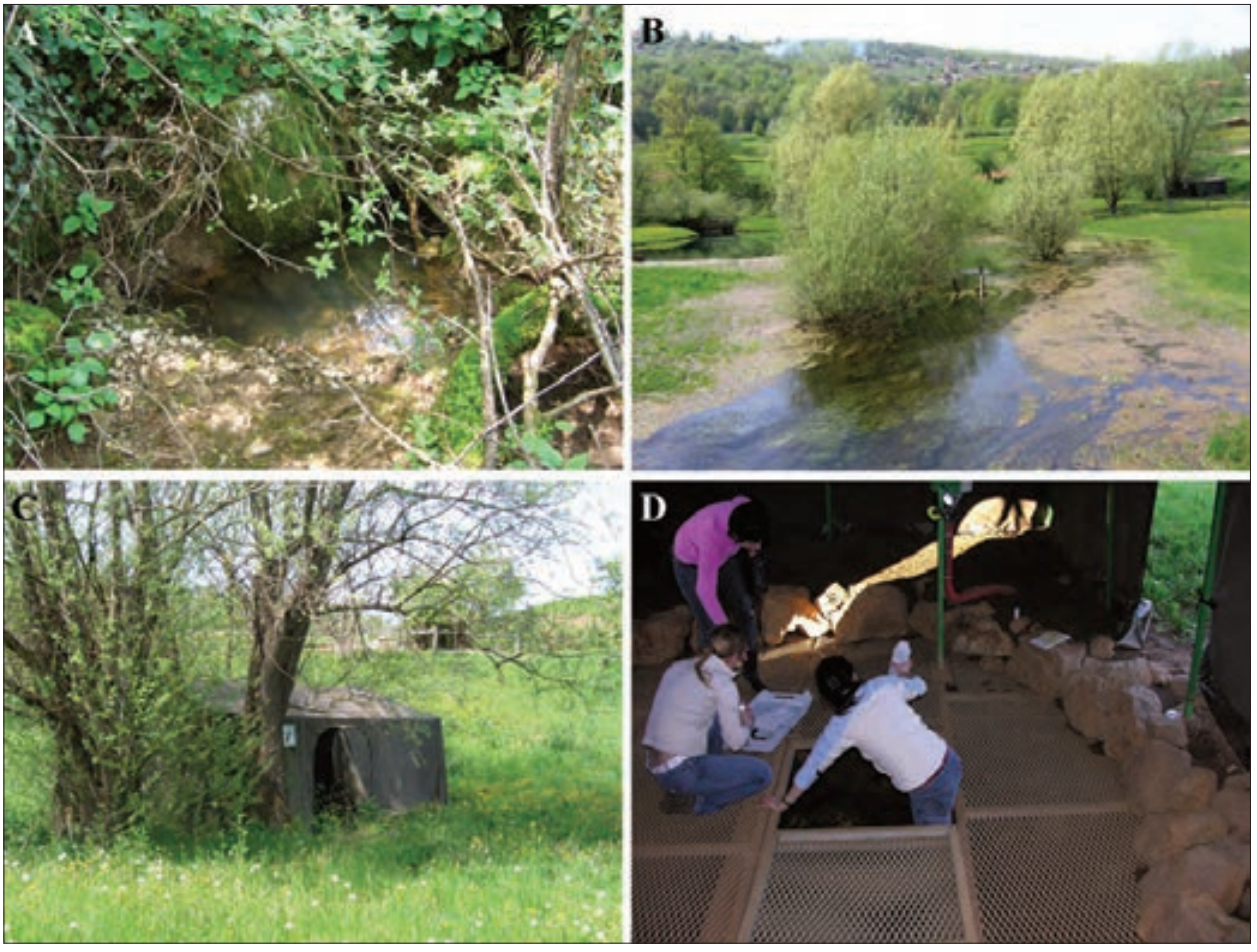

Figure 2: The Jelševnik locality of Proteus anguinus parkelj Sket & Arntzen 1994 in Bela krajina. A. The native typical appearance of the spring. B. The flooded meadow during springtime. C & D. The spring, covered by a tent for in situ observation of animals. Photos: B. Bulog in April 2006.
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MORPHOLOGICAL DESCRIPTION

The black proteus (Fig. 1) can be simply defined as a darkly pigmented and short-snouted proteus with externally visible eyes, a head with more angular and convex lateral sides, a longer trunk, shorter legs, and a shorter tail.

Specimens of adult *P. a. parkelj* mostly range from 200-280 mm in total length (exceptionally, larger specimens have been found, up to 360 mm total length). Its coloration is always close to black with some paler parts and a violet or brownish hue (Fig. 1); a large quantity of dark pigments is found in the outer layers of the dermis (Istenič 1987; Bulog 1994). The eyes are proportionally only slightly smaller than in the North American *Necturus maculosus* Rafinesque 1818, an

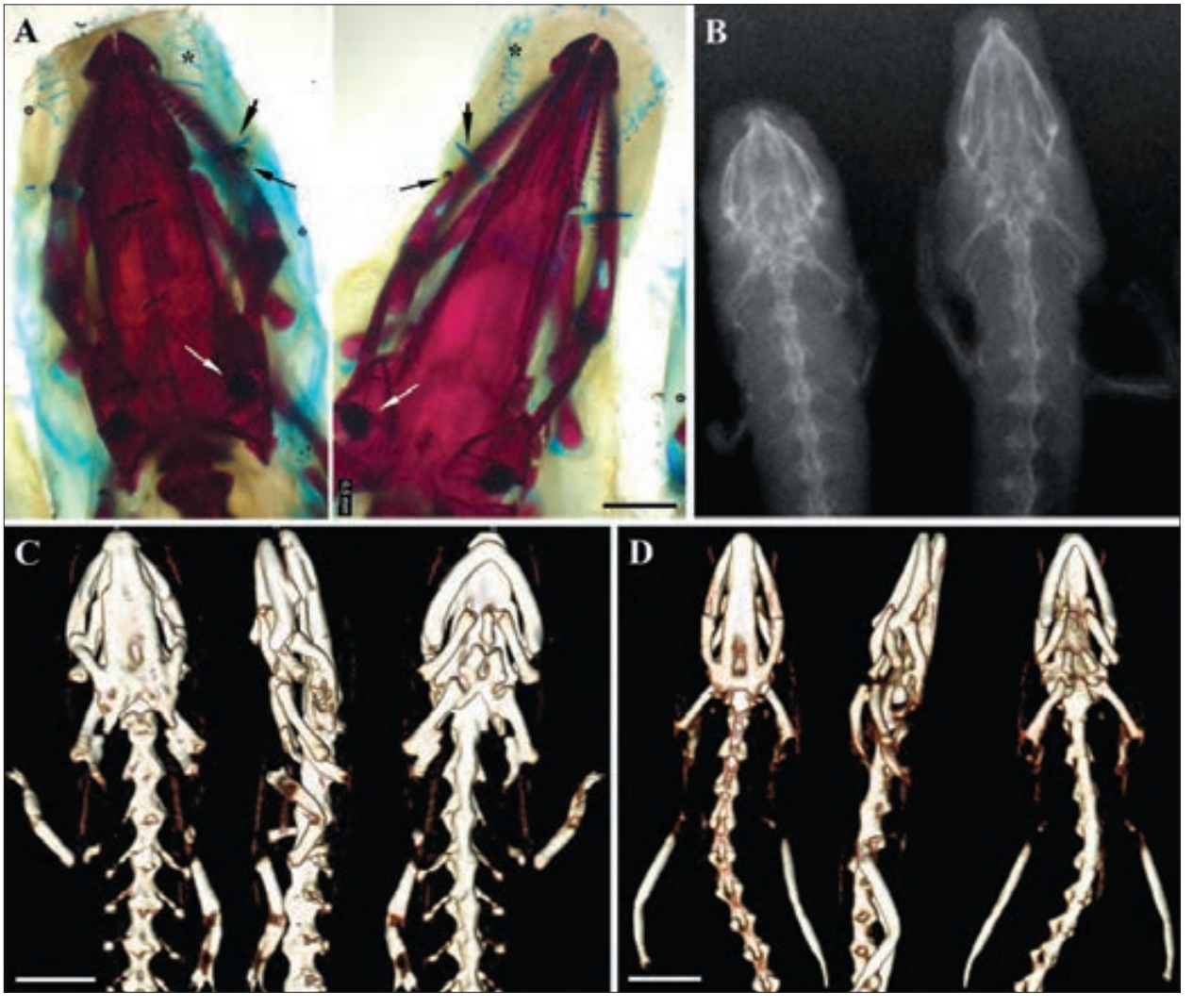

Figure 3: The skull morphology of Proteus anguinus parkelj Sket & Arntzen 1994 (left on photos) and P. a. anguinus Laurenti 1786 (right on photos). A. Clearing and staining technique for bone (red) and cartilage (blue). Asterisk – cartilages of nasal cavity, long arrow - eye, short arrow - antorbital cartilage, white arrow – otic capsule. B. X-ray technique. C & D. Computed micro-tomography from dorsal, lateral and ventral side. Scale bar: 5 mm. Photos: L. Bizjak Mali, 2015 (A), B. Sket, 1992 (B) and T. Centrih-Genov, 2011 (C&D).

Slika 3: Morfologija lobanje Proteus anguinus parkelj Sket & Arntzen 1994 (levo na slikah) in P. a. anguinus Laurenti 1786 (desno na slikah). A. Tehnika presvetlitve tkiv in barvanja za kostno (rdeče) in hrustančno (modro) tkivo. Zvezdica – hrustanci v nosni votlini, dolga puščica - oko, kratka puščica – antorbitalni hrustanec, bela puščica – slušna kapsula. B. Rentgenski posnetek. C & D. Računalniška mikro-tomografija s hrbtne, bočne in trebušne strani. Merilce: 5 mm. Fotografije: L. Bizjak Mali, 2015 (A), B. Sket, 1992 (B) in T. Centrih-Genov, 2011 (C&D).

epigean but permanently aquatic and paedomorphic species. The eyes of the black proteus are clearly visible, with a transparent cornea but lack eyelids (which is typical for other paedomorphic salamanders). The three pairs of gills are feathered with bright red filaments (when alive), and with a partly blackish cover and pale stems. The head is relatively shorter, but broader and with more massive head musculature than in *P. a. anguinus*. The skull morphology has been studied in detail after clearing and staining of whole animals where bones were stained and the remaining tissue made transparent (»cleared«) so that the bones can be easily seen (Sket & Arntzen 1994; Centrih-Genov 2011), with X-ray (Sket & Arntzen 1994) and by computed microtomography (micro-CT) (Centrih-Genov 2011) (Fig. 3A-D) and geometric morphometrics with *Necturus* as an outgroup (Ivanović et al. 2013). All of these studies showed that the skull is similar overall to that of *P. a. anguinus,* but with different proportions of bones; it is shorter and more similar to *Necturus* than to the white proteus. These differences include a head that is not duck-bill shaped (like it is in the white proteus) and with a lower number of teeth. This is especially pronounced on the dentale with only 16 to 19 teeth (while there are 23 to 33 in *P. a. anguinus*). The black proteus' skull is also wider at the jaw articulation point, its snout is wider with laterally extended, larger premaxillae, and shorter vomers which are positionend further apart. The position of the jaw articulation and the shape of buccal cavity are also different (Ivanović et al. 2013). The maxilla bones of the upper jaw are missing which is characteristic of the whole family Proteidae. Compared to *P. a. anguinus*, the black proteus also has a larger number of trunk vertebrae and myomeres. Both legs of the black proteus are remarkably shorter, but with the same reduced number of digits: three on the forelimb and two on the hind limb, a unique feature in *Proteus* among amphibians. The Wolterstorff index (an indicator of body shape) is significantly lower than in *P. a. anguinus* (WI = 10.7 ± 0.57 in *P. a. parkelj* vs. 17.0 ± 1.5 for different populations of *P. a. anguinus*) (Sket & Arntzen 1994). The black proteus also has a substantially shorter tail with a lower number of vertebrae.

CYTOGENETICS AND GENOMICS

A cytogenetic analysis of three populations of *Proteus*, including the black proteus and two populations of the white proteus, showed that the karyotype of *P. a. parkelj* is identical to that of *P. a. anguinus* with 19 pairs (2n = 38) of mainly bi-armed chromosomes with a nucleolus organizer region at the telomere of chromosome pair 12 revealed by AgNOR banding (Fig. 4) (Sessions et al. 2016). Unlike its closest relative *Necturus*, which has pronounced heteromorphic XY sex chromosomes (Sessions 1980; Sessions & Wiley 1985; Sessions et al. 2016), both subspecies of *Proteus* lack heteromorphic sex chromosomes (Sessions et al. 2016). However, C-banding of the chromosomes revealed a prominent concentration of alternating bands of C-band heterochromatin in the telomeric/subtelomeric region of the long arm of both homologues of the largest chromosome 1 in both subspecies of *Proteus*. No other C-band heterochromatin was detectable in the chromosomes of *Proteus*, and even the centromeres were unstained. The conspicuous cluster of alternating light and dark C-bands in chromosome pair 1 exactly matches the pattern of alternating C-bands in the *Necturus* Y chromosome (Fig. 4) and was interpreted to be an X-Y translocation that has become fixed as a homologous pair in both subspecies of *Proteus* (Sessions et al. 2016).

The published mean haploid genome size (C-value) of *P. a. anguinus* is 49 pg (approximately 47.9 Gb of DNA) which is relatively large in comparison with most other amphibians but is only about half as large as the genome sizes of *Necturus* species (Gregory 2016). Nevertheless, the *Proteus* genome is about 16 times the size of the human genome. Current research suggests that the large genomes seen in salamanders are due to the proliferation of transposable elements ("selfish DNA") and accumulation of various kinds of repetitive DNA (Sessions 2008; Sun & Mueller 2014). Preliminary comparative research of genome size of *P. a. parkelj* and *P. a. anguinus* with Feulgen microdensitometry of erythrocyte nuclei (Bizjak Mali, Vokač & Kladnik unpublished) showed that the C-value of *P. a. parkelj* appears to be slightly lower than in *P. a. anguinus*, but these differences are not statistically significant (p value = 0.908). Further study on a much larger sample of individuals for analyzing the genome size of different populations of protei is in progress.

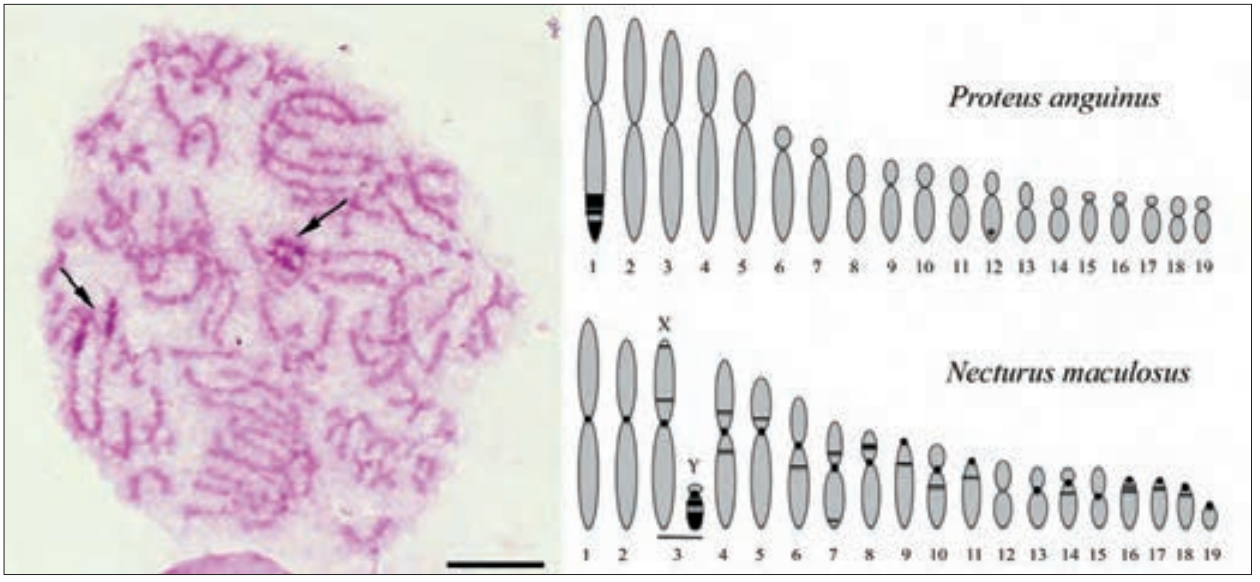

Figure 4: C-banded chromosome spread of Proteus anguinus parkelj Sket & Arntzen 1994 (left) with visible heterochromatic bands on chromosome 1 (arrows), and idiograms (right) of P. anguinus (both subspecies) and Necturus maculosus. Scale bar: 10 µm. Modified from Sessions et al. 2016.
Slika 4: Razmaz C-proganih kromosomov črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994 (levo) z vidnim heterokromatinskim vzorcem na kromosomu 1 (puščica) in idiogram (desno) od P. anguinus (obe podvrsti) and Necturus maculosus. Merilce: 10 µm. Prirejeno po Sessions et al. 2016.

DISTRIBUTION AND HABITAT

The biogeographic distribution of *Proteus anguinus* is holodinaric, with north-western localities close to the Soča/Isonzo estuary and south-eastern ones in SE Hercegovina (Fig. 5) (Sket 1997; Sket et al. 2004). The data from Montenegro (Ćurčić et al. 2008; Gorički et al. 2017) are not reliable. The known locality of the black proteus is in SE Slovenia WSW of Črnomelj (Fig. 5), in some springs positioned within an area of less than 10 km^2 , although the actual habitat of the black proteus might be under the massif of Poljanska gora which encompasses 55 km^2 at most (Sket & Arntzen 1994). Unfortunately, there are no cave entrances in the area that are accessible for searching. Most specimens of the black proteus were found on the surface immediately at the springs, evidently brought from underground after rains. In the year 2004 the black specimen was observed for the first time in its real habitat by divers at a depth of 15 to 20 meters when they dived into the siphon of Dobličica spring (Mihajlovski 2012; Hudoklin & Aljančič 2017). The only locality where the black proteus can be routinely observed *in situ* is the Jelševnik spring where researchers from the Department of Biology at the University of Ljubljana set up a »research station« (Fig. 2B-D) (Bulog & Bizjak Mali 2014). The location is covered by a tent for perpetual observation with infrared camera.

The method for specific eDNA (environmental DNA) detection allows a more detailed investigation of the distribution of the black proteus. This methodology revealed five additional sites (beside the four previously known sites) that may be inhabited by the black proteus (Stanković et al. 2016; Gorički et al. 2016, 2017). Three of these springs lie outside the limits of its previously known range and represent an extension of its presumed range north-eastward, along with the general direction of the flow of the Dobličica River. Populations of *P. a. parkelj* and *P. a. anguinus* appear to be generally allopatric, however at one locality (in the spring Šprajcarjev Zdenec), the eDNA of both taxa was found together (Gorički et al. 2017). While these data do not prove that the two populations are really syntopic, they do highlight the potential for contact through an existing intermittent hydrogeological connection between the above-mentioned springs occupied by the black proteus, and a nearby Otovski Breg which is occupied by the white proteus (Gorički et al. 2017). Even though the black and white protei in these two populations show a low degree of DNA sequence

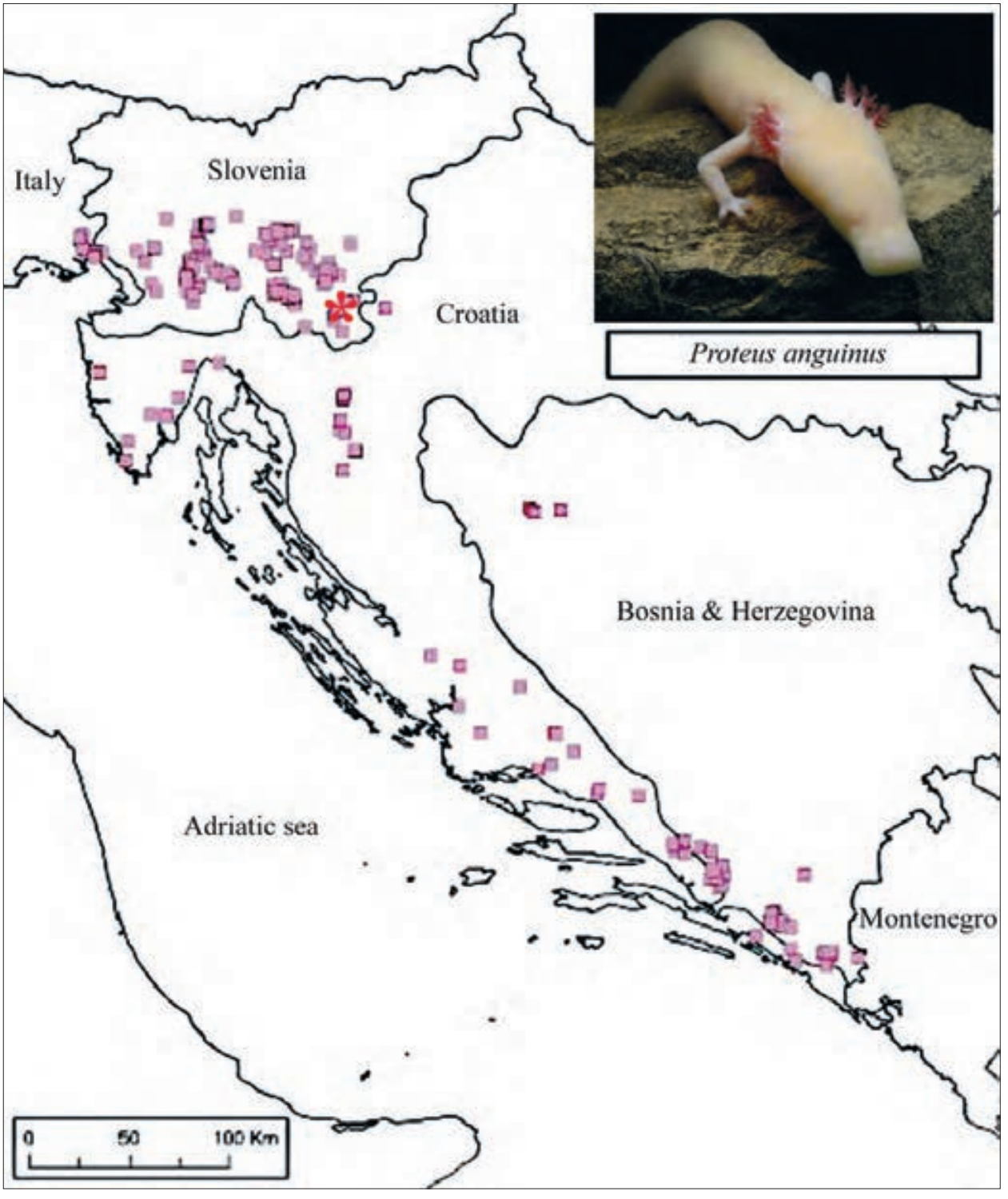

Figure 5: Distribution of Proteus anguinus Laurenti 1786 in its entire natural range. Proteus anguinus parkelj Sket & Arntzen 1994 is known only from SE Slovenia WSW of Črnomelj (asterisk). Map: B. Sket.
Slika 5: Razširjenost Proteus anguinus Laurenti 1786 v njegovem celotnem naravnem območju. P. anguinus parkelj Sket & Arntzen 1994 je poznan samo iz SV Slovenije ZSZ od Črnomlja (zvezdica). Zemljevid: B. Sket.

divergence in their mitochondrial control regions (Gorički 2006; Gorički & Trontelj 2006; Trontelj et al. 2009), none of the comparative studies to date have detected any signs of their interbreeding, e.g. haplotype sharing or intermediate morphology (Gorički et al. 2017). Thus, if the black and white protei do come into contact with each other, there is no evidence for reproductive interaction between them.

PHYLOGENY & TAXONOMY

The morphological description of the black proteus as a new taxon was accompanied by biochemical allozyme study of over 40 loci by Sket & Arntzen (1994). A more detailed phylogenetic study using mitochondrial DNA (Gorički 2004, 2006; Gorički et al. 2006; Gorički & Trontelj 2006; Trontelj et al. 2009) presented evidence that the black proteus shows closest affinity to a population of white proteus among the SE Slovenian group of populations. It seems reasonable that the black proteus are populations that experienced selection favoring either the retention or the re-acquisition of non-troglomorphic traits (e.g. body proportion, functional eyes and dark pigmentation).

The proposed taxonomy of the black proteus by Sket & Arntzen (1994) was rejected by Grillitsch & Tiedemann (1994) who claimed that it falls within the clinal variation of *Proteus anguinus* and does not deserve a taxonomical (i.e. subspecies) status. However, Arntzen & Sket (1996) used the Wolterstorff index, a morphometric tool that has been used for defining the body proportions in newts, to demonstrate clear and consistent differences between *P. a. parkelj* and three populations of the white proteus *P. a. anguinus*, making the black subspecies diagnosable, at least morphologically. In particular, the black proteus exhibits some characters, including head shape, eyes, and pigmentation, that are clearly outside the range of the white proteus. Furthermore, Arntzen & Sket (1997) presented a morphometric analysis of a number of populations and found *P. a. anguinus* and *P. a. parkelj* to be morphologically distinct. Multivariate morphometric analysis produces very clear differences and Mantel permutation tests show no firm evidence for clinal variation within the species that would encompass these differences. Thus the claim that the black population falls within the clinal variation of *P. anguinus* is not tenable, at least on purely morphological grounds.

The black proteus presents us with an interesting paradox. On the one hand, morphological data show it to be clearly distinct from any white proteus in a large number of important characters including head shape (especially lack of an elongated snout), eye development and function, pigmentation, limb length, trunk length, number of vertebrae, etc. (Arntzen & Sket 1996, 1997). On the other hand, biochemical, molecular, and cytogenetic studies (Sket & Arntzen 1994; Gorički 2004, 2006; Gorički et al. 2006; Gorički & Trontelj 2006; Trontelj et al. 2009; Sessions et al. 2016) do not support the recognition of these subspecies, the molecular genetic data revealing that both black and white protei are nested within a southeastern Slovenian clade of *P. anguinus*. In other words, the black proteus is more closely related to a geographically adjacent population of white proteus than that population of white proteus is to other populations of white proteus. One possible explanation for these differences is that the black proteus, though troglobiotic with a subterranean habitat, represents an ancestral condition that lacks most of the striking troglomorphic characters seen in populations of the white proteus. In other words, the black proteus, which occupies a relatively young and low type of karst (Paušič & Čarni 2012), represents a population that is in the early stages of troglobiotic adaptation. An alternative interpretation is suggested by phylogenetic analysis of molecular data indicating that the black proteus is genetically more closely related to adjacent populations of white proteus than either are to any other populations of *Proteus* (Gorički et al. 2006). These data suggest that, instead of representing an ancestral form that never evolved a troglomorphic phenotype, the black proteus was derived from within a population of white proteus that was exposed to a different set of selective pressures that did not favor extreme troglomorphism resulting in the evolutionary reversal of troglomorphic traits (Ivanović et al. 2013, Sessions et al. 2015). Thus, the non-troglomorphic characteristics of *P. a. parkelj* would be homoplasies rather than plesiomorphies (Sessions et al. 2015). A close relationship between white and black protei is also supported by recent cytogenetic information (Sessions et al. 2016). Thus, either i) the troglomorphic form has evolved several times independently, or ii) the black form evolved once from a white ancestor by reversing troglomorphic traits. As both Ivanović et al. (2013) and Sessions et al. (2015) have pointed out, the second scenario is formally far more parsimonious on phylogenetic grounds. The research on the developmental genetics of cave adaptations in the Mexican Blind Cave Fish, *Astyanax mexica-*

nus De Filippi 1853 (Jeffery 2005), offers a possible evolutionary developmental mechanism, involving a genetic switch, by which such a reversal could have occurred in *Proteus* (Sessions et al. 2015). Testing this idea will require access to embryonic material of both subspecies of *Proteus*.

FUNCTIONAL MORPHOLOGY

Skin morphology and bacteriome

Proteus is a paedomorphic salamander and the skin of the adults of both subspecies of *Proteus* thus retains many larval characteristics of amphibian skin as well as showing some adult characteristics. The thin, non-keratinized epidermis with outermost *stratum mucosum*, numerous unicellular glands (Leydig cells) and

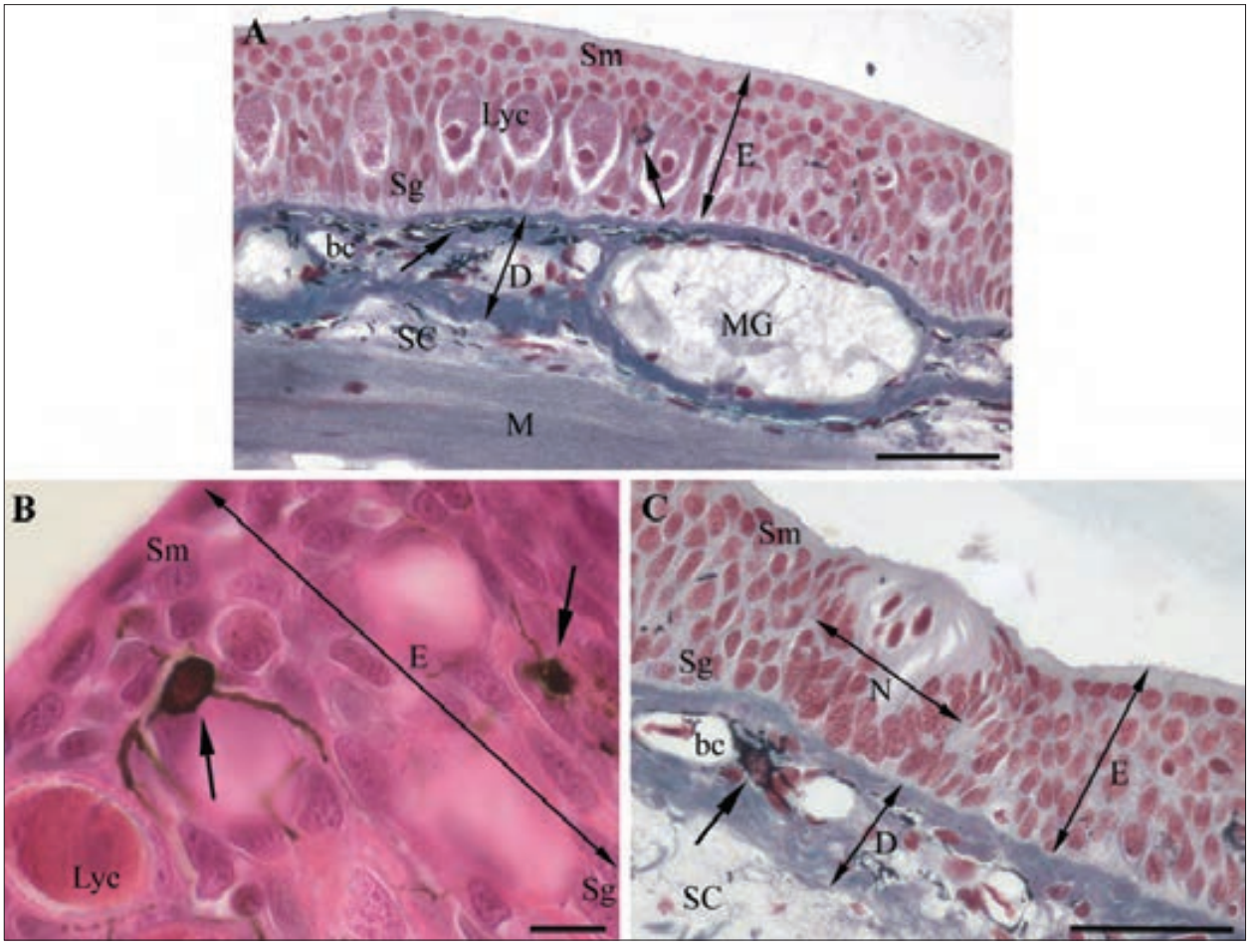

Figure 6: The skin histology of Proteus anguinus parkelj Sket & Arntzen 1994. A. The skin is thin and non-keratinized with numerous epidermal Leydig cells (Lyc), dermal multicellular mucous glands (MG) and stelate melanophores (arrows) in the epidermis (E) and dermis (D). B. The epidermal melanophores (arrows) with projections. C. The mechanoreceptive neuromast (N) in the epidermis. bc – blood capillary, M- skeletal muscles, SC – subcutis, Sg – stratum germinativum, Sm – stratum mucosum. A & C. Silver nitrate - Pollak staining. B. H & E staining. Scale bar: 100μm (A & C) and 20μm (B). Photos: L. Bizjak Mali.
Slika 6: Histologija kože črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994. A. Koža je tanka in neporoženela s številnimi Leydigovimi celicami (Lyc) v vrhnjici, z večceličnimi mukoznimi žlezami (MG) v usnjici in zvezdastimi melanoforami v vrhnjici (E) in usnjici (D). B. Melanofore z odrastki v vrhnjici (puščice). C. Mehanoreceptorni nevromast v vrhnjici. bc – krvna kapilara, M- skeletne mišice, SC – podkožje, Sg – stratum germinativum, Sm – stratum mucosum. A & C. Barvanje srebrov nitrat - Pollak. B. Barvanje H & E. Merilce: 100μm (A & C) and 50μm (B). Fotografije: L. Bizjak Mali.

mechanoreceptive neuromasts of the lateral line system (Fig. 6A-C) (Bulog 1991; Kos 1992; Kos & Bulog 1993) are unique features of the larval epidermis that are also seen in other paedomorphic salamanders. On the other hand, the numerous multicellular alveolar mucous glands in the dermis (Fig. 6A) are characteristic of adult amphibian skin and provide an important protective mucus layer over the non-keratinized surface. A comparative analysis of skin of white and black protei showed that the dark pigmented skin in the black protei has fewer larval characteristics and shows some structural characteristics of metamorphosed forms such as more numerous multicellular mucous glands in dermis (Bulog 1991), an increased number of layers of epidermal cells, where the surface epidermal cells tend to be more flattened and the basement lamella is thicker (Kos 1992; Kos & Bulog 1993). In general, the skin of black protei is thicker with numerous processes of stellate melanophores concentrated mainly in the outer part of the dermis under the basement lamella (Fig. 6A, C) (Bulog 1991; Kos 1992; Kos & Bulog 1993). Melanophores are also present in the epidermis (Fig. 6B). Even though the processes of melanophores are more numerous than in white protei, it is not known if the darker skin is due to the higher number of melanophores in the skin or more melanosomes (pigment granules) in the cytoplasm of the processes of pigment cells.

Interestingly, immunolabelling of the skin with anti-opsin antibody was positive in cells of the basal layer of the epidermis (*stratum germinativum*) of both subspecies of *Proteus* indicating that the skin is photosensitive (Kos et al. 2001). Indeed, the animals show strong photophobic reaction when their skin is illuminated (unpublished observation). Further studies are required to clarify the significance of this non-specific staining and to identify the molecules and cellular structures in the skin that bind this antibody.

Recently, a comparative metagenomic analysis of the skin bacteriomes from natural population of *Proteus* showed that all of them, with the exception of *P. a. parkelj*, exhibited considerably lower bacterial diversity compared to water samples from their habitats (Kostanjšek et al. 2017; Prodan 2018; Kostanjšek et al. 2019). The bacteriomes in these populations of white proteus individuals included similar proportions of mostly known taxa of environmental microbes: Alphaproteobacteria, Betaproteobacteria, and Actinobacteria. In stark contrast to the white protei, the bacteriome of the black subspecies was dominated by enterobacteria and aeromonads possibly originating from sewage and farming pollution (Kostanjšek et al. 2017, 2019). These data are alarming because the skin microbiome is an essential part of the innate immune system in amphibians (see in McCoy & Peralta 2018), and changes to the skin microbiome can lead to increased vulnerability to infection by potential pathogens and consequently to population decline. Indeed, besides playing a critical role in a wide range of physiological processes (e.g. regulating fluid balance, ion transport, and respiration), amphibian skin also plays a critical role in regulating the animal's health by producing antioxidants and antimicrobial peptides, and by harboring diverse, symbiotic microbial communities that protect against foreign and potentially harmful pathogens (see in McCoy & Peralta 2018). These symbiotic skin bacteria are adapted to persist in the presence of antimicrobial mucosal peptides and can inhibit pathogen colonization and infection of the skin. The black *Proteus* may be the first case of such replacement of the endemic skin bacteriome of an amphibian due to human agricultural activity. Future research will be needed to understand the long-term threat of this phenomenon to the vulnerable populations of *P. a. parkelj*.

Perception in the dark

The eye

Adult black protei have small but totally normal eyes, although they are paedomorphic and lack eyelids, which is typical for larval amphibians (Fig. 7A). The eyes have all the important parts (transparent cornea, lens, retina and optical nerve) of the optical-neural pathway leading to the central nervous system (Bulog 1992, 1993; Kos 2000) (Fig. 7B). The diameter of *P. a. parkelj* eyes (730 μm) is much larger then in *P. a. anguinus* (450 – 500 μm) (Kos 2000) but well below the size of surface dwelling (epigean) salamanders. The lens has a diameter of about 200 μm in comparison to *P. a. anguinus* where the lens is markedly reduced or even totally missing (Kos et al. 2001). Compared to the regressed retinal morphology of the white proteus, detailed morphological analyses revealed that the black proteus eye has a normal amphibian retinal structure (Bulog 1992; Kos & Bulog 1996a; Kos 2000; Kos et al. 2001). Individual retinal layers are discernible and photoreceptor cells exhibit recognizable inner and outer segments (Fig. 7C) (Bulog 1992; Kos 2000; Kos et al. 2001). Retinal immuno-cytochemistry with various anti-opsin antibodies (Kos 2000; Kos et al. 2001; Bulog et al. 2002) confirmed the light sensitive visual pigments (the first important member of the phototransduction cascade in vertebrate photoreceptor cells) in the photoreceptors of *P. a. parkelj* (as well as in

the variable rudimentary eye of *P. a. anguinus*) that indicates a light sensitivity of the eyes. This finding correlates with electrophysiological investigations that revealed that retinal photoreceptor cells of *P. a. angui-*

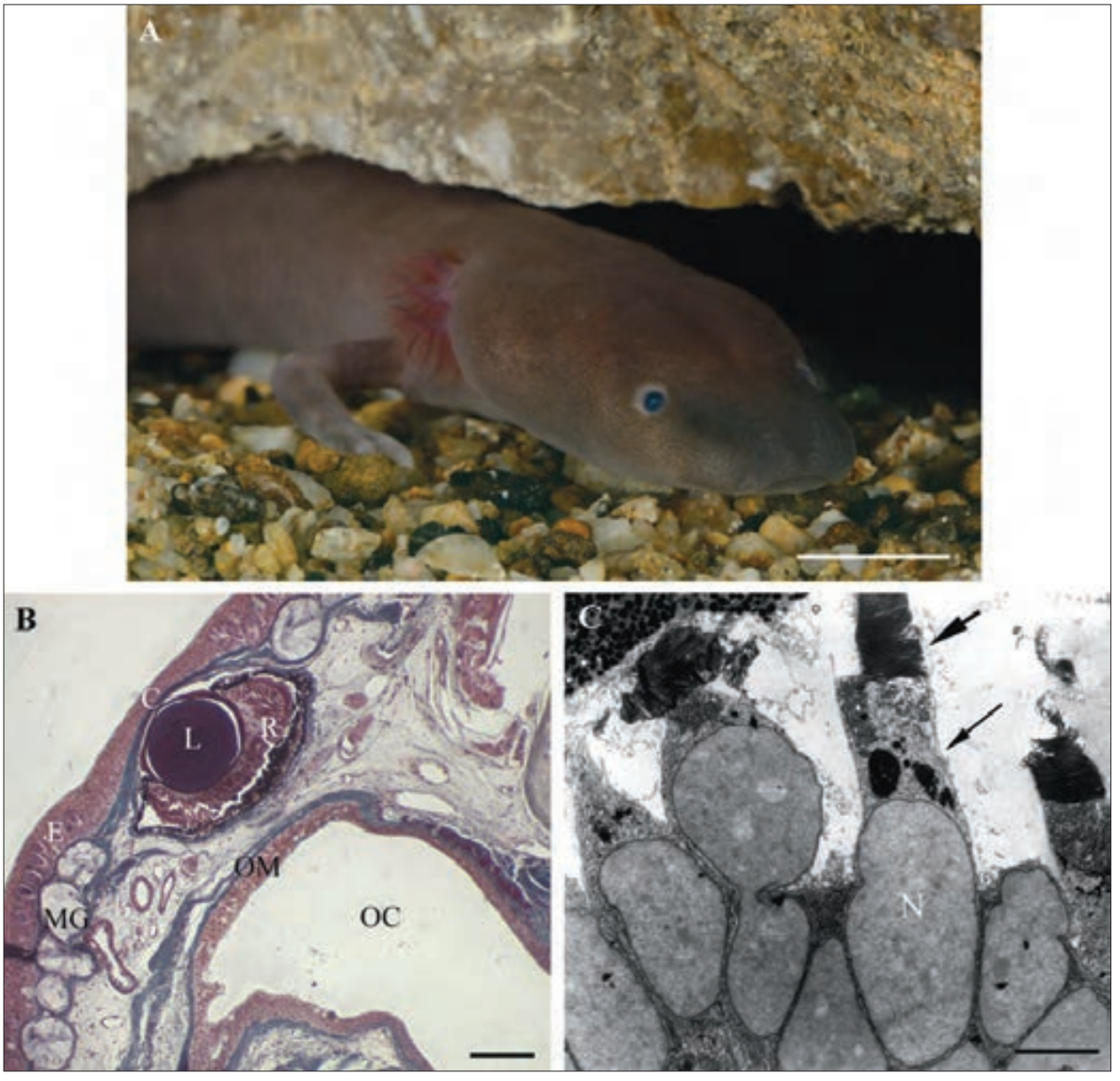

Figure 7: A. The head of Proteus anguinus parkelj Sket & Arntzen 1994 with its typical »larval« eyes and visible mechanoreceptive neuromasts on the snout. B. Cross section through the head with eyeball. C – cornea, E – epidermis, MG – multicelullar mucous gland in dermis, L – lens, R – retina with pigment epithelium, OC – oral cavity, OM – oral mucosa. Silver nitrate - Pollak staining. C. Electron-microscopy micrograph of retina photoreceptors. N – nucleus of photoreceptor cell, thick arrow – outer segment, thin arrow – inner segment. Scale bar: 1 cm (A), 200µm (B) and 10 µm (C). Photos: D. Dallesi (A), L. Bizjak Mali (B) and M. Kos (C).

Slika 7: A. Glava črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994 z očmi značilnimi za ličinke in vidnimi mehanoreceptornimi nevromasti na gobcu. B. Prečni prerez glave v predelu oči. C – roženica, E – epidermis, MG – večcelična mukozna žleza v dermidi, L – leča, R – mrežnica s pigmentnim epitelom, OC – ustna votlina, OM – ustna sluznica. C. Posnetek fotoreceptorjev mrežnice narejen s presevnim elektronskim mikroskopom. N – jedro fotoreceptorne celice, debela puščica – zunanji segment, tanka puščica – notranji segment. Merilce: 1 cm (A), 200µm (B) in 10 µm (C). Fotografije: D. Dallesi (A), L. Bizjak Mali (B) in M. Kos (C).

nus are still responsive to light even though the retina itself is rudimentary (Gogala et al. 1965 cit. in Kos et al. 2001; Žener 1973 cit. in Kos et al. 2001). In comparison with other amphibians which have two types of rods (green and red) and three types of color-specific cones (red-, blue- and UV sensitive cones) (cit. in Kos et al. 2001), the retina of both subspecies of *Proteus* contains »red« or principal rods, red-sensitive cones but that the black proteus differs from white protei in having a third photoreceptor type, which might represent blue- or UV-sensitive cones (Kos 2000; Kos et al. 2001). The number of photoreceptor cells in both is relatively low and the cones predominate. The latter is quite surprising given that the retina of most animals that are nocturnal or live underground or in turbid conditions (e.g *Necturus*, the closest relative of *Proteus*, the larval Ozark cave salamander, *Eurycea spelaea* Stejneger 1892 (syn. *Typhlotriton s.*), and the Mexican cave fish *Astyanax*) contains mostly rods which operate in dim light (cit. in Kos et al. 2001). It appears that during the regressive evolution of the eyes of *Proteus*, rods degenerated sooner than cones (Kos et al. 2001).

Pineal organ

The pineal organ of lower vertebrates is a photosensitive neuroendocrine gland in the roof of diencephalon part of brain, controlling circadian rhythms, gonadal development, metamorphosis and, body pigmentation. Photosensory cells in the pineal organ of vertebrates are structurally and functionally homologous to retinal photoreceptors having well-developed outer segments with visual pigments similar to those in the retina. The pineal organ in both subspecies of *Proteus* is reduced in size and can be found only with serial semithin sectioning of the brain (Kos 1998; Kos et al. 2001). Detailed ultrastructural studies (Kos & Bulog 1996b, 2000; Kos 1998; Kos et al. 2001) revealed structural degeneration of the outer segments of pineal photoreceptors in both subspecies, composed of irregular membranes and vesicular aggregations instead of a stack of membrane disks known for normal photoreceptors. The synaptic ribbons with clear synaptic vesicles in soma and processes of pineal photoreceptors of *Proteus* indicate the involvement of pineal cells in the transmission of light stimuli. The possibility of retained light sensitivity is supported by the finding of immunopositive red-sensitive visual pigments in the pineal photoreceptors of both subspecies (Kos et al. 2001). Supposedly, the atrophy of the outer segments of photoreceptors does not lead to the loss of the photoreceptive function of pineal in *Proteus*. The pineal also seems to have a secretory activity as evidenced by the ultrastructure of the inner segment of pineal photoreceptors (Kos 1998; Kos & Bulog 2000).

Hearing abilities

Inner ear morphology and sound detection is of particular importance in overall mechanoreception and acoustic orientation in the underground aquatic environment inhabited by *Proteus*. Like the other aquatic urodeles, *Proteus* has the ability to register sound sources via water medium and vibrations over the substrate with a specialized and complex inner ear. The mouth cavity (which is frequently filled with air that is not used in breathing activity) and lungs, together with the inner ear, act as underwater sound pressure transducers (Bulog 1990). The ability of sound pressure detection in *Proteus* is probably enhanced with the tight anatomical junction between the ceiling of the gas filled oral cavity and the oval window of inner ear (Bulog 1998; Bulog & Schlegel 2000; Schlegel et al. 2009). A three-dimensional model of the inner ear made from serial semithin sections of the otic region in both subspecies of *Proteus* enabled a comparative analysis and reconstruction of sensory epithelia and the perilymphatic system (Konec 2009; Konec & Bulog 2010) (Fig. 8A-C). This study showed that membranous labyrinth of *P. a. parkelj* is slightly shorter and less flattened, but structurally mostly identical to *P. a. anguinus*. All seven sensory epithelia (Fig. 8B-C) previously described in *P. a. anguinus* (Istenič & Bulog 1976; Bulog 1995), are present in the membranous labyrinth of *P. a. parkelj* (Konec 2009; Konec & Bulog 2010). The only difference found is in the size of the saccular macula and crysta externa, the first one is larger in *P. a. anguinus* and former is larger in *P. a. parkelj*. The saccular macula of *P. a. anguinus* has also a very complex structure with a large otoconial mass according to the utricular and lagenar; it is assumed that it plays a role in detecting the direction of the sound source, in other words, it is a specific adaptation to life in an underground, aquatic habitat (Bulog & Schlegel 2000).

The sound detection ability in both subspecies of *Proteus* is in the frequency range from 10 to 15000 Hz with the greatest sensitivity reached at 1500 Hz for *P. a. anguinus* and 2000 Hz for *P. a. parkelj* (Bulog & Schlegel 2000; Schlegel et al. 2009). This range of audible frequencies provides the unique ability to detect sound waves underwater and surpasses all amphibians and most fish that have been studied. The frequencies below 50 Hz are most probably detected at the expense of the mechanosensitive neuromasts of lateral line sensory system. It is assumed that inner ear of *Proteus* also

plays an important role in the detection of sound waves created by the rising water level during the rainy seasons that enables the animal a timely retreat into the deeper regions of their aquatic habitat before they are thrown out onto the surface (Bulog & Bizjak Mali 2014). Further research is needed in order to confirm and explain this phenomenon.

Mechano- and electroreceptors of the lateral-line sensory system

Proteus can detect its prey in total darkness over some distance using its excellent sense of smell (olfactoreceptors) as well as mechanoreceptive neuromasts and electroreceptive ampullary organs of the lateral line sen-

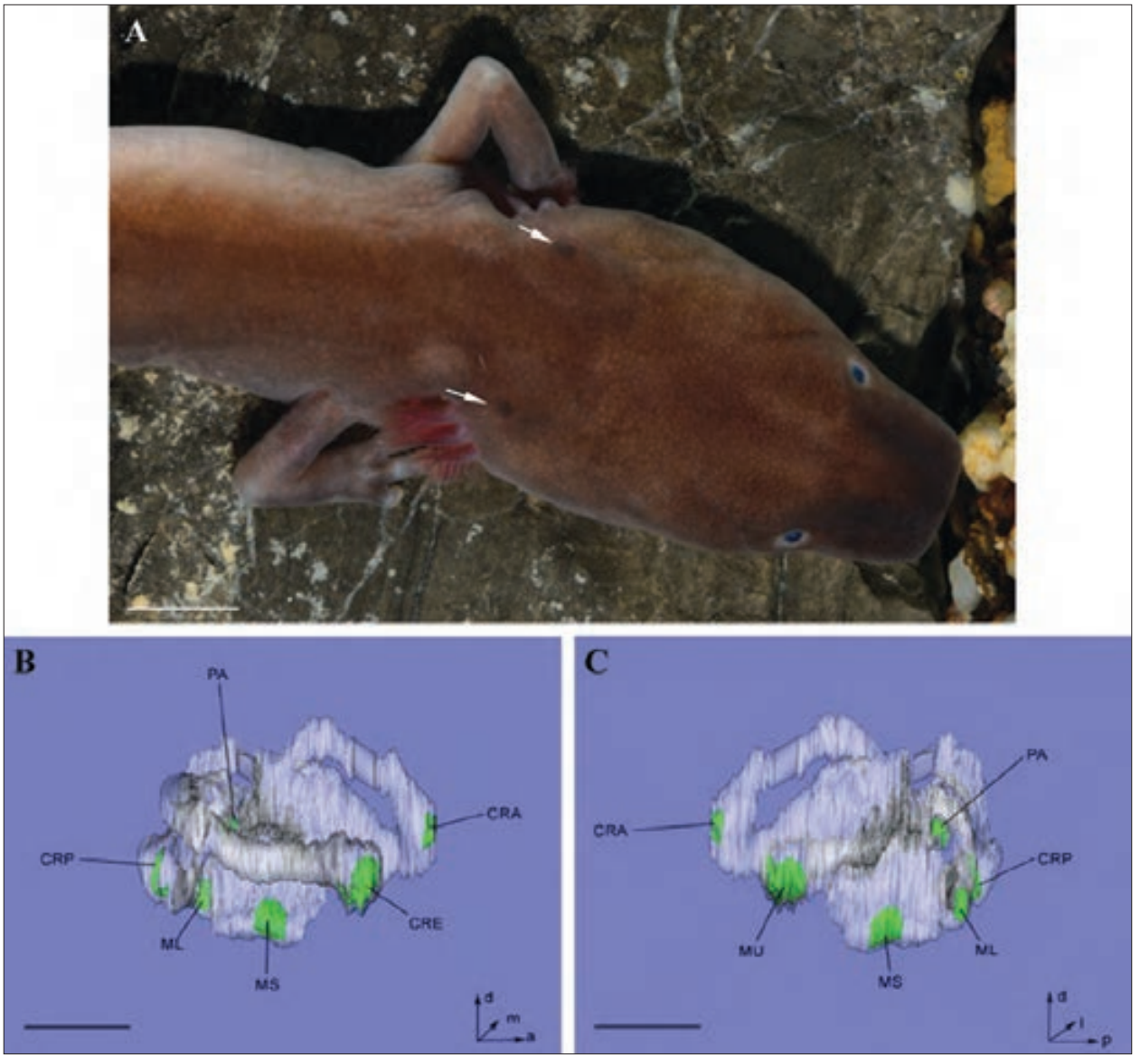

Figure 8: Head of Proteus anguinus parkelj Sket & Arntzen 1994 with visible otic region (arrow) (A) and 3-D model of inner ear from lateral (B) and medial view (C). The sensory epithelia are labeled in green. CRA- crysta anterior, CRP - crysta posterior, CRE – crysta externa, ML – macula lagenae, MS – macula sacculi, MU – macula utriculi, PA – papillae amphibiorum. Scale bar: 5 mm (A) and 1 mm (B & C). Photos: D. Dallesi (A) and M. Konec, 2009 (B & C).
Slika 8: Glava črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994 z vidno slušno regijo (puščica) (A) in 3-D model notranjega ušesa z lateralne (B) in mediane strani (C). Senzorični epiteli so označeni z zeleno. CRA- anteriorna krista, CRP – posteriorna krista, CRE – zunanja krista, ML – makula lagene, MS – makula sakula, MU – makula utrikula, PA – papilla amphibiorum. Merilce: 5 mm (A) in 1 mm (B & C). Fotografije: D. Dallesi (A) in M. Konec, 2009 (B & C).

sory system (overview in Bulog, 1994). These sensory organs of lateral line system lie in the epidermis of the skin (Figs. 6C, 7A) and, while the ampullary organs are present only on the head, the neuromasts are distri-

Figure 9: The post-hatched larva of Proteus anguinus parkelj Sket & Arntzen 1994 with visible hind limb bud (arrow). Fixed specimen from archive collection at the Department of Biology, BF, University of Ljubljana. Scale bar: 5 mm (A) and 2 mm (B). Photos: L. Bizjak Mali.
Slika 9: Izležena ličinka črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994 z vidnim brstom zadnje okončine (puščica). Fiksiran osebek iz arhivske zbirke Oddelka za biologijo, BF, Univerza v Ljubljani. Merilce: 5 mm (A) in 2 mm (B). Fotografiji: L. Bizjak Mali.

buted also along both sides of body (Istenič & Bulog 1984; Istenič 1986; Bizjak Mali 1990; Fric 2017). The sensory organs of the lateral line system are present in aquatic amphibian larvae and adult paedomorphic salamanders that retain an aquatic lifestyle (Webb 2014). The mechanosensory neuromasts enable the animals to detect water disturbances caused by currents, the movements and sounds of nearby animals, and a variety of other sources. They function as a "distant touch" sensory system important to locate objects in their environment and also play an active role in localization and orientation. With electrosensory ampullary organs the animals sense the weak bioelectrical fields generated by other animals (due to the activity of their nerves and muscles) and use it to locate them or avoid them. Behavioral studies have demonstrated that the white subspecies can detect weak electrical fields all the way to a value of 0.1 mV / cm, while the *P. a. parkelj* are slightly less sensitive (Schlegel & Bulog 1997). These mechano and electroreceptive sense organs, including a specialized and very complex inner ear, obviously play an important role in *Proteus* in orientation, search for prey, intraspecies communication, and mutual recognition in underground habitats.

Behavioral studies suggest that *Proteus* (both subspecies) is also able to detect and orient itself to magnetic fields (Aljančič & Bulog 1999; Schlegel et al. 2009). For these studies the animals were in round containers surrounded by large coils for manipulating the magnetic field. A computer-assistant program and infrared camera was used to record the direction faced by the animals at different times in the experimental arena.

What we know about the reproductive biology of the black proteus?

We understand very little about the reproductive biology of the black proteus even though captive black protei laid eggs in the Tular Cave laboratory in Kranj, Slovenia in the years 2007, 2013, and 2015 (where seven individuals have been kept in captivity since 2002) (Aljančič, personal communication). Unfortunately, none of the eggs developed successfully, and some of them were eaten by conspecifics sharing the same tank. The egg laying process (in October 2015) was recorded with an infrared camera (Jaksetič 2015) but there are no further published data for the size of the egg clutches or female behavior during laying. One captive female *P. a. parkelj* (body length 250 mm) laid eggs after one year and half in captivity in the Speleological laboratory at the Department of Biology of Biotechnical faculty, University of Ljubljana (B. Bulog, personal communication). The female laid more than 30 eggs but she ate most of them and the remaining eggs failed to develop because they were most probably not fertilized. Since this female was kept in her own, separate aquarium, the eggs laying can obviously happen in the absence of a male.

An early post-hatched black proteus larva was found at Jelševnik spring (Sket & Arntzen 1994), confirming that the black proteus, like the white proteus, is oviparous. This post-hatched larva was 21 mm in length and was at Briegleb's developmental stage 21 (Briegleb 1962) with almost three digits on the short front limbs and hind limb buds at a pre-digit stage (Fig. 9A-B). The intestinal wall was still swollen with yolk and the larva was not yet able to move around in an organized way. The eye diameter (0.4 mm) was 8% of the head length and the embryo was pigmented densely grey dorsally, fading on the sides to a lighter venter.

Studies of the gonads morphology and gametogenesis in *Proteus* have been performed to gain better base-line knowledge of their reproductive biology, with potential applications in conservation issues as well as in the management of their reproduction in captivity. Studies of detailed morphology of the ovaries, including descriptions of the developmental stages of the oocytes, was mostly performed on the white subspecies of *Proteus* (Talaber 2008; Bizjak Mali & Bulog 2010, 2011; Žibert 2010; Bizjak Mali et al. 2010, 2013). These studies showed that, at least in *P. a. anguinus*, ovarian maturation is not seasonal, although it is positively correlated with body length and mass (Bizjak Mali et al. 2010, 2013). However, a recent analysis of testes morphology of preserved adult individuals of *Proteus* (with total body lengths between 200 to 360 mm) from different populations, including both *P. a. anguinus* and *P. a. parkelj*, showed that body size is a poor predictor of reproductive/maturity state in males of *Proteus* (Kovačič 2013; Bizjak Mali et al. 2015, 2016; Bizjak Mali & Bulog 2016; Bizjak Mali 2017). The shape and meiotic condition of the testes are highly variable and totally independent of the length (age) of the animal. Even more, the two different morphological types of testes (multilobed and broad single-lobed testis) that were found indicate a possible intraspecies variability of morphological types of testes. The multilobed testis was found only in *P. a. parkelj* and broad single-lobed testis was found only in *P. a. anguinus*. Another interesting discovery is also that, contrary to *Proteus* females, meiotic activity in *Proteus* males appears to be seasonal (Bizjak Mali 2017) suggesting that gametogenesis in male and female *Proteus* is only loosely synchronous. These issues

underline how incompletely we still understand reproduction in this enigmatic animal.

The digestive system and accessory glands

The basic anatomical and histological structure of the digestive tract of *Proteus* is similar to other amphibians and it is divided into a short esophagus, a slightly widened muscular stomach, a short duodenum, a medium long small intestine that is more or less coiled depending on the size of the animal, and a short, slightly wider large intestine that opens into the cloaca (Fig. 10A-B). A preliminary analysis of the intestinal microbiota from the fecal samples of both subspecies of *Proteus* by molecular typing method (T-RFLP) showed that there was a difference in microbiota between the white proteus from Planina cave and black proteus and no clear resemblance of either to the gut microbiota of the axolotl (*Ambystoma mexicanum*) (Borštnar Vasle 2016; Avguštin et al. unpublished). Cloning and sequencing of the amplified PCR products revealed that the majority of the sequences from *P. a. anguinus* belonged to an unclassified group from the family Peptostreptococcaceae of the Gram-positive phylum Firmicutes, whereas the majority of the sequences from the *P. a. parkelj* belonged to the family Clostridiaceae from the same phylum and to the Gram negative members of the genus *Parabacteroides* from the phylum Bacteroidetes. Further studies on this topic are in progress.

The spleen and liver morphology in both proteus subspecies were investigated and compared with their closest surface-dwelling relative, *Necturus maculosus*. The spleen is a major lymphoid organ in the immune response of all vertebrates and, in fish and amphibians, it also has hematopoietic and hemocateretic functions (destruction of red blood cells and "recycling of haemoglobin"), in addition to phagocytosis, storage, and release of erythrocytes (Alvares 1990). The liver is the central organ for metabolic activity in vertebrates and is also an important storage depot for many raw materials of digestion (sugars, fats, vitamins, metal ions) (Hadley 1985).

The spleen of both subspecies of *Proteus* is diffuse, with the lymphoid tissue (white pulp) evenly distributed with the red pulp (Fig. 11 A-B) (Mrak 2007). Most of the spleen is red pulp, consisting of cell cords (lymphocytes, erythrocytes, hemocytoblasts and erythroblasts) and numerous sinusoids full of erythrocytes. The spleen of both subspecies of *Proteus* also has pigmented melanomacrophages similar to macrophages with phagocytic activity described for ectothermic animals, including amphibians (Augis 1980).

Figure 10: A. Proteus anguinus parkelj Sket & Arntzen 1994 with open posterior part of the body cavity. A higher magnification view (B) of the visible posterior part of liver (l) with gall bladder (gb), stomach (st), small (si) and large intestine (li), tiny, immature testes (arrows), kidney (k) with urinary (Wolffian) ducts, urinary bladder (asterisk), and cloaca (c). Scale bar: 1cm. Photos: L. Bizjak Mali.

Slika 10: A. Črni močeril Proteus anguinus parkelj Sket & Arntzen 1994 z vidnim odprtim posteriornim delom telesne votline. Pod večjo povečavo (B) je viden posteriorni del jeter (l) z žolčnikom (gb), želodec (st), tanko (si) in debelo (li) črevo, drobceni nezreli testisi (puščici), ledvica (k) s stranskima sečevodoma, sečni mehur (zvezdica) in stok ali kloaka (c). Merilce: 1cm. Fotografije: L. Bizjak Mali.

The liver of both subspecies of *Proteus* occupies more than half of the length of body cavity (Fig. 10A-B) and represents the 5.35 (±1.68) % of the body mass. The hepatocytes are large and arranged in laminae that are two or more cells thick, separating adjacent sinusoids (Fig. 11C-D). One of the most outstanding features of the liver in *Proteus* is a remarkable accumulation of energy–rich storage material (e.g. lipid droplets and glycogen) in the hepatocytes (Fig. 11C) (Bulog et al. 2000; Bizjak Mali et al. 2001; Lužnik 2004) that are used to meet metabolic needs during food deprivation (Bizjak Mali et al. 2013) and reflect adaptation to stress situations in its environment, such as sporadic and discontinuous food supplies and/or hypoxia. The second outstanding feature is the numerous pigment cells which are grouped in large clusters among the hepatocytes (Bizjak Mali et al. 1999, 2001; Prelovšek et al. 2005, 2008), and contain haemosiderin (iron-storage complex), melanin, and lipofuscin (lipid-containing residues of lysosomal digestion) (Fig. 11C-D). In comparison with *Necturus,* the pigment cells are more numerous and form larger clusters, and are also structurally more heterogeneous and contain a larger amount of haemosiderin. It seems that the liver pigment cells are an important site of iron accumulation in *Proteus.* Furthermore, synthesis of melanin was confirmed in the liver pigment cells of *Proteus* (Prelovšek & Bulog 2003). Melanin can absorb and neutralize free radicals, cations, and other potentially toxic agents derived from degradation of phagocytosed cellular material (Zuasti et al. 1989). It is assumed that the pigment cells of this extracutaneous system in *Proteus* has an important role in supporting the antioxidant system of reactive oxygen species (Bizjak Mali, unpublished) in defense against free radicals that are harmful to cells, protecting the liver from the negative effects.

Behavior

Virtually almost nothing is known about behavior of the black proteus except for the following report by prof. Tine Valentinčič (Sket et al. 2014; Trontelj et al. 2017), who showed that black protei were so aggressive towards white ones in the common aquarium that the experiment was discontinued and the animals had to be separated. In terms of behavioral patterns in their natural environment, we know that black protei come regularly to surface water bodies in the evening, where it is also possible to see them early in the morning (Aljančič, Bulog, Hudoklin, Mlinar, Župančič, pers. comm.). There is no evidence that this behavior is associated with feeding patterns, even after one month of continuous observation (Bulog, pers. comm.). Similar is the behavior of the white protei.

THREATS AND CONSERVATION STATUS & ACTIONS

The water resources in the karst underground are extremely vulnerable to all kinds of pollution and contamination with hazardous organic and inorganic compounds. Any pollution of the karst surface may affect the quality of water in its underground. The self-cleaning capacities of the karst underground are poor (Sket & Velkovrh 1981; Novak 1995; Sket 1996). Among the most serious chemical pollutants are pesticides, polychlorinated biphenyls (PCBs), and heavy metals which persist in the environment, being slowly, if at all, degraded by natural processes (Bulog et al. 2002).

Most of pollution in karst areas is due to unsustainable anthropogenic activities including intensive agriculture and industry, unregulated communal infrastructure and industrial landfills. *Proteus anguinus parkelj* is particularly endangered due to its limited distribution, which might be estimated at even less than 3 km^2 (Gorički et al. 2017), as well as its specific biology, such as permanent aquatic life history, its thin, non-keratinized skin, and its longevity and consequent potential bio-accumulation of pollutants. The chronic exposure to contaminants can cause the weakening of the immune system of amphibians, and consequently increased susceptibility to parasitic infections and other pathogens (Hayes et al. 2010). Many pollutants in the environment act as endocrine disrupters, leading to hormonal balance disorders and a negative impact on the reproductive system and reproduction. The main threats for *Proteus* in Bela Krajina are the overuse of pesticides and nitrogen fertilizers, and, after 2009, the free distribution of biogas slurry (Bulog 2007, 2012; Hudoklin 2011; Bulog & Bizjak Mali 2014; Bizjak Mali & Bulog 2016; Năpăruș-Aljančič et al. 2017). Furthermore, only 700 m away from the black proteus locality at Jelševnik springs, foundry sand with heavy metals was dumped into a doline between the years 1989 and 1993 (Bulog et al. 2002; Hudoklin 2011). The groundwater was loaded with a high content of aromatic hydrocarbons, phenols, and iron (Novak 1995; Hudoklin 2011). The accumulation of zinc and arsenic in both habitat and tissues of *P.*

a. parkelj has been shown (Bulog et al. 2000, 2002). The sand from this landfill was drained into the spring and because of its coarseness the thin skin of the protei was injured and subsequent lethal infections with pathogenic water mold *Saprolegnia* sp. developed (Kogej 1996), resulting in the death of some of the protei (Bulog personal; Hudoklin 2011).

Human sewage represents another potential problem because local villages have no centralized sewage system, and the waste water is decanting from septic tanks directly into the karst underground. The presence of proteus individuals in the low karst plain indicates its higher exposure to these sewage and agricultural pollutants. Increased levels of nitrates and phosphates have been detected in the Jelševnik springs (Bulog 2007, 2009, 2011, 2012, 2015; reinterpreted by: Hudoklin 2011; Bulog & Bizjak Mali 2014; Bizjak Mali & Bulog 2016). The values of nitrates were significantly increased in 2010 and 2011 when a biogas plant at Lokve in Črnomelj began to operate and especially in the spring reached values higher than 15 mg/L of NO_3 (in some nearby localities the levels reached

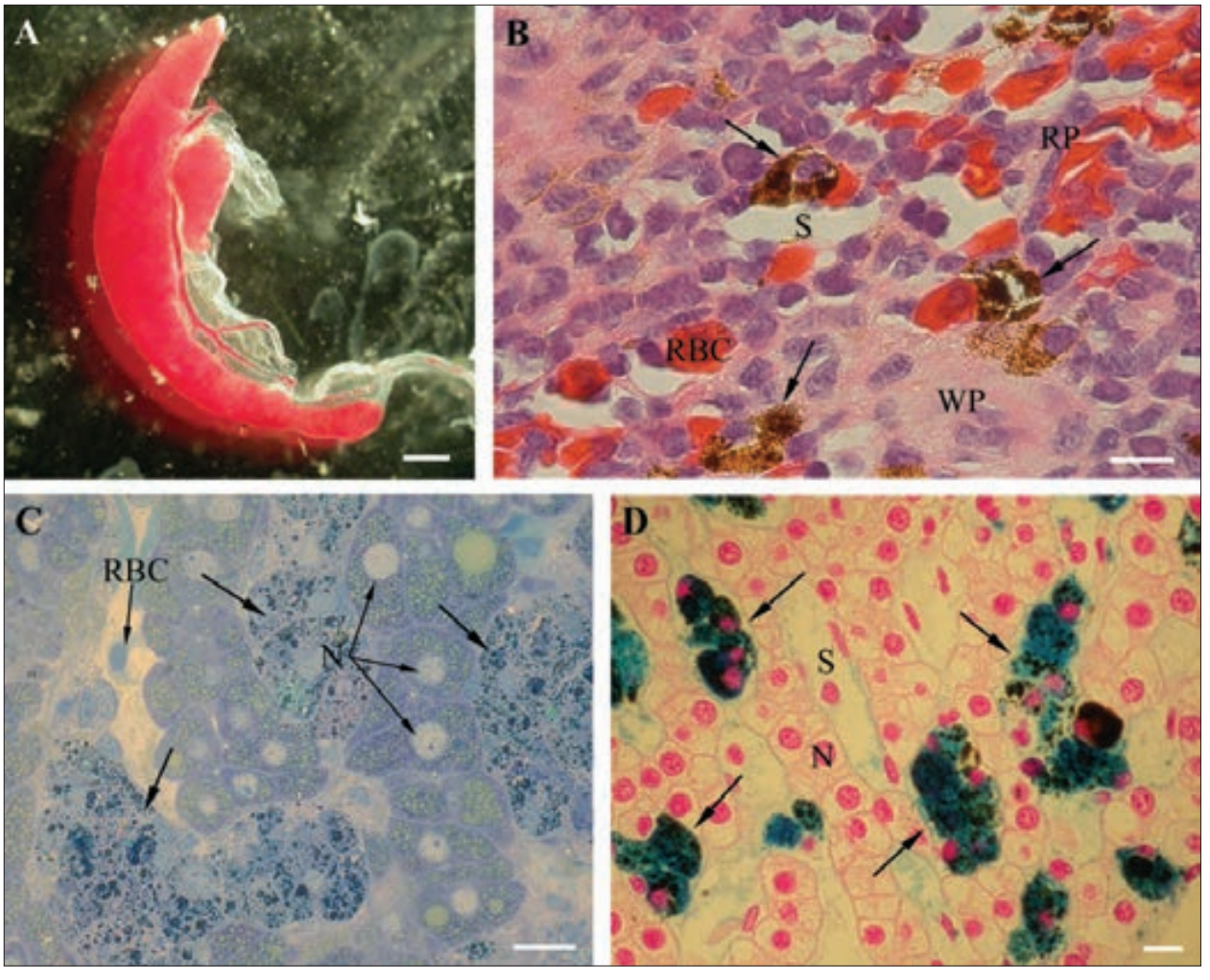

Figure 11: Spleen (A & B) and liver (C & D) of Proteus anguinus parkelj Sket & Arntzen 1994. arrows – clusters of pigment cells, N – nuclei of hepatocytes, S – sinusoid, RBC – red blood cell in sinusoid, RP – red pulp, WP – white pulp. B. H&E staining. C. Azur II - Methylen blue staining, semithin section. Lipid droplets in hepatocytes are green. D. Perls histochemical staining for hemosiderin (blue). Scale bar: 1 mm (A), 20 µm (B, C & D). Photos: P. Mrak, 2007 (A & B) and M. Lužnik, 2004 (C & D).
Slika 11: Vranica (A & B) in jetra (C & D) črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994. Puščice – skupki pigmentnih celic, N – jedra hepatocitov, S – sinusoid, RBC – rdeča krvnička v sinusoidu, RP – rdeča pulpa, WP – bela pulpa. B. Barvanje H&E. C. Barvanje Azur II - metilensko modro, poltanka rezina. Lipidne kaplje v hepatocitih so zelene. D. Histokemijsko barvanje po Perlsu za hemosiderin (modro). Merilce: 1 mm (A), 20 µm (B, C & D). Fotografije: P. Mrak, 2007 (A & B) in M. Lužnik, 2004 (C & D).

even up to 20 mg/L), probably as a consequence of intensive manuring and pouring of slurry onto agricultural surfaces, and the consequent leaching of nitrates into underground water. Natural background concentration of nitrate in groundwater in temperate regions range from trace amounts to 3 mg/L (in Slovenia the levels of nitrate in groundwater are evaluated on average 3.81 mg NO_3/L; Mezga 2014); concentrations above 3 mg/L reflect anthropogenic contamination (see in Rouse et al. 1999).

The pollution trends with nitrates and orthophosphates at *P. a. parkelj* localities were assessed using the IDW (Inverse Distance Weight) interpolation tool from ArcGIS 10.3.1 (Năpăruş-Aljančič et al. 2017) and published data from springs Dobličica and Jelševnik in the years 1987 and 2014. This pilot GIS analysis revealed a growing trend for both of these parameters implicating intensified use of fertilizer in agriculture and unregulated sewage disposal in human settlements of this area. The study also pointed out the necessity for the implementation of a monitoring scheme for the black proteus and its habitat, and also exposed the importance of GIS analysis as an indispensable tool for future conservation measures for protection of the endangered black proteus.

Increasing nitrate levels in surface and ground water are of global concern to amphibians, causing death and developmental anomalies in amphibians and impact other animals in aquatic ecosystems. The field data suggest that nitrogen fertilizers may be contributing (along with pesticides) to the decline of amphibian populations in agricultural areas (review in Camargo et al. 2005). Laboratory studies have shown that the toxicity of nitrate compounds to amphibians increases with exposure times (review in Camargo et al. 2005). A nitrate concentration of 10 mg NO_3-N/L (USA federal maximum level of nitrogen for drinking water) can adversely affect freshwater invertebrates, fishes and amphibians, at least during long-term exposures (Camargo et al. 2005). Safe levels below this nitrate concentration are recommended to protect sensitive freshwater animals from nitrate pollution. Furthermore, a maximum level of 2 mg NO_3-N/L would be appropriate for protecting the most sensitive freshwater species (Camargo et al. 2005). Nitrates have been shown to cause methaemoglobinaemia (cit. in Hamer et al. 2004), in which the symbiotic microbiota in the intestine convert nitrates to nitrites, which is absorbed and then oxidizes iron in hemoglobin to form methaemoglobin that is unable to bind oxygen (Huey & Beitinger 1980; Rouse et al. 1999).

The groundwater quality standard in Europe for the protection of human health for drinking water for nitrates is a concentration of up to 50 mg NO_3/L (Fontelles & Pekkarinen 2006). However, water quality criteria for nitrate for the protection of wildlife do not exist. At the request of the RS Nature protection agency, the National Laboratory for Health, Environment and Food in Maribor, Slovenia, performed a study for the assessment of risk that nitrates pose to the groundwater ecosystem in the project area of LIFE Kočevsko (Kolar 2017). They propose several risk mitigation measures that should apply in the Karst region in order to reduce the risk of nitrate for proteus. One of the measures listed is the implementation of the threshold value of 9.2 mg NO_3/L (which is equivalent to 2.1 mg NO_3-N /L) in groundwater as an environmental quality standard for proteus habitats.

In Slovenia, *Proteus* has been protected by national legislation since 1922 and is currently classified as 'Vulnerable' by the International Union for Conservation of Nature (IUCN) red list of threatened species (Arntzen et al. 2009) because of its fragmented and limited distribution and declining population. In 1982 *Proteus* was placed on a list of rare and endangered species in Slovenia. After joining the European Union, Slovenia had to establish mechanisms for protection of the species included in the EU Habitats Directive. *Proteus anguinus* is included in the Slovenian Red List of endangered species (Sket 1992). The caves inhabited by protei were also included in the Slovenian part of the Natura 2000 network (Hudoklin 2014).

The black proteus (*P. a. parkelj*) does not have any special classification, but it is protected within the species *Proteus anguinus*. However, it is in need of a particular protection, as its distribution range is so limited. This makes it the most vulnerable and threatened population of *Proteus* to environmental pollution and to various potential pathogens that are of global concern to amphibians. The Council for the Protection of the Environment of the Slovenian Academy of Science and Arts (Kranjc 2018) formulated the standpoints to support the actions of scientists and non-government organizations (e.g. the civil society Društvo Proteus in the region of Bela krajina, the Cave laboratory Tular) (Aljančič et al. 2017) for special protection of *P. a. parkelj*. Some protection measures in force should to be made stricter. An application to the state ministries of environment and of agriculture was made for the rapid preparation of a provisional law for particularly strong protection measures for the black proteus area. These should be replaced by well-considered permanent legislation. »*Black proteus and its habitat in Bela krajina are unique, so the state, the local community and local inhabitants must take special responsibility for it*!« (Kranjc 2018).

During the rainy season and flooding, proteus individuals are regularly washed out from their subterranean habitat. Unfortunately, current laws and policies concerning the protection of *Proteus* limit the use of such specimens for scientific purpose. With the permission of the ARSO the "rescue" and return of washed-out individuals of *Proteus* to their original natural habitat is currently performed by the Tular Cave laboratory (SOS Proteus – Refuge for protei) in collaboration with a veterinarian (Zatočišče za zaščitene prostoživeče živali Golob d.o.o) (Aljančič & Aljančič 2015). The return of rescued proteus to cave habitats, however, is potentially dangerous, especially if they are housed in captivity for any length of time, due to emerging pathogens that are of global concern to amphibians and can be inadvertently spread by human contact. Therefore, we recommend that microbial analyses should be a part of routine procedure before the animals are released. Even more importantly, non-destructive samples for genetic analyses should be obtained from such animals to avoid inadvertent contamination of genetically divergent populations. An unfortunate example is the rescue of three black protei washed out to the surface at Kanižarica (Ivanovič 2012), which was at the same time a newly found locality. These protei were then released into another locality at Jelševnik spring, because it was the only accessible location; this was done without any regard for possible contamination or accidental mixing of different gene pools. For these reasons we strongly discourage attempts to return stranded protei to their natural habitat after human contact. Instead, these animals should be kept in captivity in a proper laboratory setting where they can be utilized for much needed scientific research on this important animal.

PUBLICITY AND POPULAR SCIENCE

From the time it was first discovered, *Proteus anguinus* (*človeška ribica*, the »human fish«), in the form of the strange-looking troglomorphic white proteus, has long attracted the interest of the public. It is of iconic significance for the country of Slovenia and a proteus used to be featured on a Slovenian coin. In the first years of discovery of the black proteus, newspapers and popular scientific journals in Slovenia frequently presented short news stories on this strange creature, sustaining a certain amount of interest on the need for environmental protection of this species and in general (see list of »other references«: Istenič & Bulog 1986; Sket 1992; Hodalič 1993; Bulog 2005, 2007; Ušaj 2005; Pavlovič 2006; Ivanovič 2012; Kukman 2012; Aljančič et al. 2015; Bezek-Jakše 2015; Dolžan 2015; Krese 2015; Marušič 2015, 2016; Cvjetkovič 2016; Červek 2016; Maljevec et al. 2016; Žiberna 2016; Levstik 2017a, b; Rajšer 2017; Stankovič 2017; Vlašič 2017; Žmahar 2017; Mezinec 2018a, b). Among particularly interesting news was the laying of black proteus eggs in the Tular Cave laboratory in Kranj (Jaksetič 2015). Various interviews and documentary films about the black proteus and its environmental problematic have been recorded over the years, including the famous Nick Baker's documentary (see list of »other references«: Mlinar 1999, 2018a, b; Bulog et al. 2003; Kutin 2005; Baker et al. 2007; Mihelčič & Bizjak, 2008; Jecič 2015; Aljaničič et al. 2016; Bizjak Mali et al. 2016; Šuštarič et al. 2017). A permanent exhibition was set up at Jelševnik by the Department of Biology, BF, University of Ljubljana (Žnidaršič 2002, Bulog & Bizjak Mali 2014) in the house of the Župančič family who owns the land where the black proteus localities are found and who has played an important role in the public awareness and conservation of this subspecies. A sculpture of the black proteus made by the academic sculptor Boštjan Kavčič was placed near the Jelševnik locality in October 2018 (Fig. 12) to raise awareness on the vulnerability and threats to this remarkable animal (Bezek-Jakše 2017). In 2018 a special postage stamp was issued at the 250th anniversary of the formal description of *Proteus anguinus*. It was supplemented by a bulletin with some illustrated data on *Proteus*, includ-

Figure 12: A sculpure of Proteus anginus parkelj Sket & Arntzen 1994 by the academic sculptor B. Kavčič (2018) at the Jelševnik locality to raise awareness on this remarkable, vulnerable and threatened animal. Photo: L. Bizjak Mali.
Slika 12: Skulptura akademskega slikarja B. Kavčiča (2018) črnega močerila Proteus anguinus parkelj Sket & Arntzen 1994 na Jelševniku, ki opozarja na to izjemno, ranljivo in ogroženo žival. Fotografija: L. Bizjak Mali.

ing *P. a. parkelj*. A descriptive article of the black proteus by Sket & Arntzen 1994 was used in a popular educational article (Sket 1993c) to illustrate the scientific process and writing; in one column a popularly reshaped scientific paper was presented, in the other were presented principles of scientific writing. The black subspecies of *Proteus* is presented in detail in several scientific encyclopedias (e. g. Bulog 2004; Durand 2005; Gorički et al. 2012; Sket 2012), in a monograph (Aljančič et al. 1993), in natural science books (Parzefall et al. 1999; Pobolšaj 2003; Bulog & Bizjak Mali 2014), textbooks (Sket & Dermastia 2013), and on verified webpages e.g. Wikipedia (Bulog & Polajnar 2011), AmphibiaWeb (Bulog & Van Der Meijden 1999), and IUCN (Arntzen et al. 2009).

Despite this attention, the black proteus is still not nearly as familiar among ordinary citizens, and even among biologists, as the iconic white one. But its discovery, with its swarthy skin, beady eyes, and bright red gills, still seems a little shocking, as reflected by its

Figure 13: Proteus anguinus parkelj Sket & Arntzen 1994 in all its glory. Photos: D. Dalessi, 2012, Speleological laboratory at Department of Biology, BF, University of Ljubljana.
Slika 13: Črni močeril Proteus anguinus parkelj Sket & Arntzen 1994 v vsem svojem veličastju. Fotografije: D. Dalessi, 2012, Speleološki laboratorij na Oddelku za biologijo, BF, Univerza v Ljubljani.

taxonomic name »parkelj«, the Slovenian name for Krampus, a terrifying mythological black demon who goes from house to house during the Christmas season, frightening naughty children. It seems ironic that the proteus named after such an »evil« creature is itself so vulnerable due to human-made pollution in its natural habitat in Bela krajina. The true evil (and even national shame) is the fact that the skin of living individuals of the black proteus has become so contaminated with fecal bacteria from human agriculture and sewage that they might not be able to survive in their own natural habitat.

POVZETEK

Namen tega preglednega članka je bil, zbrati sklepe vseh dosedanjih raziskav o črni rasi in podvrsti močerila (*Proteus anguinus parkelj* Sket et Arntzen 1994), ki je endemit podzemeljskih voda belokranjskega krasa in jugovzhodne Slovenije.

Prikazali smo glavna področja raziskav na črnem močerilu, ki so potekale predvsem na Oddelku za biologijo Biotehniške fakultete, Univerze v Ljubljani. Sodelovali so tudi raziskovalci z drugih ustanov, pa tudi dodiplomski in podiplomski študentje. Skupina za zoologijo in speleobiologijo pokriva široko področje od taksonomije, evolucije in biogeografije podzemeljskih habitatov in organizmov, do splošne biodiverzitete. V skupini za funkcionalno morfologijo vretenčarjev pa se ukvarjajo predvsem s funkcionalno morfološkim prilagajanjem proteja na njegov habitat, v kontekstu ranljivosti od strupenega kemičnega in organskega onesnaženja, z daljnosežnim ciljem razumevanja dejavnikov, ki lahko prizadenejo močerilovo preživetje v njegovem naravnem okolju. Pomemben doprinos predstavljajo tudi raziskave jamskega laboratorija Tular s prispevki za ozaveščanje javnosti o naravovarstveni problematiki.

Prvi črni osebek močerila so ujeli raziskovalci Inštituta za raziskovanje krasa (iz Postojne) oktobra 1986 ob poskusnem črpanju podzemeljske vode na izviru Dobličice pri Črnomlju v Beli krajini (Aljančič in sod. 1986; Mihevc 1986; Sket & Arntzen 1994). Prvo poročilo o anatomskih značilnostih je podala Lili Istenič 1987, pozneje Boris Sket (1993 b, c), novi takson je bil že zelo temeljito znanstveno opisan in poimenovan kot *Proteus anguinus parkelj* Sket et Arntzen leta 1994 na osnovi zunanje morfologije, osteološke slike in biokemijske alocimske analize.

Podrobnejše filogenetske študije po kontrolni regiji mitohondrijske DNK so uvrstile črno raso v jugovzhodno slovensko skupino populacij (Gorički 2006; Gorički & Trontelj 2006; Trontelj et al. 2009). Kljub opravljeni filogenetski študiji ni povsem jasno, katera rasa je filogenetsko in evolucijsko prvobitnejša.

P. a. parkelj potrebuje strogo varstvo, saj je njegova razširjenost skrajno omejena (izračunan areal je le nekaj kvadratnih kilometrov (Gorički et al. 2017), nekaj bioloških posebnosti pa dela njegove populacije najbolj ranljive in ogrožene pripadnike proteja; ogroža ga tako onesnaženje okolja, kot tudi potencialni patogeni, ki ogrožajo dvoživke po vsem svetu.

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HISTORY OF RESEARCH ON *PROTEUS ANGUINUS* LAURENTI 1768 IN SLOVENIA

ZGODOVINA RAZISKOVANJA ČLOVEŠKE RIBICE (*PROTEUS ANGUINUS* LAURENTI 1768) V SLOVENIJI

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ABSTRACT

History of research on *Proteus anguinus* Laurenti 1768 in Slovenia

Olm or proteus (*Proteus anguinus* Laurenti 1768) was the first taxonomically described cave animal in the world, by J. N. Laurenti, 1768, upon a specimen that was apparently found on the famous lake Cerkniško jezero, Slovenia, yet the existence of this unusual animal in Slovenija had been known long before.

The research on *Proteus* is one of the oldest Slovenian natural history projects, a 330 year spiritual bond: from the first description by one of pioneers of karst research J. V. Valvasor in 1689, to the renowned naturalists J. A. Scopoli, who was the first researcher to actually examine proteus from the Stična area in 1762. One of the central figures of the early proteus research was Ž. Zois, the first who studied proteus behaviour, and conducted earliest physiological and ecological observations, together with Viennese zoologist Karl von Schreibers. Zois's work was continued by two researchers of proteus distribution F. J. Hochenwart and H. Freyer, and other researchers of the 19th and 20th century.

For the last 250 years, this mysterious animal has constantly raised scientific and public attention, and gradually became not only an important symbol of Slovenia's nature, but also a part of its cultural heritage. The zoologically extraordinary *Proteus* was also an important object in the history of international nature research, puzzling the minds of most prominent naturalists, from Linnaeus, Cuvier and Humboldt, to Lamarck and Darwin.

This article also presents reproductions of the earliest illustrations of proteus: a collection of ten published and unpublished work between 1752 and 1849, a forgotten heritage of the first 100 years of proteus research. *In Memoriam* Žiga Zois (1747–1819).

Key words: Olm, Proteus anguinus, history of natural history, Slovenia, Zois

IZVLEČEK

Zgodovina raziskovanja človeške ribice (*Proteus anguinus* Laurenti 1768) v Sloveniji

Človeška ribica ali močeril (*Proteus anguinus* Laurenti 1768) je bila prva taksonomsko opisana jamska žival na svetu. Laurenti jo je opisal leta 1768, po primerku, ki naj bi ga našli na Cerkniškem jezeru, vendar je bil obstoj te nenavadne dvoživke v Sloveniji že dolgo znan.

Raziskovanje človeške ribice je eden od najstarejših slovenskih naravoslovnih projektov, 330 letna duhovna vez. Od Valvasorja, enega od pionirjev raziskovanja krasa, ki je objavil prvo omembo proteusa že leta 1689, do priznanega naravoslovca Scopolija, prvega raziskovalca, ki je človeško ribico, najdeno leta 1762 v okolici Stične, dejansko prvi preučil. Ena od osrednjih osebnosti zgodnjih raziskovalcev človeške ribice, Ž. Zois, je kot prvi preučeval vedenje človeške ribice (1795), in je v sodelovanju dunajskim zoologom Karlom von Schreibersom izvedel najzgodnejše fiziološke in ekološke raziskave na tej vrsti. Zoisovo delo sta nadaljevala dva raziskovalca razširjenosti človeške ribice, muzealca F. J. Hochenwart in H. Freyer, ter drugi raziskovalci 19. in 20. stoletja, do danes.

Zadnjih 250 let je ta skrivnostna žival nenehno dvigovala pozornost znanstvenikov in javnosti, ter postopoma postala ne le pomemben simbol slovenske narave, temveč tudi del njene kulturne dediščine. Človeška ribica, je bila zaradi svojih zooloških posebnosti večkrat pomemben objekt v zgodovini razvoja mednarodne naravoslovne misli med 17. in 19. stoletjem, in je zbujala vprašanja v najpomembnejših naravoslovcih, od Linnéja, Cuvierja in Humboldta, do Lamarcka in Darwina.

V prispevku so predstavljene tudi reprodukcije najzgodnejših ilustracij človeške ribice: zbirka desetih objavljenih in neobjavljenih del med letoma 1752 in 1849, dediščina prvih 100 let raziskovanja človeške ribice. V spomin na Žigo Zoisa (1747–1819).

Ključne besede: človeška ribica, Proteus anguinus, zgodovina naravoslovja, Slovenia, Zois

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1 INTRODUCTION

Karst is a geomorphological landscape, named after the region of Kras [Italian: *Carso*, German: *Karst*], a limestone plateau above the Gulf of Trieste, on the north western corner of the Dinaric karst (Gams, 2004). Its monumental phenomena, such as the river thundering into the abyss of Škocjanske jame, fascinated antique writers and travellers along the only practicable road from Central Europe to Mediterranean (Kranjc, 2019). Around these karst features also raised early researchers (e.g., Imperato, Valvasor, Nagel, Steinberg, Hacquet, Gruber, Hochenwart), and through early international scientific cooperation the region *Karst* transformed in landscape *karst,* observed in landscapes around the world. By the end of the 19th century the understanding of karst developed into karst science (e.g., Cvijić, Kraus and Martel) (Kranjc, 1998; Gams, 2004; Kranjc, 2019).

But this journey could not be completed before the cognition that karst underground harbours unique life, which emerged through the second part of the 19th century. The birth of speleobiology was triggered by Ljubljana entomologist Ferdinand J. Schmidt (1791–1878) with his description of the first cave beetle *Leptodirus hochenwartii* Schmidt 1832 (Schmidt, 1832; Aljančič, 1991; Polak, 2005), followed soon by discoveries of other cave-adapted invertebrates in Postojnska jama (Aljančič et al., 1993; Sket, 1993A; Sket, 2012). The hotspot of karst research finally revealed the global hotspot of the subterranean biodiversity recognised today (Sket, 1993A; Sket, 1999; Culver and Sket, 2000; Culver & Pipan, 2009; Sket, 2012). An essential part of this process at the emergence of modern science was the research of the olm or proteus (*Proteus anguinus* Laurenti 1768).

2 FIRST RECORDS ON PROTEUS

In Slovenian part of the Dinaric karst (Gams, 2004), proteus spans from the regions of Kras and Vipava valley in the west, trough Notranjska and Dolenjska, to Bela krajina on its south-east, in 330 years of research documented at over 180 localities (reviews of proteus distribution in Scopoli, 1772; Hochenwart, 1838; Freyer, 1846A; Aljančič, 1962; Aljančič, 1964A; Aljančič, 1984; Sket & Arntzen, 1994; Sket, 1997; Gorički et al., 2017; Hudoklin & Aljančič, 2017). In most of these regions, proteus occasionally appears on the surface habitats (e.g., at karst spring, well, surface stream, flooded karst polje). *People knew it from their tradition and experience* (Zois, 1807), found it after floods or came across it on karst springs while collecting drinking water or watering their livestock (Michahelles, 1831; Hochenwart, 1840), such as the Virski Studenec spring near Stična, Slovenia, where this unusual animal was called in Slovenian *bela riba* [white fish] or *človeška riba* [human fish], *because of its toes and fleshy skin colour* (Zois, 1807).

In the karst landscape, where surface water is always lacking (Gams, 2004), proteus may have served as an indicator of a reliable source of drinking water, which could explain the symbolism of the depiction of two supposed protei on a stone well-head (10th century), which was once located in front of the San Nicolò church on the Venetian Lido (Vornetscher, 1972; Shaw, 2005), perhaps quarried and sculpted somewhere on the Classical karst (Aljančič et al., 1993).

It is not a surprise that proteus was for the first time shortly described 330 years ago by Janez Vajkard Valvasor (1641–1693), a Slovenian polymath and one of the pioneers of karstology, in his fundamental work *Die Ehre des Herzogthums Krain* [The Glory of the Duchy of Carniola] (Valvasor, 1689). This is the earliest known published description of any cave animal.

When Valvasor was returning from one of his many study travels around the Duchy of Carniola (today's central Slovenia), people from the area between Logatec and Vrhnika (25 km south-west from Ljubljana), told him about local curiosities, among them about the Lintvern, an unusual spring from which the water flows only twice a day. The next day, on 25 June 1684, Valvasor enquired further and visited the spring. The local guide explained the phenomenon of periodic flow by attributing it to a legend of a dragon that lives in the hill behind the spring. Namely, when the water level rises up to dragon's throat, it provokes discomfort; therefore the dragon has to move causing the water to flow from the spring. And that happens twice a day. As proof, he told Valvasor about the occasional findings of washed-out dragons. Valvasor interviewed the Vrhnika postal master Hofmann about the matter, who described the not fully grown dragon he collected two years earlier and displayed to the public. This led Valvasor to conclude, that this was, of course, not a mythological creature, but an animal *shorter than a span, similar to a lizard, in sum, an earthly reptile,*

which can be occasionally found here and there (Valvasor, 1689). Unfortunately, Valvasor never saw the animal, although visited or thoroughly explored several proteus localities (e.g., Podpeška jama; Aljančič et al., 1993).

Proteus was also recognised from the mentioning in the book of Franc Anton Steinberg (1684–1765), Slovenian geographer and one of pioneers of karst research, who described an unusual finding of *five white, four-legged fish,* caught by fisherman Primož Ziherle in 1751 in the flooded Planinsko polje near the spring of Malni (Steinberg, 1758; Freyer, 1846A; Grošelj, 1933; Aljančič et al., 1993; Shaw, 2010). It is interesting to note, that although Steinberg tried to explain how Valvasor's intermittent spring Lintvern may function, Steinberg himself never noticed the resemblance between with the animals described by him and Valvasor (Freyer, 1846A).

Both mentioning of proteus before its actual taxonomic description (Valvasor, 1689; Steinberg, 1758) were recognised already by the early researchers (Freyer, 1846A). Significance of such precious mentioning and representation was just recently recognised and evaluated by Trewor Shaw and Alenka Čuk (Shaw & Čuk, 2015), hiding on a beautiful though imaginative map, one of 12,000 units of the Moll Atlas kept at the Moravian Library in Brno (Geyer, 1752; Shaw & Čuk, 2015). Along with other seven original representations of karst features from Carniola, attributed unknown artist Geyer, the particular Map of Postojna and surroundings from 1752 (Geyer, 1752; Shaw & Čuk, 2015; Moll-0001.210; Fig. 1) has depicted a cave entrance, with an intrigues panel (translated from German after Trewor Shaw; Shaw & Čuk, 2015): "A small cave in which the peasant inhabitants here catch a lot of snakes and sell them to Venice". The cave was identified by Shaw & Čuk (2015) as being the Črna jama, where proteus has first been found in the underground (Hochenwart, 1838; Shaw & Čuk, 2015; see details below).

The artist drew at least five snake-like creatures inside this stylized cave, indeed creating a realistic sight on a group of proteus somewhere in the Postojna-Planina Cave System. This map represents the oldest known drawing of proteus (Shaw & Čuk, 2015). It is

Figure 1: Geyer, 1752: Imaginative presentation of the Črna jama with several proteus (A), detail at the Map of Postojna and surroundings, 63,5 x 89 cm (B) from the Moll Atlas (Geyer, 1752; first published in Shaw & Čuk, 2015; Collection of the Moravian Library in Brno, Czech Republic, Moll-0001.210, with permission).

surprising that Steinberg, born near Postojna, did not mention such activity among the local people only six years after the map was drawn. If the stated yearly selling of proteus to Venice (or Trieste?) is correct, such traffic could be attributed rather to be used as fishing-bite, or sold as delicacy, as occasionally reported to be on sale at the fish-market in Trieste in the first half of the 19th century (Configliachi & Rusconi, 1819; Shaw, 1999). It is also worth to mention, that *bela kačica* [white snake, diminutive form] was indeed one of the documented Slovene vernacular names (Freyer, 1850; see below).

3 HOW PROTEUS WAS DISCOVERED

The first researcher to actually examine proteus was Joannes Antonius Scopoli (1723–1788), a South Tyrolean physician, between 1754 and 1769 appointed to his first post at the mercury mine in Idrija, Slovenia (Soban, 2004). There he became one of the distinguished naturalists of his time, with special dedication to fungi, plant and animal taxonomy of Carniola (Soban, 2004); among higher taxa, Scopoli introduced *Caudata* (Aljančič, 2012).

An unusual animal (perhaps two specimens; Soban, 2004) was brought to Scopoli from the area of Stična (25 km south-east of Ljubljana) by his associate botanist Franz X. Wulfen (1728–1805). In his letter to Carl Linnaeus (1707–1778), dated 3rd May 1762, Scopoli presents the animal of an unknown amphibian living in caves around Stična, with detailed taxonomic description under the name *Lacerta caeca* [*blind lacerta*] to be included in the next edition of *Systema Naturae,* and offered to send him the specimen (Scopoli, 1762; translated from Latin by Darinka Soban; in Soban, 2004):

To the distinguished and illustrious Sir
Mr. Carl Linnaeus
Knight of the North Star etc., etc.
Restorer of the Natural Sciences,
and to the most learned Assembly
of the Royal Academy of Sciences
in Uppsala.

This new Lacerta species
is presented and dedicated
by Joannes Scopoli, physician at Idrija.

Among the natural specimens which I was the first to discover in the Duchy of Carniola, this new amphibian species certainly is not of the least importance. I obtained it recently as a living animal in Ljubljana from my learned friend F. X. Wulfen, of the Society Jesu. It is worth being included in the Systema Naturae of the distinguished Knight Carl Linnaeus as

9. caeca. Lacerta [blind lizard]: *It has a short, two-sided tail, three fingers on the hands and two toes on the feet. It lives in fresh waters which emerge from the underground caves near the place Stična. Not frequent.*

Description: Body clumsy, cylindrical, bare, mucous, thicker than a human thumb.

Head rounded, partly flattened, thicker and smaller on the back, with an obtuse mouth and a shorter lower jaw; no eyes, two protruding tubercles in their place; on both sides of the throat auricular combs, composed of 3-4 fringed ramifications, cinnabar-coloured. Both jaws with teeth, the mouth opening small, only 3 lin. [6.3 mm] long. Legs: anterior with three fingers, posterior with two toes; without nails.

Variation 1º stature of standing animal, white all over, auricular comb with four ramifications.

2º stature and colour as shown in the picture, auricular comb with three ramifications. It feeds on tiny snails, abundant in our waters. I add some samples.

I keep this animal preserved in alcohol, together with Sepia sepiola. I will send it to you together with the bird Upupa muraria and the rhizomes and specimens you graciously asked me for. My only request is that you prevail upon Mr. Jacquin, whom you already know from elsewhere, to receive in Vienna the items enumerated above and forward them to you. Please kindly acknowledge the receipt of my box, filled with insects, plants and rocks, which I had sent to Mr. Jacquin in order to be forwarded to you via Mr. Gronovius, as soon as you get it. In the meantime, I wish you good health, and remain benevolent to me.

Posted at Idria on 3rd May 1762.

If you will kindly answer, please direct the letter as follows:

Vienna – Ljubljana – Idrija.

Such letters, together with its valuable supplements (e.g., specimens, seeds, drawings, new books), were practically the only way to contribute material for the growing *Systema Naturae*. Well packed for 1-18 month long post delivery from Idrija to Upsala,

the mail was first examined in Vienna (Soban, 2004). Many of these descriptions of new species from Carniola are still valid today, and Linnaeus himself named Scopoli as one of the *auctores reformatories* (Soban, 2004; Aljančič, 2012). A closer insight into the part of the early natural history science of the Linnaean period is embraced in the remaining correspondence between Linnaeus and Scopoli (1760–1775), devotedly collected, translated and interpreted by physician and botanist Darinka Soban (Soban, 1995; Soban, 2004).

The enclosed drawings of proteus were unfortunately lost; probably archived separately, or even forwarded for an opinion – perhaps not destroyed. Although Linnaeus' reply to the letter is also lost, and the discovery was never again mentioned in the preserved correspondence, we may well understand concerns of Linnaeus and his time: "Undoubtedly, it is as hard to recognise animals in their larval forms as masked people at the theatre;" (Linnaeus and Österdam, 1766; Soban, 2004). Though, the animal in question indeed belongs to a species not known before, the obvious amphibian larval characteristics of its body (e.g., external gills, flat tail fin) implied it must still be a tadpole of an unknown species. Not aware of proteus neotenic nature (Aljančič et al., 1993; Sket, 2007), Linnaeus hesitated to publish it until Scopoli finds an adult specimen as well (Scopoli, 1772; Schreibers, 1801; Hochenwart, 1838; Aljančič et al., 1993; Soban, 2004; Aljančič, 2012). The next, 12th edition of *Systema Naturae* did not contain Scopoli's *Lacerta* (Linnaeus, 1766), while Linnaeus himself was not as strict in the case of the greater siren (*Siren lacertina*) (Schreibers, 1801), another neotenic amphibian. It appears that Linnaeus has never actually saw proteus.

Finally, in 1768, Viennese physician and naturalist Joseph Nicolaus Laurenti (1735–1805) formally described the species under the name of *Proteus anguinus,* and included it in his extensive study *Sinopsis Reptilium* [An Overview of Reptiles] (Laurenti, 1768). Description of the new genus and species (translated from Latin by Darinka Soban; in Soban, 2004):

[Page 35–36, description of the new genus]
GENUS V.
PROTEUS
An amphibian that has simultaneously gills and presumably lungs. Under the surface of the water it breathes water with the gills, when on dry land it inhales air with the lungs; perhaps it can thus leave a dried-out lake and go elsewhere. The jaws and the fingers stunted. The tail ridged. It differs from some interim development stage

Figure 2: Joseph N. Laurenti, 1768: First accurate illustration of proteus, in a swimming position, although depicting a specimen stored in the collection of Sigismund Hohenwart (Fig. III, Laurenti, 1768; Ernst Mayr Library, Museum of Comparative Zoology, Harvard University, USA).

by its ability to use the gills and the lungs simultaneously, not successively.

[Page 37, description of the new species]
XXXVI. Proteus anguinus. Tab. IV, Fig. 3.

Diagnosis:
It walks with its hind legs. The body rounded, oblong, very pallid, without fins, with coral-red gill appendages. The tail flattened, covered with skin. It has no eyes.

It lives in Lake Cerknica in Carniola in the spring. The specimen has been kindly provided by the reverend father Hohenwarth, a Jesuit, for the purposes of research and for the drawing.

NB: Whoever pretends this is just a large larva should show the animal that grows from it, lest he lose his credibility.

The note at the end of the description was pointing at Linnaeus, indicating that some discussion on proteus may have existed even before first publication (Soban, 2004). Proteus was first mentioned in the 13th edition of *Systema Naturae* (1789), in a short comment explaining where proteus should taxonomically be placed (i.e., in Amphibia, between *genus Rana* and *Draco*; see comments on the taxonomical classification of the time in Sket, 2007), if most careful observations of more researchers would establish that no slower or later metamorphosis occurs (Gmelin, 1789; Aljančič, 2007).

The description is short, with errors due to little information Laurenti could possibly received from Hohenwart, with no opportunity to dissect it (Schreibers, 1801). The description is accompanied by an illustration of the specimen, preserved in alcohol, in a reconstructed swimming position (Fig. 2), although Fitzinger presumes that it was drawn upon a live animal (Fitzinger, 1850). The finding site indicated by Laurenti was the intermittent lake Cerkniško jezero, Slovenia, a karst polje already famous around the world (Valvasor, 1689; Steinberg, 1758; Fitzinger, 1850; Aljančič et al., 1993; Gams, 2004).

Six years after Laurenti, Scopoli finally published his description of proteus (Scopoli, 1772), although less detailed as in the letter to Linneaus. Scopoli corrected Laurenti's *terra typica*, saying that proteus is *not in the Cerkniško jezero, but in the underground cave near Stična* (translated from Latin by Darinka Soban; in Soban, 2004), occasionally washed-out in summer (Scopoli, 1772). In this short comment, he did not explain why he disagrees with Laurenti's Cerkniško jezero, and the origin remained open (Sket, 2007). Indeed, 200 years after Scopoli and Laurenti, the first case of washed-out proteus has been documented at the edge of the Cerkniško jezero (Aljančič, 1966C), and recently proteus was also found *in situ* (Drole, 2017). Although rarely, proteus does appear in the area *in spring-time* (e.g., washed-out after spring floods) as was written down by Laurenti (Sket, 2007).

Details on these earliest specimens could be found in publications of researchers, who may still had access to original unpublished information (e.g., Žiga Zois, Franc J. Hochenwart, Karl von Schreibers, Henrik Freyer; see their contributions further below). Carl Schreibers remembers that the Museum of Natural Curiosities in the University of Vienna received a specimen nearly the same time as Hohenwart, and that Scopoli received more than one specimen (Schreibers, 1801). At the beginning Henrik Freyer accepts Laurenti's Cerkniško jezero (Freyer, 1842), later explains that people of Stična raised Scopoli's attention on proteus, that Scopoli sent one specimen to Johann J. Well (1725–1787), professor at the Medical Faculty of the University of Vienna (1776–1780), and that Hohenwart received his exemplar from Scopoli (Freyer, 1847A).

The area of Stična seems to be more plausible origin of Laurenti's exemplar, if we look closer, who actually collected these very first specimens. As mentioned before, Scopoli received proteus from his associate Wulfen, of Swedish origin, at that time lecturing logic, metaphysics and Newton's physics at the Jesuit Lyceum in Ljubljana (Praprotnik, 2016).

On the other hand, Laurenti received his specimen not more than six years later from naturalist Sigismund Hohenwart (1745–1825), at that time vicar in Klagenfurt/ Celovec. Jesuit Sigismund Hohenwart was born in Celje (not to confuse with other naturalists of this old Carniolan noble family; SIC Soban, 2004), and started to accompany his teacher Wulfen at field-excursions, often together with other naturalists (Dežman, 1856). His large collection became one of foundations of the first Austrian museum, the Styrian Provincial Museum (Joanneum) in Graz/Gradec (1811).

We should not overlook the connection of Jesuits Wulfen and Hohenwart with the aincient Cistercian monastery in Stična, and the possibility that the monks from Stična draw the attention to proteus (Soban, 2004; Južnič, 2009, but check author's claims in the primary sources), but this seems to be less likely, because Scopoli would not have given the credit only to Wulfen. Nevertheless, it does appear that the monks

have kept proteus at the Stična Monastery to forcast changes in weather (Agapito, 1823; Soban, 2004).

Within the network of these Enlightenment naturalists, we may presume, Scopoli must have known the origin of the Hohenwart's specimen when correcting Laurenti, since otherwise he would simply publish his data as an additional area of proteus distribution, not as its sole. But, from which karst spring within this small area of Stična? Already from the experience of early researchers (Zois, 1807; Hochenwart, 1838; Freyer, 1846A), which we may only confirm (Bressi et al., 1999; Kordiš, 2016; Hudoklin & Aljančič, 2017), the only reliable site to see rare proteus outside caves in the area is the Virski studenec, from this point of view the most plausible *locus typicus* of Laurenti's proteus.

4 EARLY STUDIES

After a few echoes on the taxonomic description were settled, proteus seemed to be forgotten (Zois, 1807). It was Karl Franz Anton von Schreibers (1775–1852), physician and later professor of zoology at the Medical Faculty of the University of Vienna and director of the Viennese Natural History Collection, who first studied the proteus in detail. In 1795, while rearranging the museum collection, he found a jar with half dry specimen not alike any animal he knew (Aljančič, 2007). To further explore proteus anatomy, young Schreibers has asked renowned Ljubljana naturalist Žiga Zois, through his teacher Professor Peter Jordan, Zois' acquaintance, for fresh specimens.

Baron Žiga Zois (1747–1819) was the main figure of the Slovene Enlightenment, named after him the *Zois Circle*. For half a century this was the centre of scien-

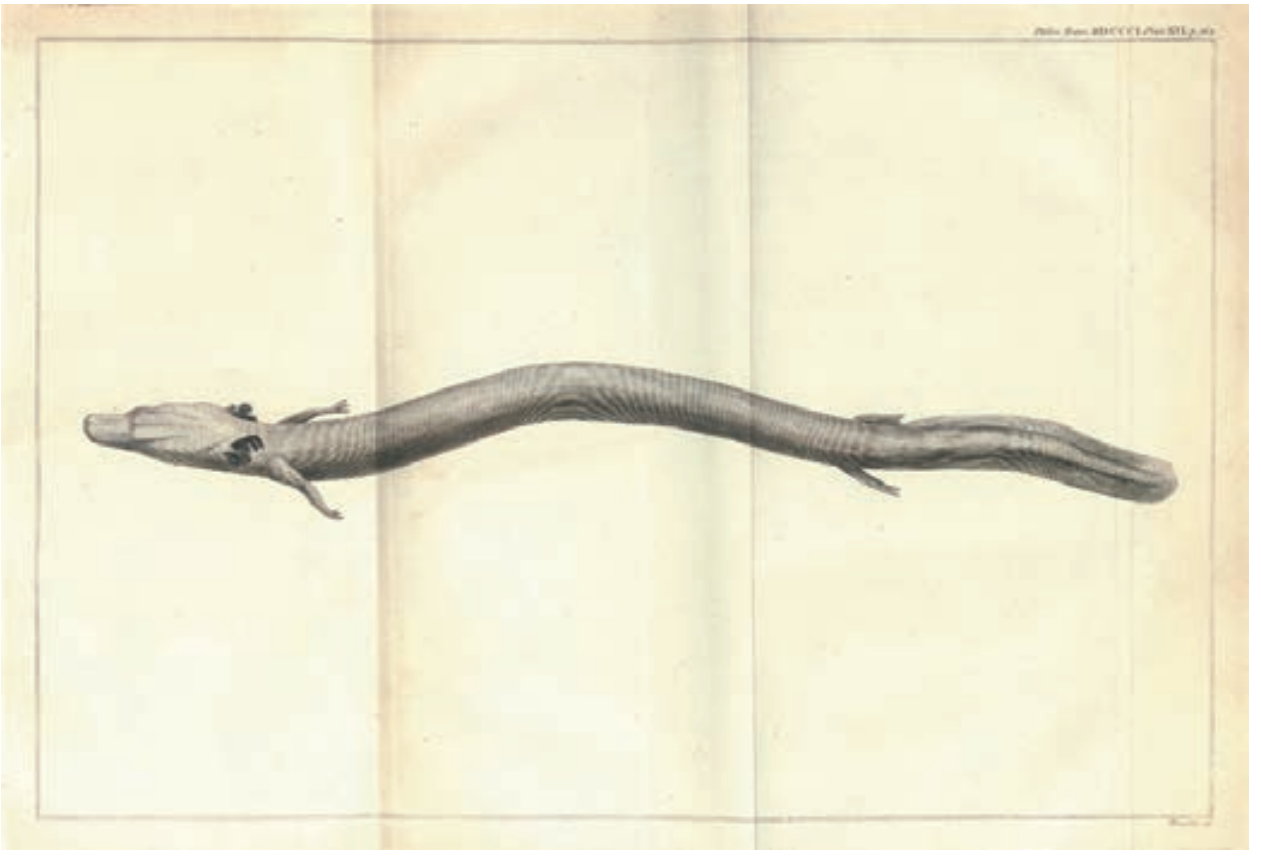

Figure 3: Karl von Schreibers, 1801: Proteus depicted in swimming position, with red external gills – *information from Zois reports on proteus behaviour, since Schreibers had not the opportunity to see a live animal during this early study (Schreibers, 1801; Library of the Royar Society, The United Kingdom).*

tific efforts in many different fields of science in Ljubljana, closely connected with similar natural history circles in cities across Europe (Aljančič, 1997; Aljančič, 2007). These fragments of the early modern science were thoroughly presented by Marko Aljančič (Aljančič, 1997; Aljančič, 2007; with Slovene translation and reprint of Zois, 1807). Among naturalists being part of the *Zois Circle*, we should mention his brother Karel Zois (1756–1799), Balthasar Hacquet (1739/40–1815), Franc J. Hochenwart (1771–1844), Valentin Vodnik (1758–1819), Rihard Ursini Blagay, and Valentin Stanič (1774–1847). Following the mountaineering steps of Scopoli, they were among the first collecting botanical, zoological, paleontological and mineralogical material in Alps of Carniola and Carinthia (Austria), during which the *circle* also accomplished some of the first documented ascents on higher peaks of Alps, from Triglav (2864 m; 1778) in Slovenia, to Grossglockner (3797 m; 1800) in Austria (Mikša & Zorn, 2016). Zois collection of minerals became one of foundations of Ljubljana Museum (Dežman, 1856).

Zois collected fresh specimens for Schreibers' anatomical research, and was the first who actually studied live proteus. He was determining the appropriate breeding parameters and was the first who researched proteus behaviour and physiology (feeding, locomotion and reaction to light, heart pulse and gill blood flow, etc.) (Aljančič, 2007). Between 1795 and 1807, Zois maintained proteus in his Ljubljana palace; long enough to first dispute the aforementioned Linnaeus' comment (Gmelin, 1789) of a possible later metamorphosis into an adult animal through long-term captivity (Zois, 1807; Hochenwart, 1838; Aljančič, 2007).

Schreibers' detailed study was also the first on the anatomy of proteus. One of main goals of Schreibers study was to demonstrate the adult stage of proteus through anatomical proof, which was supported with Zois' observations from Ljubljana and Stična (reports were submitted in three letters: 1795, 1799 and 1800) cited through the paper, published upon a lecture at the Royal Society in London (Schreibers, 1801; Fig. 3). On his travel to London and Paris (1800), Schreibers presented results of his studies, and for the first time properly introduced proteus to the science, which initiated the interest of famous naturalists Georges Cuvier (1769–1832) in France, Lorenz Oken (1779–1851) and Karl Michahelles (1807–1834) in Germany, and Pietro Configliachi (1777–1844) and Mauro Rusconi (1769–1832) in Italy.

The only Zois' (unsigned) published contribution is dedicated to proteus (Zois, 1807). There, Zois pre-

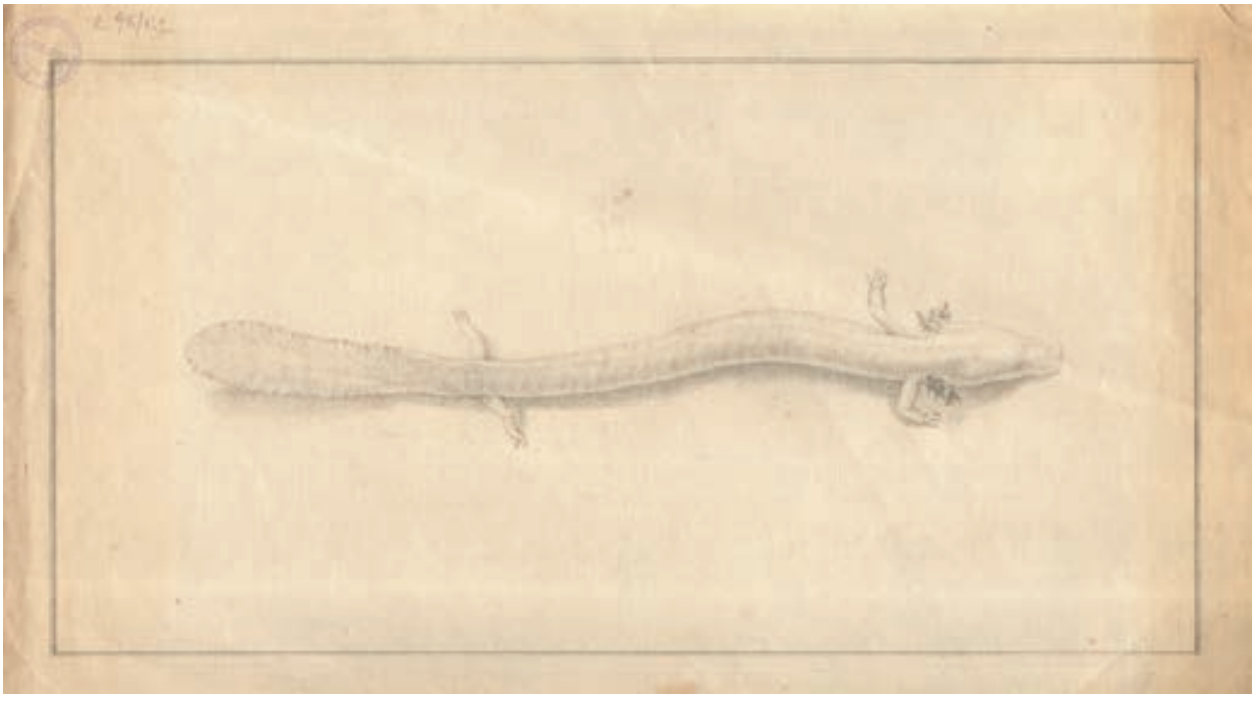

Figure 4: Vinzenz Dorfmeister, upon preparations of Žiga Zois (I), around 1805: one of three earliest drawings of proteus upon a live animal (pencil drawing, unpublished; details in Aljančič, 1998; Library of the Slovenian Academy of Sciences and Arts, Zois Legacy R 98/1, with permission).

sents proteus on high scientific level, explaining the geology of Stična, proteus distribution, history of research and review of literature, and the results of Schreibers (1801) and Zois' own research (Aljančič, 2007). Since the already explained inaccessibility and rarity of proteus, at the time known only from the Stična area, Zois rather sent accurate coloured illustrations to naturalists and museums around Europe, produced for that purpose by Vinzenz Dorfmeister, professor of drawing at the Ljubljana Lyceum (Zois, 1807; Fitzinger, 1850). Only three drawings were preserved, hidden in the archive of the Library of the Slovenian Academy of Sciences and Arts (R 98/1; legacy of Zois), where they were found in 1998 by archivist Drago Samec among the legacy of the study material of Academician Primož Ramovš (1921–1999), and firstly showed the drawings to Marjana Peterlin (Natural History Society of Slovenia), who realized their potential importance. It is not possible to describe the excitement of Marko Aljančič later the same day, when he finally saw the drawings he was searching for many years. According to Marko Aljančič, these illustrations were produced around 1805, representing the earliest preserved illustrations of proteus, drawn upon a live animal (Aljančič, 1998; Marjana Peterlin, per. comm. 8 March 2019; Figs. 4, 5 & 6).

Most unfortunately, as reported by Freyer (1849), almost all scientific material from the time of early researchers, which Schreiber gathered at the Vienna Museum, was destroyed in fire during March Revolution 1848 (Aljančič, 1991; Aljančič, 1997). Lost was the invaluable collection of early specimens, Schreibers' exhaustive notes on Scopoli's and particularly Zois' new finds, observations, illustrations, etc., including the most precious live proteus from Laze on Planinsko polje (Freyer, 1849), apparently the specimens documented by Freyer a few years earlier (Freyer, 1846B; Figs. 8, 9 & 10). One of rare objects which were not destroyed, is an accurate wax model of an particularly well grown proteus, that Zois collected at Rupe near Stična in 1806 (Aljančič, 1991). While Zois ordered illustrations of proteus to overcome the constant shortage of specimens before the presence of proteus in the Črna jama became generally known (Aljančič, 1998), Schreibers ordered such models, perhaps also to create more educative presentation of proteus at the Vienna museum (Aljančič, 1991). It is interesting to note, that both presentations appeared in about same time, perhaps created upon the same individual.

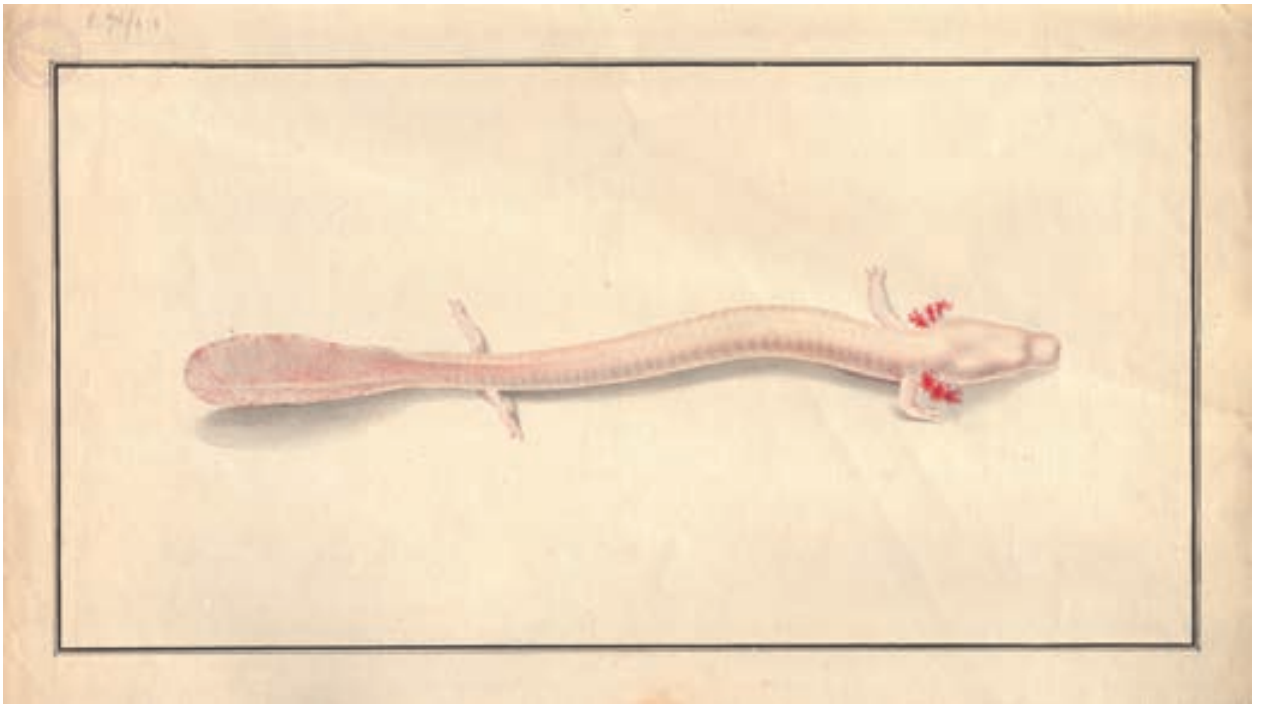

Figure 5: Vinzenz Dorfmeister, upon preparations of Žiga Zois (II), around 1805: coloured version of the same animal and position as in Fig. 4; a particularly well grown adult (coloured drawing in approx. life-size; first published in Aljančič, 1998; Library of the Slovenian Academy of Sciences and Arts, Zois Legacy R 98/1, with permission).

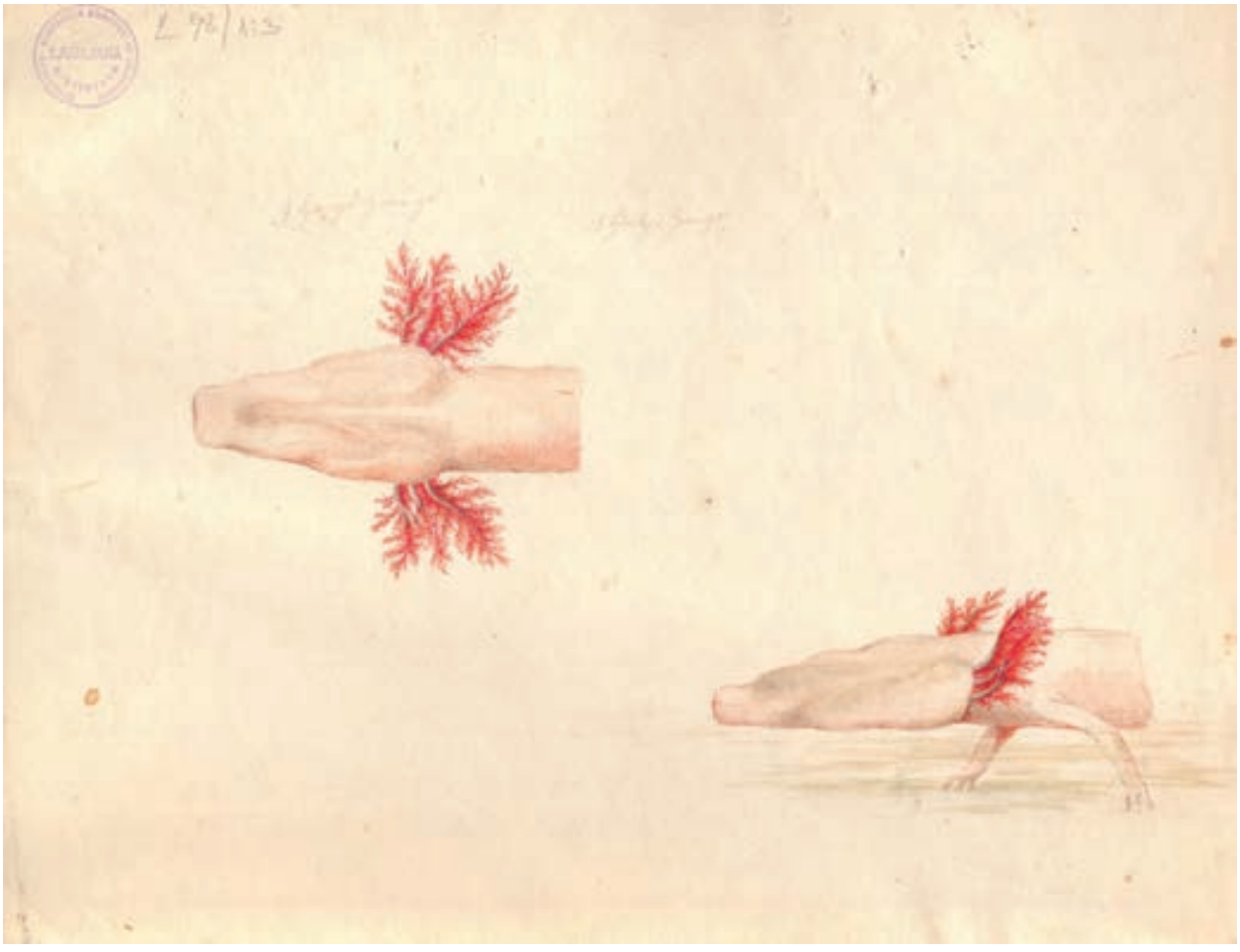

Figure 6: Vinzenz Dorfmeister, upon preparations of Žiga Zois (III), around 1805: detailed dorsal and lateral drawing of the head, external gills particularly precisely depicted (coloured drawing, unpublished; details in Aljančič, 1998*; Library of the Slovenian Academy of Sciences and Arts, Zois Legacy R 98/1, with permission).*

5 RESEARCH OF PROTEUS DISTRIBUTION

Not all proteus studies have remained as fundamentally important as they seemed to the early explorers. One of such truly long-term studies on proteus is the research of proteus distribution, by far the highest in number of researchers involved, as well as by the extent of general public involvement, since it largely depends on reports from local people. Also, search for proteus in the inaccessible subterranean habitat was always physically, materially and financially most demanding (Freyer, 1849), and thus progressing only slowly.

The distribution of proteus was first studied by Franc Jožef Hanibal Hochenwart (1771–1844), who completed Zois' initiative of foundation of the Carniolan Provincial Museum Ljubljana (Rudophinum). Hochenwart listed about ten finding sites of proteus in the Krka and Ljubljanica river basins. These localities were all revealed through finds of washed-out specimens after floods, except one - the first discovery of proteus in a cave, proteus' true habitat. Namely, in 1814, Hochenwart found proteus in Črna jama (Postojna-Planina Cave System, Slovenia), during the visit of Jožef Jeršinovič (1775–1847), later initiator of the modern cave research and tourism in Postojnska jama, who at the occasion remembered to first saw proteus there in 1797 (reported by Hochenwart; cited in Configliachi & Rusconi, 1819; Hochenwart, 1838). In Črna jama were also collected specimens studied by Con-

figliachi & Rusconi in Pavia (Fig. 7; Configliachi & Rusconi, 1819).

Hochenwart had also kept protei long-term in his apartment in Ljubljana since 1797, following Zois, all together for over 17 years (Hochenwart, 1838; Aljančič, 1984; Aljančič, 1997; Hudoklin & Aljančič, 2017).

Hochenwart's research of proteus distribution was continued more systematically by Henrik Freyer (1802–1866), the first curator of the Ljubljana Museum (1832–1852). With the support of the Schreibers fellowship, he completed a list of finding sites, which were, at the time, all limited to Carniola. He regularly invited the public to help with the gathering of valuable specimens for the collection of the Ljubljana Museum (Freyer, 1846A; Freyer; 1850; Aljančič, 1966A). Freyer visited all sites himself; in the updated list of over 30 sites, he outlined all areas of proteus distribution known today in Slovenia, with exception of Bela krajina and Kočevsko. He also documented the earliest finding sites of proteus outside of Carniola, among them proteus from the spring of Goručica near Sinj, Croatia, which was given to the museum in 1846 by Captain Joseph Appel (Freyer, 1847A).

Freyer was interested in the morphological differences of proteus between the sites, especially the shape of the head, the branching of the gills and skin colour. Based on occasional findings of washed-out proteus with prominent golden yellow patches on the flooded Planinsko polje at Laze in 1836 and 1845, Freyer described a new species *Hypochthon chrysostictus* (Freyer, 1846B). The article was accompanied by illustrations from C. F. Schmidt, upon Freyer's own drawing (Fig. 8). Probably representing one of the two proteus which (Freyer, 1846B). Animals on Figs. 8, 9 & 10 are all individuals of the nominal white proteus, washed-out onto the Planinsko polje where they were longer period exposed to sun light hence darkly pigmented (Freyer, 1842; Freyer, 1846B; Aljančič, 1966A; Božič, 2010), while the prominent golden-yellow skin

Figure 7: Faustino Anderloni, upon preparations of Mauro Rusconi, 1819: Proteus from Črna jama (Configliachi & Rusconi, 1819; Library of the Natural History Museum of Trieste, Italy, with permission; figure rotated 90° CW).

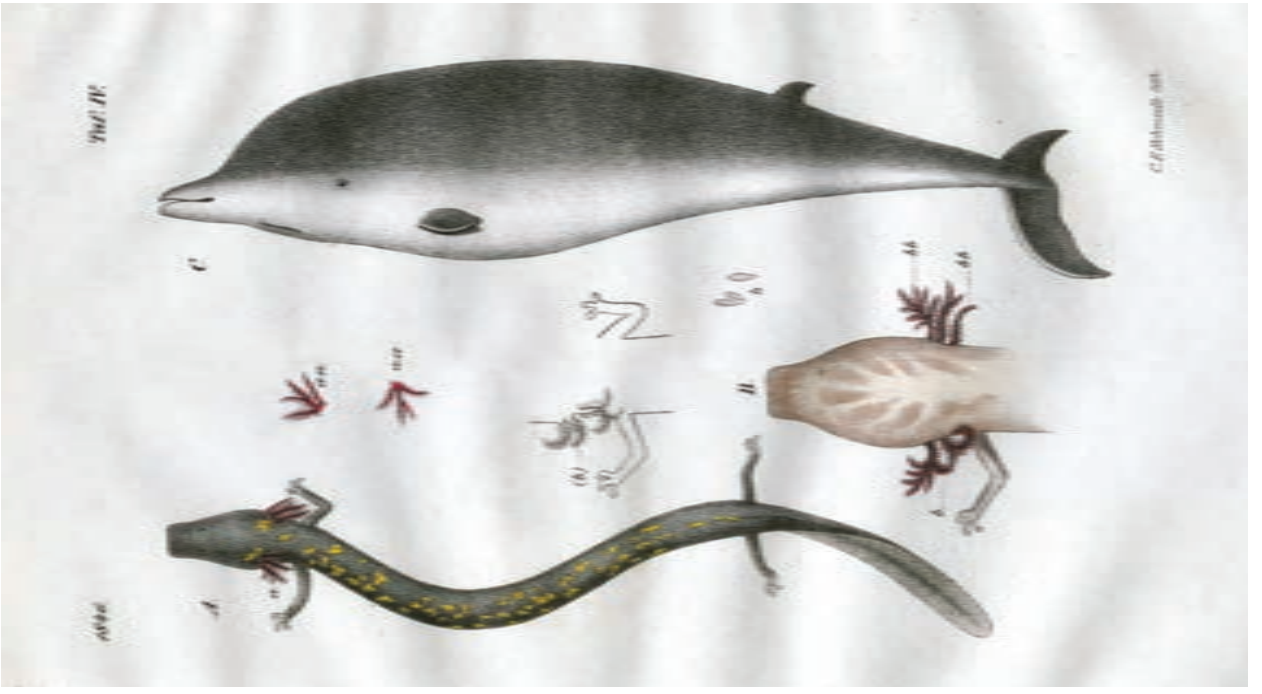

Figure 8: C. F. Schmidt, upon drawing of Henrik Freyer, 1845/ 1846: A) Hypochthon chrysostictus *sp. n., subadult proteus found on flooded Planinsko polje at Laze, beginning of July 1845; B) head of* Hypochthon Laurentii *Fitzinger, proteus washed-out in Rupe near Stična, 15 July 1845 (Freyer, 1846B; University Library at the Humboldt University of Berlin, Historical Collection, 2656:12:2:F8).*

Figure 9: Michael Sandler, 1845/ 46: Hypochthon chrysostictus *Freyer /* H. xanthostictus *Fitzinger, from the flooded Planinsko polje in Bedenj, Laze; appears to be a different individual (watercolour & gouache;* Freyer, 1846B; Freyer, 1847B; *first published in* Božič, 2010; *Collection of the National Museum of Slovenia, R-2134, photodocumentation of the Graphics Cabinet of NMS, with permission).*

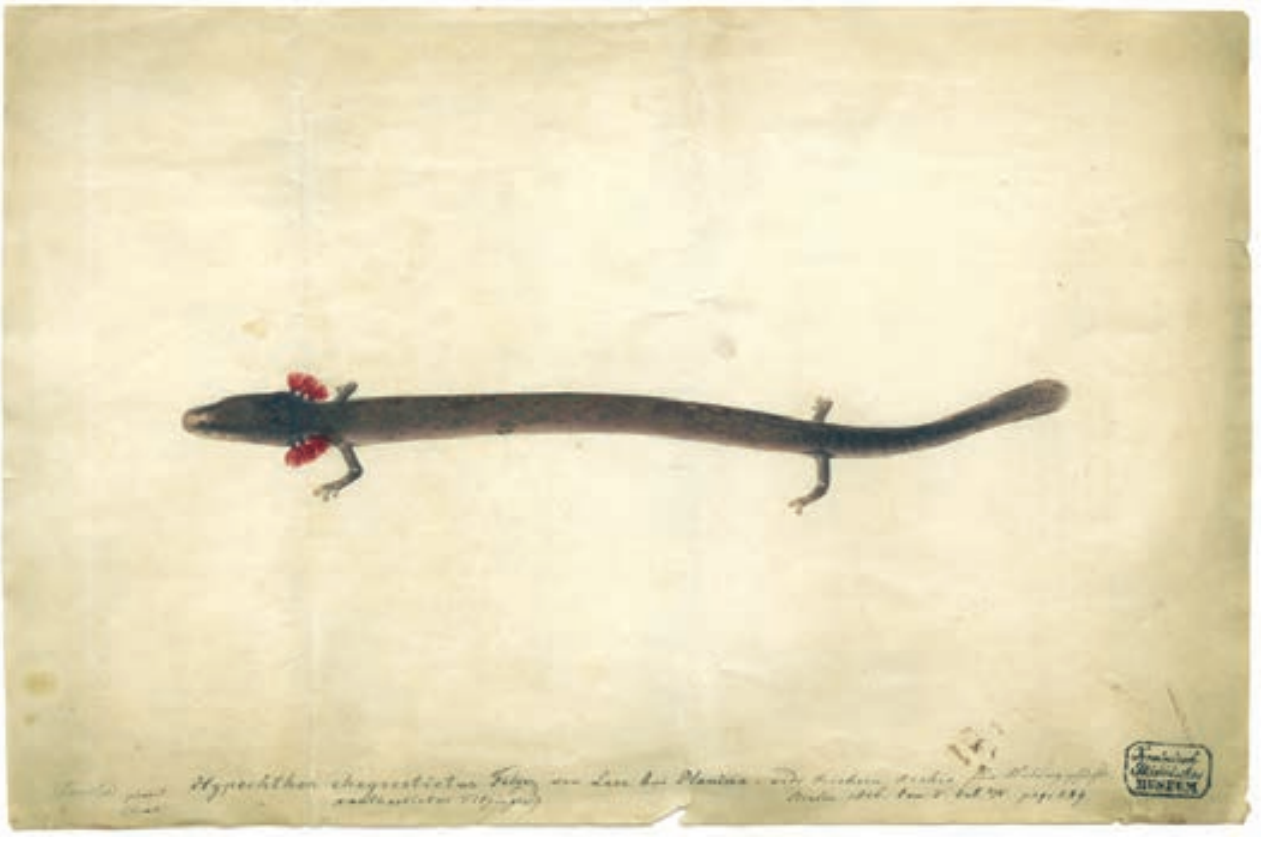

Figure 10: Michael Sandler, 1845/ 46: Hypochthon chrysostictus *Freyer* / H. xanthostictus *Fitzinger, from the flooded Planinsko polje in Bedenj, Laze; animal depicted with overdeveloped left eye? (watercolour & gouache; Freyer, 1846B; Freyer, 1847B; first published in Božič, 2010; Collection of the National Museum of Slovenia, R-2133, photodocumentation of the Graphics Cabinet of NMS, with permission).*

patches got their specific colour due to not yet explained concentrations of riboflavin (Istenič & Zigler, 1974; Simonič, 2013).

Two precious illustrations of such individuals were donated to the Ljubljana Museum in 1846 (Freyer, 1847B), but later presumably lost – until they were uncovered in 2009 by Blaženka Firs in the Graphics Cabinet of the National History Museum in Ljubljana, and described by archaeologist Prof. Dragan Božič (Božič, 2010; Figs. 9 & 10), indeed another breathtaking discovery, reminding us that more such invaluable evidence of both history of science, as well as the unique opportunity to better understand the condition of the species from pre-industrial times. Both two illustrations were painted by Michael Sandler (1790–1856), renown natural history illustrator at the Vienna Museum (Božič, 2010). By regularly sending the specimens and the data on distribution to the Viennese Museum, Freyer made a significant contribution for the taxonomic review of proteus, as prepared by Schreibers' successor Leopold Fitzinger (Fitzinger, 1850).

Here we should briefly mention curator Karel Dežman (1821–1889), who successfully succeeded Freyer at the Ljubljana Museum (1852–1889). Although Dežman's main scientific focus was not directed on proteus, he had closely studied proteus literature (Južnič, 2006; Južnič, 2009; but check author's claims in primary sources), continued to collect reports on proteus finds, and contributed to public presentations of proteus (Dežman, 1856; Dežman, 1862).

Important contribution to the search for proteus in the almost inaccessible karst underground was given by many speleologists and cavers from and around the Classical karst since the middle of the 19th century onward. Particularly extensive is the contribution of the Society for Cave Research from Ljubljana since 1910, growing into numerous caving societies of the Speleological Association of Slovenia after 1950s (overview in Novak, 1988), already documented about 13,000 caves in Slovenia (Franjo Drole, pers. comm., March 2019). The most difficultly collected was the data brought by cave divers (overview in Mlinar,

1993; Mlinar, 1996), hereafter listed in alphabetic order: Robert Anžič, Janko Brajnik, Simon Burja, Bojan Cvar, Miran Erič, Gašper Finžgar, Sašo Finžgar, Ugo Fonda, Sebastjan Gantar, Arne Hodalič, Martin Ilenič, Uroš Ilič, Franc Kljun, Marko Krašovec, Primož Krivic, Alan Levinger, Marko Matotek, Matej Mihailovski, Ciril Mlinar-Cic, Samo Morel, Janko Petkovšek, Anton Praprotnik, Martin Schweiger, Matej Simonič, Boris Sket, Rado Smerdu, Mitja Vezovnik, Igor Vrhovec, Tomo Vrhovec, Dušan Zwölf, Peter Žalec, Gregor Aljančič, and others. Here we should mention the pioneer contribtion of Ciril Mlinar-Cic & Marko Krašovec, and Arne Hodalič in underwater filming, photograpy and promotion of proteus (Aljančič et al., 1993; Mlinar, 1994; Mlinar, 2016).

From the beginning of the 1960s, data on the distribution of proteus was collected by speleobiologist Marko Aljančič (1933–2007) of the Tular Cave Laboratory (Aljančič, 1962; Aljančič, 1964A). He discerned numerous data from the already forgotten 19th century bibliography, and has carefully collected reports from locals on the findings of proteus after floods (overview in Aljančič, 1984; Sket, 1997; Hudoklin & Aljančič, 2017). Many information on finding sites and written sources along the Dinaric karst were sent to him by speleologist and entomologist Egon Pretner (1896–1982), Karst Research Institute ZRC SAZU (hereafter IZRK ZRC SAZU), one of the main experts in caves and cave animals of the Dinaric karst of his time (Aljančič, 2008; Pretner, 2016).

Distribution data were also collected at the Department of Biology (Biotechnical Faculty, University of Ljubljana) by Academician Boris Sket, who published a complete list of proteus localities across its entire range (Sket, 1997); his work is continued by Prof. Peter Trontelj and colleagues.

New localities from the area of Dolenjska and Bela krajina, were collected particularly by Andrej Hudoklin and Mira Ivanovič (Institute of the Republic of Slovenia for Nature Conservation; Hudoklin, 2003; Hudoklin, 2012; Ivanovič, 2012), Borivoj Ladišić (Speleological Society of Novo Mesto; Ladišić, 1987), Andrej Mihevc (IZRK ZRC SAZU; Mihevc, 1987), Ciril Mlinar-Cic and Marko Krašovec (Mlinar, 1986), Stanislav Klepec (Klepec, 1981) and Jože Gešelj (Bela krajina Speleological Society of Črnomelj), Martin Schweiger and others. From Notranjska by Slavko Polak (Notranjska Museum Postojna), Andrej Mihevc, Franc Malečkar, Franjo Drole and Janja Kogovšek (IZRK ZRC SAZU; Habič et al., 1990; Kogovšek, 1989; Drole, 2017) (details in Sket, 1997; Hudoklin & Aljančič, 2017); recently new localities are also reported by Tina Kirn (Kirn, 2018) and Matej Blatnik (IZRK ZRC SAZU).

6 PROTEUS RESEARCH AFTER THE FIRST AND SECOND WORLD WAR

When Ljubljana gain its full University in 1919, the newly established Zoological Institute started also with its research on cave fauna, actively from 1924 (Sket, 1993A). The first doctorate of biology was given in 1924 to the Russian immigrant Vladim Dolivo-Dobrovolsky (Wraber, 2000), for a dissertation on proteus skull (Dolivo-Dobrovolsky, 1926), who later became an assistant at the Zoological Institute.

Before the World War II, professors Albin Seliškar (1886–1973) and Hubert Pehani (1900–1995) studied the metamorphosis of tailed amphibians at the Institute of Biology (since 1971 Institute of Human Biology, and since 1991 Institute of Cell Biology) Faculty of Medicine, University of Ljubljana, and disputed the presumptions of Karoline Reis on the metamorphosis of skin grafts of protus (Pehani & Seliškar, 1941; Aljančič, 1996). Seliškar was also one of the pioneers of cave diving; in 1933 he already dived in the Štirne at Planinsko polje (Aljančič, 1996; Mlinar, 1996).

After the World War II, cave fauna was researched at the Department of Biology (Biotechnical Faculty, University of Ljubljana) from 1950s (Sket, 1993A; Aljančič, *in press*), while proteus was more actively researched from the end of the 1960s, most markedly the functional morphology of proteus, by the Research group for comparative anatomy of vertebrates, led by Prof. Lilijana Istenič, with Aleš Sojar, Boris Bulog, Danilo Musar and associates; particular attention was put on adaptations of proteus to occasional hypoxic conditions of groundwater and lung breathing, accumulation of riboflavin in skin, and studies of inner ear sensory epithelia and mechanoreceptive lateral line system (selected studies: Istenič, 1971; Istenič & Sojar, 1974; Istenič & Zigler, 1974; Istenič, 1976; Istenič & Bulog, 1976; Istenič, 1979; Istenič & Bulog, 1979; Sojar, 1980; Istenič & Bulog, 1984; Bulog, 1989A; Bulog, 1989B), continued by Prof. Boris Bulog since 1989, with Danilo Musar, Lilijana Bizjak-Mali and Marjanca Kos, with numerous students and young researchers (Katarina Mihajl-Dobrovoljec, Gregor Aljančič, Petra-Maja Prelovšek, Marjeta Konec, and others).

This research group determine proteus adaptations to its cave environment through advanced histological investigations of proteus morphology, such as the capacities of proteus sensory system (mechano- and electroreception, undeveloped eyes and pineal gland; orientation by Earth magnetic compass and hearing), in collaboration with German physiologist Prof. Peter A. Schlegel (1941–2008) (Bulog & Schlegel, 2000; Schlegel & Bulog, 1997; Schlegel et al., 2009), studies of digestive system (particularly slowed metabolism, adaptation to starvation and storage of energy) combining with the facility of their cave laboratory (see below), this research group has gathered, throughout the decades, a fundamental collection of proteus morphology (overview in Bulog, 1994; Bulog et al., 2000; Bulog, 2004; Bulog, 2007; selected studies: Bulog, 1990; Bulog, 1995; Bulog, 1996A; Bizjak-Mali & Bulog, 1996; Kos & Bulog, 1996; Kos & Bulog, 2000; Kos et al., 2001; Prelovšek & Bulog, 2003; Bizjak-Mali & Bulog, 2004; Prelovšek et al., 2008; Bizjak-Mali et al., 2013). The research group has also cooperated with Prof. Kristijan Jezernik, Institute for Biology at Faculty of Medicine (Bulog & Jezernik, 1996; Erdani-Kreft, 1996), Prof. Gorazd Avguštin, Department of Animal Science, Biotechnical Faculty (Ambrožič-Avguštin et al., 2009), and others. Lili Istenič, but in particular Boris Bulog and his colleagues introduced environmental research on accumulation of pollutants in proteus tissues, and the monitoring of pollution at selected proteus localities, focused on the threatened black proteus (Dremelj et al., 1985; Bulog, 1996B; Bulog et al., 2002; Dobrovoljc et al., 2003; Pezdirc et al., 2011; overview in Bulog, 2007; Bizjak-Mali & Bulog, 2016), with several studies in co-operation with the Department of Environmental Sciences at the Jožef Stefan Institute.

Since 2015, the programme is continued by Prof. Rok Kostanjšek with Assist. Prof. Lilijana Bizjak-Mali and associates. Since 2009, Bizjak-Mali is also focused on proteus reproductive biology (morphology of sexual organs in correlation with seasonality and animal size; cytogenetics of sexual chromosomes, currently in collaboration with Prof. Stanley K. Sessions; Bizjak-Mali & Bulog, 2010; Sessions et al., 2016; Bizjak-Mali, 2017); cultivation of proteus blood cells, and development of non-invasive methods to asses proteus physiological condition by monitor its hematological parameters, with young researcher Tajda Gredar (Gredar & Bizjak-Mali, 2017; Gredar et al., 2018). Rok Kostanjšek with associates study skin bacteriome of proteus, and the interaction of proteus with parasites and microorganisms (Kostanjšek et al., 2017, Kostanjšek et al., 2019). The special emphasis of the latter is given to determination of potential pathogens in free-living and captive proteus individuals (Bizjak-Mali et al., 2018), which are studied in collaboration with Prof. Nina Gunde-Cimerman. She and Kostanjšek, recently initiated proteus genome project, in collaboration with the Lars Bolund Institute for Regenerative Medicine, China, and University of Aarhus, Denmark, and a significant progress in research of proteus is expected from its outcomes.

In the Laboratory for Speleobiology at the Department of Biology, the biodiversity of subterranean habitats is studied mainly through taxonomy, evolution and biogeography. Academician Boris Sket, for many decades head of this group, has gathered a complete list of proteus localities across the Dinaric karst; he explained the pattern of proteus distribution as a consequence of paleogeographic development of the Dinaric karst, and corroborated his findings with the pattern of today's distribution of other cave species (Sket, 1997; Sket, 2012).

All were surprised by the discovery of an unusual dark-pigmented proteus in Bela Krajina (south-eastern Slovenia): first specimen known to the science was found in 1986 at the spring of Dobličica by karstologist Andrej Mihevc from the Karst Research Institute at the Scientific Research Centre of the Slovenian Academy of Sciences and Arts (Aljančič et al., 1986; Mihevc, 1987; Sket, 2017; Aljančič, 2017). In 1994, Boris Sket together with Dutch herpetologist Jan Willem Arntzen (Naturalis Biodiversity Center) taxonomically describes this extraordinary proteus population as *Proteus anguinus parkelj* (Sket & Arntzen, 1994; see also Sket, 1993B; Arntzen & Sket, 1996; Arntzen & Sket, 1997; Sket, 2007; Sket, 2017; hereafter: the black proteus).

Peter Trontelj and associates continued with study of proteus phylogeny. With Špela Gorički and Samo Šturm they demonstrated the sister relation between *Proteus* and the North American genus *Necturus* using molecular phylogenetic methods (Trontelj & Gorički, 2003), showed the molecular evolution of proteus by identifying several independent genetic lineages of proteus (Gorički & Trontelj, 2006; Gorički, 2012) and cryptic speciation along the Dinaric karst (Trontelj et al., 2009), and estimated a timescale of proteus evolution using molecular clock (Trontelj et al., 2007). Jure Jugovic and associates studied the predator–prey interactions (Jugovic et al., 2010). Recently, Peter Trontelj and Valerija Zakšek have focused on proteus nuclear DNA, confirming that the taxon is deeply subdivided into 6 to 9 mitochondrial DNA lineages (Trontelj & Zakšek, 2017). They are determin-

ing the conservation genetics of proteus populations (Zakšek et al., 2017), developing genetic and non-genetic monitoring methods to estimate the size and state of selected proteus populations, with Žiga Fišer, Teo Delić, and associates (Trontelj & Zakšek, 2016; Fišer et al., 2017).

Interesting pilot research at the Department of biology to be mentioned here, was an electrophysiological investigation of proteus reduced eye, performed by physiologists Academician Matija Gogala, Prof. Štefan Michieli (1933–1968) and Borut Žener (1935–1974) (Gogala et al., 1969; Žener, 1973).

7 CAVE LABORATORIES IN SLOVENIA

In research of proteus in Slovenia, special attention was given to the idea of using a cave as a laboratory. One of the earliest of such kind, with proteus from the Postojna-Planina Cave System, arranged by Armand Virè, one of the pioneers of modern speleobiology – in the catacombs of Paris, flooded by Sienna in 1910.

The earliest plans of a cave museum in Postojna came from the Cave commission in 1904, in following years thoroughly elaborated by speleologist Ivan A. Perko (1876–1941), who by 1911 raised a considerable fund, foreseeing a future Cave Research Institute (Perko, 1911). This would be the first karstological institute in the world, but the pioneer ideas were overtaken by the World War I (Shaw, 2010). However, the first cave laboratory actually built in Slovenia was active in the cave Podpeška jama (south Slovenia) between 1928 and 1931, arranged by professors Roman Kenk and Albin Seliškar at the Zoological Institute of the University of Ljubljana (Kenk & Seliškar, 1931). In 1930, after establishing the Karst institute in Postojna in 1929, Perko has finally completed his vision by building a modern Biospeleogical Station in Postojnska jama (Dudich, 1933). Albin Seliškar (Institute of Physiology at the Faculty of Medicine) started the renovation of the station in 1951 under the custody of the Slovenian Academy of Sciences and Arts, and remained in charge until 1960, when he was forced to close the laboratory due to insufficient support (Aljančič, 1996).

Marko Aljančič started to develop his interests as a keen student at the Gimansium in Kranj, where he founded school's Natural history circle (1946), gain first laboratory and fieldwork experience, and got his first opportunity to observe proteus behaviour in school tank (Aljančič, 2008; Gogala and Furlan, 2013; Aljančič, 2015). Aljančič elaborated his plans for a cave laboratory in his graduation thesis, arranged upon the Subterranean Laboratory in Moulis (Aljančič, 1960). With the support of Prof. Hubert Pehani, and the Town of Kranj, Aljančič set up a biospeleological laboratory in the Tular Cave in Kranj as a part of the Institute of Biology (Faculty of Medicine, University of Ljubljana) (Aljančič, 1961; Vandel, 1964), in order to facilitate long-term ecological and behavioural studies on proteus (Aljančič, 1961; Aljančič, 2008; Aljančič, 2015).

At the Institute of Biology, Marko Aljančič was focused mainly on morphology and physiology of proteus (e.g., erythrocyte ultrastructure, limb regeneration, skin pigmentation, stimulation of metamorphosis; selected studies: Aljančič, 1963; Aljančič & Sket, 1964; Aljančič, 1974), while at the Tular Cave Laboratory he studied proteus mainly by observation of its behaviour (Aljančič, 1964B). He was especially interested in ecology and behaviour of proteus, involved in the national project Ecology of cave animals (Prof. Janez Matjašič). In his pioneering comparison of physical-chemical parameters of groundwater ecotope in selected proteus localities (1962–1965), in collaboration with chemist Prof. Ladislav Guzelj, Marko Aljančič compared ecological conditions in selected proteus localities, but the study also alerted on high pollution of proteus habitat in the Kočevsko region (central south Slovenia) (Aljančič, 1969), where, most regretfully later proteus has locally gone extinct (Sket, 1997; Hudoklin, 2011). Findings from the nature helped in searching for adequate conditions for long-term maintenance of proteus in captivity, which were largely unknown at the time, mainly with regard to feeding, providing a semi-natural habitat and developing animal-friendly observation methods. After reorganization of the Biological Institute into the Institute of Human Biology, the Tular Cave Laboratory after 1976 continued its programme independently on the initiative and with dedication of both Marko and Marija Aljančič, biologist, active in the laboratory since 1965. After 2002, the laboratory operates under the custody of the Society for Cave Biology.

Since 2007, their son, Gregor Aljančič continues the work at the Tular Cave Laboratory, mainly by researching the distribution of proteus (Gorički et al., 2017; Hudoklin & Aljančič, 2017), its reproductive behaviour (Aljančič & Aljančič, 1998), adaptation to cave environment, e.g., proteus potential detection of

floods, with Mitja Prelovšek (Aljančič & Prelovšek, 2010); cave-related adaptations of the skull, with Ana Ivanović (Institute for Zoology, Faculty of Biology, University of Belgrade) and Jan W. Arntzen (Naturalis Biodiversity Center) (Ivanović et al., 2013); interactions between predator and prey, with Jure Jugovic (Jugovic et al., 2010). He continues with long-term observations on proteus at Tular with Magdalena Năpăruş-Aljančič (e.g., space use, reproduction and feeding behaviour, locomotion, longevity, etc.; Aljančič & Năpăruş, 2009).

In nature, their studies on proteus are conservation-oriented. Gregor Aljančič and Magdalena Năpăruş-Aljančič developed new conservation tools of monitoring proteus presence by detecting its environmental DNA along the Dinaric karst, with key experts Špela Gorički and David Stanković, and partners Prof. Matjaž Kuntner (Jovan Hadži Institute of Biology ZRC SAZU), Aleš Snoj and Prof. Peter Dovč (Department of Animal Science, Biotechnical Faculty, University of Ljubljana), Prof. William R. Jeffery (Department of Biology, University of Maryland, USA), Prof. Alberto Pallavicini (Department of Life Sciences, University of Trieste, Italy), Miloš Pavićević (Biospeleological Society of Montenegro, Montenegro), Jasminko Mulaomerović (Centre for Karst and Speleology, Bosnia and Herzegovina) and associates, revealing the presence of proteus environmental DNA at the edge of its range in Montenegro, and surveying the narrow area of actual distribution of the black proteus, and its contact with the white population in Bela krajina, Slovenia (Aljančič et al., 2014; Pennisi, 2016; Stanković et al., 2016; Gorički et al., 2016; Gorički et al., 2017). Since 2017, Špela Gorički is continuing at the Scriptorium biologorum - Biološka pisarna d. o. o., developing eDNA methods for monitoring stygobiotic species (Gorički et al., 2018).

Starting in 1964, the laboratory studies the phenomenon of proteus being occasionally washed out from its subterranean habitat during seasonal flooding. The Sanctuary for proteus was set up in 2008, with a regular veterinarian care provided for injured proteus in collaboration with veterinarian Zlatko Golob since 2013 (Aljančič et al., 2016). Both, the Sanctuary and the Laboratory operate under strict quarantine, with regular pathogene monitoring (ranaviruses, Bsal, Bd) analyzed at the Department of Biology.

The Tular Cave Laboratory is focused on conservation of the most rare and endangered populations of proteus, such as the black proteus and the Stična population of the white proteus, e.g., monitoring of distribution and GIS analysis of pollution of its groundwater habitat (Năpăruş-Aljančič et al., 2017). Since 2017, Tular Cave Laboratory is partner of the national consortium the European eScience Infrastructure of biodiversity and Ecosystem research LifeWatch-ERIC.

An important part of the laboratory's activity is dedicated to raising awareness on the vulnerability of proteus and groundwater in countries along the Dinaric karst, addressing both the public as well as the research and nature conservation organisations (Năpăruş-Aljančič et al., 2018), in the network of the biennial International meeting SOS *Proteus* (Aljančič et al., 2016; Aljančič et al., 2017; Aljančič et al., 2018).

At the Department of Biology in Ljubljana, proteus was maintained in the basement at the Faculty of Arts from the early 1960s until 1993. For the purpose of educating school children, protei were kept in the Vivarium (Borut Žener, Emerik Mezgolits, Rudi Ocepek and Dušan Vrščaj), while for the research proteus was maintained in a nearby room (France Velkovrh, Lili Istenič, Boris Sket, Milan Velikonja and associates), later Istenič arranged a special refrigerated dark chamber. For several years, Prof. Tine Valentinčič has utilized the vivarium for practical exercises in behaviour of proteus for students of biology (Emerik Mezgolits & Rudi Ocepek, pers. comm. November 2017; Lilijana Bizjak-Mali, per. comm. February 2019; Boris Sket, per. comm. March 2019; Janko Božič, per. comm. March 2019).

At the end of October 1986, Lili Istenič, Boris Sket, Boris Bulog, Tine Valentinčič, Matija Gogala, Andrej Mihevc, Marko Aljančič and associates had here the opportunity to observe the very first individual of the black proteus (Aljančič et al., 1986; Istenič, 1987; Mihevc, 1987), almost as surprised as Scopoli and Wulfen 220 years before when looking at the white proteus. Later, in the new laboratory, laying of eggs of the black proteus was recorded by Boris Bulog. Beside both subspecies of proteus, laboratory occasionally maintained several invertebrate cave species (Boris Sket, per. comm. 22 March 2019).

When Department of Biology was moved to the new building in 1993, a modern cave laboratory was arranged in a climate-controlled room upon plans of Boris Bulog and Boris Sket. A cave laboratory is now used by both, the Research group for comparative anatomy of vertebrates, and the Laboratory for Speleobiology, mainly in studies of Lilijana Bizjak-Mali, Rok Kostanjšek, Cene Fišer, Katja Zdešar-Kotnik and associates).

8 RESEARCH ON PROTEUS REPRODUCTION

More than its eyelessness and subterranean life, the researchers and the public had been giving special attention to the mysterious proteus reproduction since the very beginning (Aljančič et al., 1993; Aljančič & Aljančič, 1998), probably deriving already from the initial Linnaean search for an undoubted proof of specimens maturity. Zois, Hochenwart and Freyer had been searching in vain for females with eggs or embryos, and Schreibers has offered a reward of 25 Guldens (Hochenwart, 1839; Freyer, 1846A; Grošelj, 1933 Aljančič & Aljančič, 1998; Sket, 2007). The animals described in the following cases of reproduction derive from Slovenia, almost exclusively from the Postojna-Planina Cave System, where they were most easily accessible.

In absence of evidence, the question, whether proteus is oviparous or viviparous was stirred up the protocol of Ljubljana naturalist Joseph H. Stratil, wherein Janez Kek, municipal judge and local of Vir near Stična, witnessed in detail the viviparity of proteus, which he observed in a bottle filled with water, between 17 and 20 June 1825 (Michahelles, 1831). A supposed case of viviparity in Postojnska jama was reported by the newspaper Novice on 26 February 1862, but the Viennese comparative anatomist Joseph Hyrtl (1810–1894) showed it was only a worm, and the proteus – a male specimen (Dežman, 1862; Aljančič et al., 1993; Aljančič, 1994). Eighty years later, just before the World War I, impetus to the hypothesis of viviparity was given again by the influential, but later discredited Viennese experimental biologist Paul Kammerer (Kammerer, 1907; Kammerer 1912; van Alphen & Arnten, 2016), and another case of viviparity was also reported by Polish zoologist Józef Nusbaum (Nusbaum, 1907).

The first confirmation of oviparity came from the Postojnska jama in 1875. Beginning of May 1875, one of the animals has laid 56 eggs in a bucket that was prepared to be shown to the visitors by the cave guide Prelesnik; however, the eggs have all decayed (Schulze, 1876). Soon thereafter, animals from the Postojna-Planina Cave System laying of eggs in captivity was observed by German researcher Marie von Chauvin in 1882, and finally Ernst Zeller succeeded in growing larvae from eggs in 1886 (von Chauvin, 1883; Zeller, 1888; Aljančič & Aljančič, 1998; Sket, 2007).

The eggs of proteus were not recorded until 1958, when Prof. Albert Vandel and Michel Bouillon first succeeded with breeding of proteus at the Moulis Underground Laboratory (today Experimental Ecology Station of the CNRS at Moulis; Vandel & Bouillon, 1959; Vandel, 1965). In 1962 proteus reproduction was described in detail by Wolfgang Briegleb, who bred the animals for some years in the basement of the Zoological Institute in Munich, Germany (Vandel & Bouillon, 1959; Briegleb, 1962; Aljančič & Aljančič, 1998; Sket, 2007).

At the Tular Cave Laboratory Marko and Gregor Aljančič recorded the first young proteus in 1991, laying of eggs in 1993, and successful *ex situ* reproduction of the white proteus is monitored since 1998 (Aljančič & Aljančič, 1998; Culver & Pipan, 2009; Aljančič, 2008; Grosse et al., 2018). The endangered black proteus is maintained in Tular since 2002, though other that egg laying was not recorded.

In the touristic Postojnska jama, proteus was on public display through the 19th century on (Shaw, 2005; Shaw & Čuk, 2015), maintained by cave guides. In 2001, speleobiologist Slavko Polak (Notranjska Museum Postojna) became the first curator of proteus showed in this touristic cave. He introduced husbandry standards of the Tular Cave Laboratory in 2002, rebuilt the formal Biospeleological Station for public display and constructed a new tourist aquarium in 2010, with Ksenija Dvorščak (Postojnska jama) and associates (Aljančič, 2008; Dvorščak, 2011). In 2013, after almost 140 years, and due to improved conditions of captivity, Polak has been observing first egg laying in the tourist aquarium of Postojnska jama, in collaboration with Gregor Aljančič. However, eggs were eaten or damaged by other adults in the aquarium. The first larvae were successfully hatched there from the eggs in 2016, reared by Primož Gnezda, Sašo Weldt and Katja Dolenc-Batagelj (Postojnska jama), in cooperation with Lilijana Bizjak-Mali and Stanley K. Sessions (Bizjak-Mali et al., 2017).

Proteus from Postojna-Planina Cave System are also maintained in a touristic cave Hermannshöhle in Harz, Germany since 1931, documenting laying of eggs since 2016 (Ipsen et al., 2017; Grosse et al., 2018).

In the late 1950s and early 1960s German biologist Wolfgang Briegleb (1928–2006) built the fundaments of modern ecology of proteus, studying the species in the Postojna-Planina Cave System and captive facility arranged in the basement of the Zoological Institute in Munich, Germany, for his doctorial thesis (Briegleb, 1962; Aljančič, 1963; Aljančič, 2008). Extensive fieldwork in the Postojna-Planina Cave System was carried out together with biologist and hydrologist France Hribar (1915–1999) of IZRK ZRC SAZU (Briegleb, 1963).

The actual proof, that proteus lays eggs in nature, was shown by B. Sket and F. Velkovrh in 1976. They caught two eggs with well-developed embryos, washed-out by high groundwater at the Virski studenec (Sket

& Velkovrh, 1978). Sket later found a late embryo/hatchling of the black proteus being washed-out at the springs in Jelševnik (south-eastern Slovenia) under similar conditions (Sket & Arntzen, 1994).

Academician Jovan Hadži (1884–1972) had left an influential mark on proteus research in the period before, and especially after the World War II, mostly by directing biospeleological research (Hadži, 1965; Aljančič, 1996). His expert opinion was supporting the nature conservation permit for acquisition of the protected species from nature, which were mostly performed in the Postojna-Planina Cave System, as in case of the Underground Laboratory CNRS in Moulis (France) from 1952, as well as specimens for the Tular Cave Laboratory from 1960 (Aljančič, 2008), while the 2nd acquisition of proteus to the touristic cave Hermannshöhle (Germany) in 1956 was unlawful (Ipsen & Knolle, 2017).

9 PROTEUS IN SLOVENE NATURAL HISTORY TERMINOLOGY

We should here briefly mention an important contribution of proteus research to the development of Slovene natural history terminology in the 19th century, a subject not well studied (Aljančič, 1995).

The Slovenian vernacular name *človeška ribica* [human fish] was documented in the area of Stična (Zois, 1807; Freyer, 1842), perhaps though it was already the most common of all local synonyms, of which only a few were written down by Zois and Freyer, before this linguistic diversity was lost forever. Nevertheless, through the first half of the 19th century *človeška ribica* replaced other synonyms (i.e./ literally translated in English/ *bela riba* [white fish], *bela kačica* [white snake, diminutive form]*;* Zois, 1807; Freyer, 1850; review in Aljančič, 1989; Trontelj et al., 2017), and was probably translated in other Slavic languages (Aljančič, 1989).

During the period when Henrik Freyer was curator of Ljubljana Museum (1832–1852) (Aljančič, 1966A), Slovene natural history terminology started to developed more rapidly, following the progress of modern science, and the growing public attention, often raised through promotion of nature wonders of Carniola and cave tourism in Postojna (Aljančič et al., 1993; Shaw & Čuk, 2015). Not to be misunderstood when naming species of Slovenian flora and fauna, Freyer also searched for their exact common Slovene names and collected synonyms in the first list of amphibians of Carniola (Freyer, 1842), following the pioneer work of Žiga Zois (Jančar, 1999). He also coined Slovene binomial scientific name for proteus, the *Temnotna močerila* (Freyer, 1842; Freyer, 1849), through following years perhaps testing derivatives, such as the *Močarilec* (Freyer, 1850), to find the proper name accepted by public. Freyer's name is still use today, like the *Olm*, invention of famous German naturalist Lorenz Oken (Freyer, 1846A; Aljančič, 1989), reused from the Thuringian vernacular name for newt [*Molch*] (Trontelj et al., 2017).

Freyer is also author of the first description of proteus in Slovene language (Freyer, 1850), which is also one of the earliest Slovene natural history articles. The manuscript for this article was described and published by Marko Aljančič, although at the time he was not aware that the final version of Freyer's manuscript was indeed published (Aljančič, 1966B). Freyer was preparing the manuscript for a popular science article in a very natural history orientated Slovene language textbook, based on his public lectures, largely relying on data from his *Museum report for the year 1845* (Freyer, 1846A). This article keeps its high scientific value and rich data, largely based on Freyer's own observations (e.g., distribution of proteus, general biology and history of research).

However, the first article on proteus in Slovene language, together with an accurate drawing by A. Jurman, was published a year earlier, on 28 June 1849, in the first Slovene youth newspaper *Vedež* (published between 1848–1850) (Anon., 1849) (Fig. 11). The article is unsigned, much shorter, but the author seems to be well informed on the subject, although the text contains small mistakes. Perhaps intestinally naive for the school readers, the article contains interesting historical details of a vivid nature history community in Ljubljana (compare Hochenwart, 1838).

This short review of early authors is complete with the most popular Slovene natural history writer of the 19th century, naturalist Fran Erjavec (1834–1887), with short article on proteus included in his influential book on animals (Erjavec, 1864; Aljančič, 1995; Dular, 1995).

The Natural History Society of Slovenia, which formally arose from the Museum Society of Carniola (founded by Hochenwart and co-members in 1839), have popularise research of proteus and its conservation generations for 180 years, particularly influentially after the World War I. Since 1933, the society publishes the Proteus, Slovenia's oldest natural history

Figure 11: A. Jurman, 1849: Illustration of proteus in the Vedež, first Slovene youth newspaper, with unrealistic nostrils, perhaps to attract young reader (lithographic print by K. Egerčin; Anon, 1849). Assembled from two incomplete copies at the Slovene National and Study Library in Trieste, and the University Library Maribor (left and right edge), with permission.

magazine. With its name, the first issue of the magazine lined its mission in the often reprinted article "How proteus was discovered?" written by the initiator and first editor Prof. Pavel Grošelj (1883–1940) (Grošelj, 1933). In 80 volumes, which had a fundamental impact on the development of modern Slovene natural history terminology and writing, the magazine published about 50 articles concerning proteus.

Another fruitful promoter is the Speleological Association of Slovenia, with over 40 articles on proteus in its journal Naše jame [Our Caves], published between 1959 and 2008, for many years edited by Marko Aljančič (1977–1999) (Aljančič, 2008). Since 2008, the Association publishes its new magazine Jamar [Caver].

On proteus was discussed in about 20 scientific papers published in the journal Acta carsologica (Karst Research Institute ZRC SAZU) since 1955. Since 2016, the journal Natura Sloveniae (Biotechnical Faculty, University of Ljubljana and National Institute of Biology) published presentations from the first three International meetings SOS *Proteus* (Aljančič et al., 2018), already 32 short scientific communications on proteus.

10 BEGINNINGS OF PROTEUS CONSERVATION

In the 19th century proteus quickly became threatened by excessive collection, focused mostly on a few of the easily accessible caves of the Postojna-Planina Cave System. Much before his time, F. Hochenwart had expressed his concern for the growing vandalism already in 1838. He estimated that in the period between 1800–1838, particularly from the cave Črna jama, over 4,000 specimens were caught (Hochenwart, 1838; Aljančič, 1997; Sket, 2007), sent to the collections all over the world or sold as souvenirs to the visitors of the Postojnska jama (Aljančič, 1997; Shaw, 1999; Dvorščak, 2011). The famous cave explorer of the Classical karst, Chech speleologist Adolf Schmidl (1802–1863), had collected 500 specimens on 24 August, 1850, soon after discovering this untouched proteus population in the Pivka branch of the Planinska jama, and sent them all to Vienna, where the four survived specimens were presentated at the Academy of Sciences in Vienna (Schmidl, 1850). *In vivo,* Proteus was often presented in Ljubljana, Trieste and Vienna, and it was occasionally exhibited worldwide (Zois, 1807; Hochenwart, 1838; Schmidl, 1850; Aljančič et al., 1993; overview in Shaw, 2005), where only few animals survived for longer periods in inadequate conditions. A proteus brought in 1861, after 17 days of travel from Postojna to London, by Scottish geologist Hugh Falconer, appear to have more luck. The next day he offered it to his friend Charles Darwin, who was – like Lamarck before him – puzzled by proteus eyelessness (Darwin, 1859; Culver & Pipan, 2009). Darwin was probably well aware of the delicate care needed to keep it at home, so he rather kindly suggested letting proteus to the London Zoo, where indeed Falconer's gift was recorded on 27 June 1861 (Shaw, 1999; Shaw, 2008).

After developing into an international karst tourist attraction during the 19th century, the Postojna Cave promoted proteus as its most famous attraction (e.g., specimens exhibited at the World Exhibition in 1863 and 1873; Shaw, 2005). In the second half of the 19th century, proteus has become so rare in the Postojna-Planina Cave System, that even the guides of Postojnska jama had difficulties to purchase proteus for tourist display, while proteus became rare also in other caves of Carniola (Schulze, 1876). The high attention of the public not only encouraged poaching but also attracted researches, and Postojnska jama became an attraction for science as well (Aljančič et al., 1993; Shaw, 1999; Shaw, 2008; Dvorščak, 2011; Shaw & Čuk, 2015; Lučić, 2018). Nature conservation awareness, raised in public prior its time by F. J. Hochenwart (Hochenwart, 1838; Aljančič, 1997; Sket, 2007), has only gradually developed. First ideas to legally protect cave fauna and caves in Slovenia arose in the years before the World War I at the Museum Society of Carniola. The programme was partially achieved in 1921 with the legal protection of caves (Peterlin, 1995), though nominally proteus is protected in Slovenia since 1951.

Excessive collection of proteus has ceased after the World War I, but a new, more serious threat has already appeared – the pollution of groundwater in Slovenia. Negative anthropogenic influences derive mainly from intensive agriculture, which is not adjusted to the vulnerable karst landscape, and from non-regulated urbanisation and industry (Aljančič, 1969; Sket B., 1972; Bulog, 2007; Hudoklin, 2011; Aljančič et al., 2014; Aljančič & Aljančič, 2015; Mezga et al., 2016; Kordiš, 2016; Gostinčar, 2016; Tičar & Ribeiro, 2017; Kolar, 2018). Dolenjska and Bela krajina are the most vulnerable areas (Bulog et al., 2002; Hudoklin, 2016; Bizjak-Mali & Bulog, 2016; Prelovšek, 2016; Aljančič, 2017; Ribeiro & Tičar, 2017; Năpăruş-Aljančič et al., 2017), and in several caves proteus have already disappeared (Sket, 1997).

11 CONCLUSION

The research on proteus is one of the oldest natural history projects in Slovenia, 330 years of spiritual bond, outlined by Valvasor's pioneer studies of karst and first mentioning of proteus (Andrej Mihevc, pers. comm., Aljančič, 2008). With contributions of the early naturalists, and raised public attention, proteus gradually became not only an important symbol of Slovenia's karst nature, but also a part of its cultural heritage (Aljančič et al., 1993), which is reflected in diversity and persistence of proteus research in Slovenia. Proteus also became a myth, often presented as a dweller of the untouched karst underground. However, the reality of the growing negative pressure in karst landscape has long gave a strong motive – to proteus researchers as well as people living in the karst landscape – we need to continue studying proteus, in order to preserve the vulnerable karst ecosystems for the future.

This overview of proteus research in Slovenia, however brief and incomplete, relies particularly on the historical reviews offered by Žiga Zois, Franc J. Hochenwart, Henrik Freyer, Pavel Grošelj, Marko Aljančič, Darinka Soban, Boris Sket, Trevor Shaw, and others. Particularly Marko Aljančič devoted himself to studying and illuminating the history of proteus research, with emphasis on the contributions given by Valvasor, Scopoli, Zois, Schreibers, Hochenwart, Freyer, Seliškar and others. His popular science articles and exhibitions are one of the most fruitful contributions to the promotion of proteus as a symbol of vulnerable karst nature in his homeland and worldwide (Sket, 2007; Aljančič, 2008; Gogala and Furlan, 2013).

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PHYTOSOCIOLOGICAL DESCRIPTION OF *FAGUS SYLVATICA* FORESTS IN THE RAŠA VALLEY (SW SLOVENIA)

FITOCENOLOŠKI OPIS BUKOVIH GOZDOV V DOLINI RAŠE (JUGOZAHODNA SLOVENIJA)

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ABSTRACT

Phytosociological description of *Fagus sylvatica* forests in the Raša Valley (SW Slovenia)

The paper discusses and supplements the knowledge of the phytosociological composition of *Fagus sylvatica* forests in the Raša Valley, on the northeastern edge of the Karst, or more specifically, in the area between the plateau of Vrhe, the Senožeče lowland and the Karst. They are classified into two associations, *Seslerio autumnalis-Fagetum* and *Hacquetio-Fagetum*. A new subassociation (*-lamietosum orvalae*) and a new geographical subvariant (subvar. geogr. *Helleborus istriacus*) were determined for the association *Hacquetio-Fagetum*. Although they occupy small areas these beech forests are an important part of the predominantly oak and hop hornbeam forest vegetation of the Karst, constituting a Natura 2000 habitat type Illyrian *Fagus sylvatica* forests (*Aremonio-Fagion*). They are threatened by climate change and excessive logging.

Key words: phytosociology, synsystematics, *Aremonio-Fagion, Hacquetio-Fagetum*, Raša, Kras, Slovenia

IZVLEČEK

Fitocenološki opis bukovih gozdov v dolini Raše (jugozahodna Slovenija)

Dopolnili smo vednost o fitocenološki sestavi bukovih gozdov v dolini Raše, na severovzhodnem robu Krasa, natančneje med planoto Vrhe, Senožeškim podoljem in Krasom. Uvrščamo jih v dve asociaciji, *Seslerio autumnalis-Fagetum* in *Hacquetio-Fagetum*. Za slednjo smo ugotovili novo subasociacijo (*-lamietosum orvalae*) in novo geografsko subvarianto (subvar. geogr. *Helleborus istriacus*). Kljub majhnim površinam so ti bukovi gozdovi v zdajšnji prevladujoči hrastovi in črnogabrovi gozdni vegetaciji Krasa pomembni, saj sodijo v Natura 2000 habitatni tip Ilirski bukovi gozdovi (*Aremonio-Fagion*). Ogrožajo jih podnebne spremembe in premočne sečnje.

Ključne besede: fitocenologija, sinsistematika, *Aremonio-Fagion, Hacquetio-Fagetum*, Raša, Kras, Slovenija

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1 INTRODUCTION

The source of the Raša River is in the area of Osarsko, in the flysch hills that separate the Upper Vipava Valley and the Senožeče lowland (Senožeško podolje) (Radinja 1972). After its headwaters converge it leaves the flysch area and is joined a little more than a kilometre later by the Ločnik creek on the left; the creek begins at Dolenja Vas near Senožeče and is considered by some to be the beginning of the Raša River. In the Cretaceous limestone of the Karst the river had carved a gorge oriented NE-SW. Under the benchmark (survey point) at 612 m the river turns towards northwest and continues its course across the geological fault line. The valley slightly widens only after the confluence with the Griški Potok creek. The slopes on both sides of the gorge are steep, stony and, except for screes and rocks, overgrown with forest. The slopes above the left bank belong to the Karst and the slopes above the right bank to the Vrhe Plateau, to which belong also the slopes of the Griški Potok creek, the first larger right tributary of the Raša. Beech occurs in a major part of the Raša Valley (Figure 1), but more contiguous stands are preserved only in the upper and partly in the central part of the valley, extending to the confluence with the Griški Potok creek and the shady slopes of this creek. The dominant beech forest community in Raša, the association *Seslerio autumnalis-Fagetum*, had been described some time ago (Dakskobler 1997) when we discussed also more mesophilous beech stands that supposedly belong to two other associations (*Hacquetio-Fagetum, Lamio orvalae-Fagetum*) and whose stands were observed only in smaller areas in the upper part of the valley.

With further phytosociological studies conducted in 2012–2017 we wanted to determine:

Into how many associations can beech forests in the Raša Valley be classified?

How similar are mesophilous beech forests in the Raša Valley to the submontane and montane mesophilous beech forests on limestone parent material elsewhere in southwestern Slovenia?

2 METHODS

Forests in the Raša Valley were recorded applying the Central-European method (Braun-Blanquet 1964). A total of 34 phytosociological relevés in which beech was either the dominant species in the tree layer or held an important percentage there were entered into the FloVegSi database (T. Seliškar, Vreš & A. Seliškar 2003). Floristic similarity between the relevés was estimated with the software package SYN-TAX 2000 (Podani 2001). For this purpose, we transformed combined cover-abundance values into ordinal values 1– 9 (van der Maarel 1979). The relevés were arranged into the analytical table (Table 1) based on the results of hierarchical classification using the "(Unweighted) average linkage" – UPGMA method, where we applied Wishart's similarity ratio. The same method was used also in the comparison of floristic composition of mesophilous beech forests in the Raša Valley with similar beech forests elsewhere in southwestern Slovenia.

The nomenclatural source for the names of vascular plants, except for the name *Helleborus odorus* subsp. *istriacus* Schiffner, is Martinčič & al. (2007), Martinčič (2003, 2011) for the names of mosses, and Šilc & Čarni (2012) for the names of syntaxa, except for the name of the class *Querco-Fagetea* Braun-Blanquet et Vlieger in Vlieger 1937.

2.1 Ecological description of the study area

The predominating geological parent material in the Raša Valley is Cretaceous limestone (Jurkovšek et al. 1996); soils are rendzinas and brown soils on limestone. The climate in the study area is warm, with mean annual temperature of 10 – 11 °C and the vegetation period with mean daytime temperature exceeding 10 °C for around 180 days, from (early) mid-April to mid-(end of) October (Cegnar 1998). The average annual precipitation is 1400 to 1500 mm, with more than half of precipitation received during the vegetation period. Precipitation is more frequent and abundant in spring and autumn, less so in winter and summer (Zupančič 1998). The shady slopes of the upper part of the very narrow valley have a colder local climate. This part of the valley is largely wooded. Forests are secondary. On the sunny side of the valley (the right side) they developed mainly through spontaneous afforestation of former pastures and on the shady (left) side as a result of intensive logging in the first half of the 20th century. Stands of three oak-hop hornbeam associations prevail: *Seslerio autumnalis-Quercetum petraeae, Seslerio autumnalis-Ostryetum* and *Aristolochio luteae-Quercetum pubescentis*, in smaller areas also stands of associations *Seslerio autumnalis-Quercetum cerridis*, *Amelanchiero ovalis-Ostryetum* and *Ornithogalo pyrenaici-Carpinetum betuli* (Dakskobler 1997, 2016, Dakskobler et al. 2017).

3 RESULTS AND DISCUSSION

In terms of floristic similarity the relevés with dominating beech in the tree layer (Figure 1) formed two larger groups (Figure 2). Based on the dendrogram in this figure we arranged them in Table 1. Three relevés (in the far right part of the dendrogram and at the beginning of Table 1) stood out mainly because beech is not the dominant species in the tree layer. Relevé 1 in Table 1 is a development stage of beech forest on a gravelly plain immediately next to the river (potentially belongs into the association *Hacquetio-Fagetum*), while relevés 2 and 3 are a degradation stage of beech forest on a convex slope (potentially they belong to the association *Seslerio autumnalis-Fagetum*). Relevés on the left side of the dendrogram (relevés 4 –16 in Table 1) can be classified into the association *Seslerio autumnalis-Fagetum*. Floristically, the group of relevés on the right side of the dendrogram is distinctly different. Although these relevés comprise both character species of the association *Seslerio autumnalis-Fagetum*, namely *Sesleria autumnalis* and *Lathyrus venetus*, their entire species composition allows for their classification into other, more mesophilous associations. These relevés were made mainly on concave, steep and stony slopes with moister soils. Based on our on-site examinations, site appearance, relief, rockiness and soil conditions they have so far been classified into two associations: *Hacquetio-Fagetum* and *Lamio orvalae-Fagetum*. To accurately assess our existing classification they should be compared with two syntaxa that were reported and described in this part of Slovenia by Accetto (1989, 1990): *Fagetum submontanum* var. geogr. *Sesleria autumnalis* (according to the rules of the Code, Weber et al. 2000, the valid name of this syntaxon is *Hacquetio-Fagetum* Košir 1962 var. geogr. *Sesleria autumnalis* Accetto 1990) and *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis*. However, Accetto did not publish any analytical or synoptic ta-

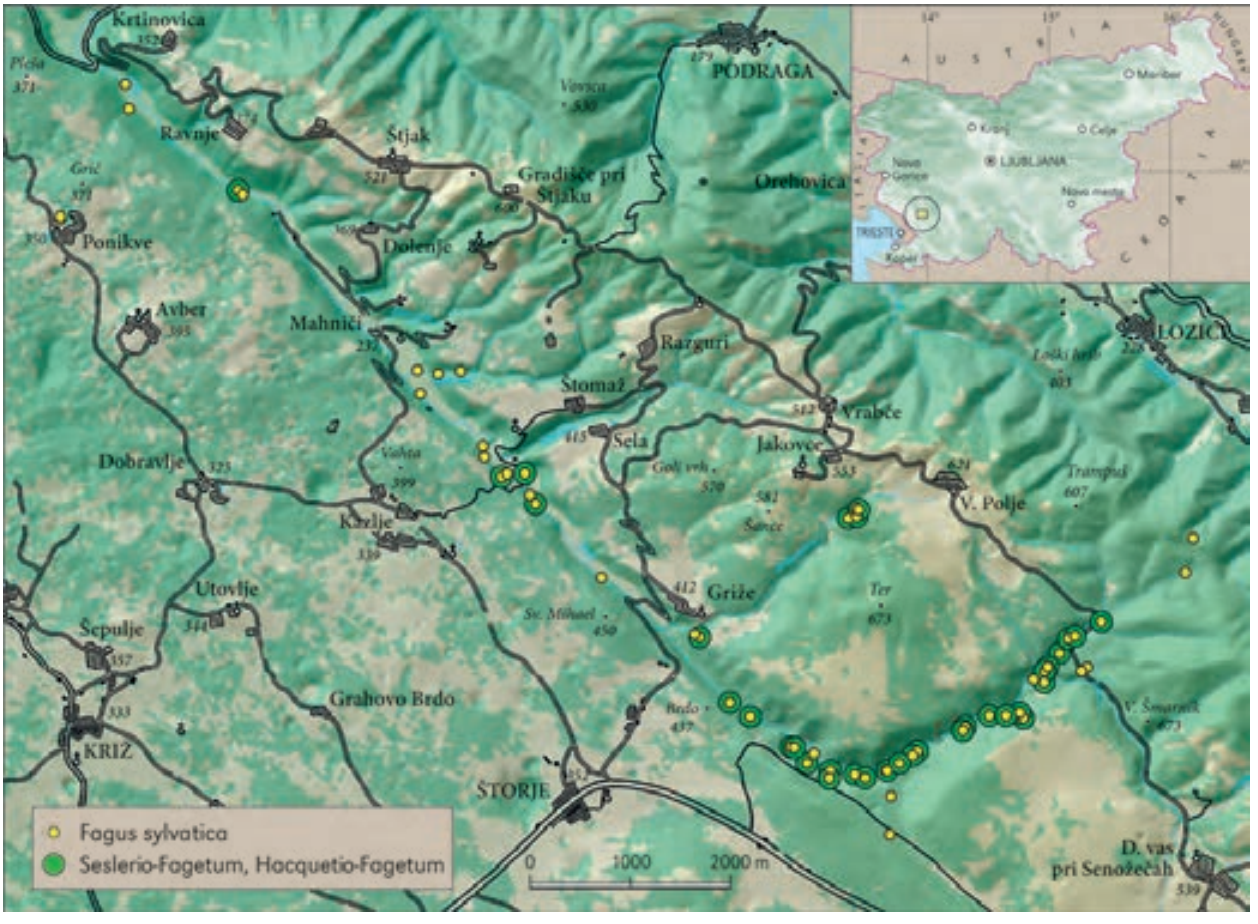

Figure 1: Localities of Fagus sylvatica and researched beech stands in the Raša Valley
Slika 1: Nahajališča bukve in njenih preučenih sestojev v dolini Raše

bles. They might have been preserved in his legacy, which is currently not yet available to the professional public. In making the synoptic table (Table 2) we could therefore only use the descriptions from his study (Accetto 1989) and the published table which, however, shows only the presence of some of the species (Accetto 1990). For the stands of the association *Lamio orvalae-Fagetum* we also took into consideration six of our relevés from the Čičarija region (Dakskobler & Rešček 2015). The synoptic table therefore shows the frequencies of species in the communities described by Accetto. These are estimated values, but roughly correspond to the situation on site, although certain species are probably missing.

Comparison between four syntaxa, namely our relevés from Raša, relevés of the syntaxon *Fagetum submontanum* – Vremščica, Ravnik, relevés of the association *Lamio orvalae-Fagetum*, separately for Vremščica and Ravnik, and Čičarija, demonstrates that the stands from Raša are clearly different (Figure 3) and cannot be classified into two, but only into one association. Character species of the association *Hacquetio-Fagetum*, as well as certain character species of the association *Lamio orvalae-Fagetum,* are well represented in the studied stands (better than in the stands of the syntaxon *Fagetum submontanum* var. geogr. *Sesleria autumnalis*). In terms of site characteristics, such as shady and very rocky slopes, brown rendzina, brown soils on limestone, abundance of sycamore maple (*Acer pseudoplatanus*) and wych elm (*Ulmus glabra*) in the tree layer, they resemble the stands of the association *Lamio orvalae-Fagetum,* whereas in terms of their elevation zone spanning 350 – 550 m a.s.l. and individual *Quercus petraea* trees in the tree layer they are undoubtedly closer to the stands of the association *Hacquetio-Fagetum* s. lat. Of the three classification options for this mesophilous submontane stands, namely into the association *Seslerio autumnalis-Fagetum, Hacquetio-Fagetum* or *Lamio orvalae-Fagetum*, the analyses and comparisons that we have conducted affirmed that the classification into the association *Hacquetio-Fagetum* is the most justified.

The analysis by groups of diagnostic species (Table 3, taking into account the presence of tree and shrub species in different stand layers) demonstrates distinct differences between the studied stands and stands of the

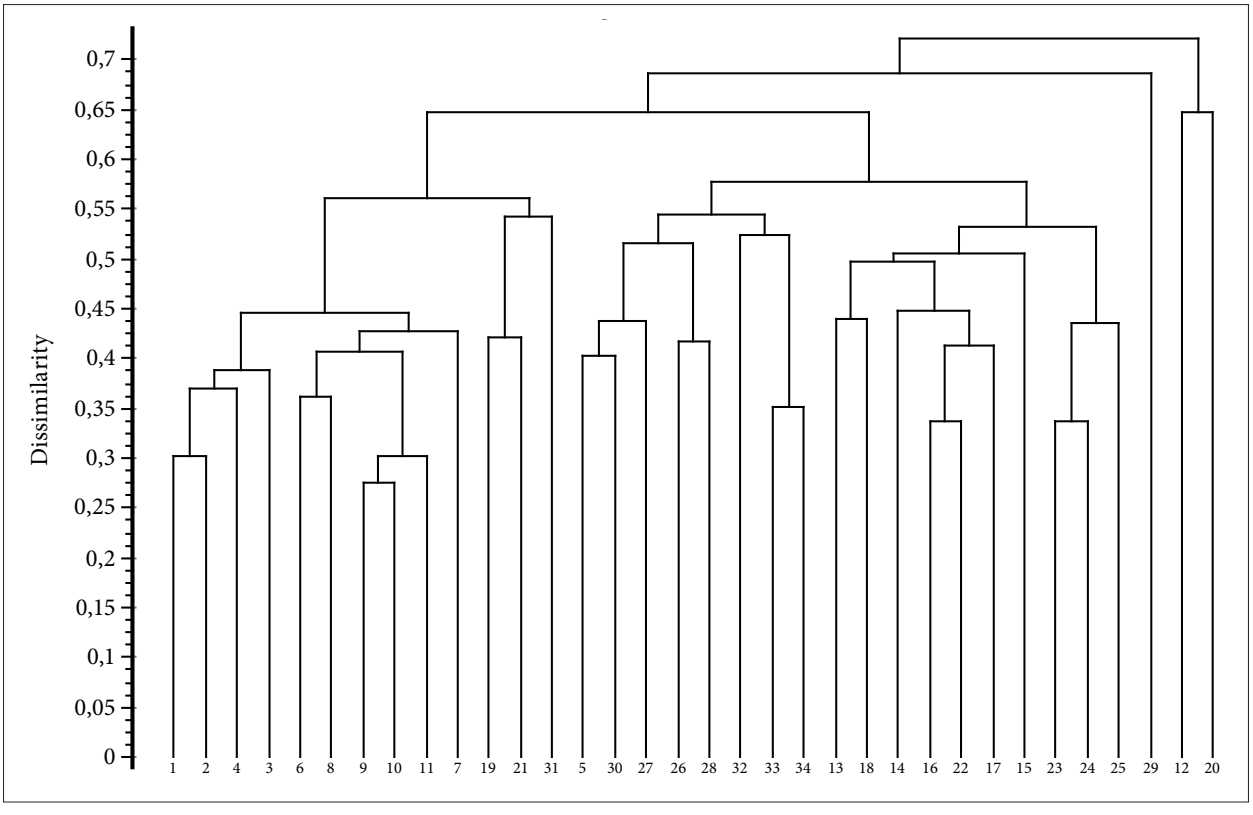

Figure 2: Dendrogram of Fagus sylvatica stands in the Raša Valley (UPGMA, similarity ratio)
Slika 2: Dendogram bukovih sestojev v dolini Raše (UPGMA, similarity ratio)

association *Seslerio autumnalis-Fagetum*, in particular a significantly higher proportion of diagnostic species of alliances *Aremonio-Fagion* and *Tilio-Acerion*, order *Fagetalia sylvaticae* and class *Querco-Fagetea*, and a significantly smaller proportion of species of the order *Quercetalia pubescenti-petraeae* and classes *Rhamno-Prunetea* and *Trifolio-Geranietea*. However, the adapted synoptic table and its analysis (Tables 2 and 4, tree and shrub species are taken into account only in one layer) demonstrate that the stands of the association *Lamio orvalae-Fagetum* in southwestern Slovenia comprise a distinctly higher proportion of species of the alliance *Tilio-Acerion* and classes *Asplenietea trichomanis* and *Thlaspietea rotundifolii*, and a distinctly smaller proportion of species of the alliance *Erythronio-Carpinion* and order *Quercetalia pubescenti-petraeae* than in the stands of the studied beech forests in the Raša Valley. These findings do not support the classification of the studied stands into the association *Lamio orvalae-Fagetum*.

There are considerable ecological and floristic differences between the stands in the Raša Valley and the stands of the syntaxon *Fagetum submontanum* var. geogr. *Sesleria autumnalis* from Vremščica and Ravnik. The last grow on different elevations, between 500 and 700 m a.s.l., they do not comprise one of the character species of the association *Hacquetio-Fagetum*, namely *Hacquetia epipactis*, and in addition, our relevés cannot be classified into any of the subassociations de-

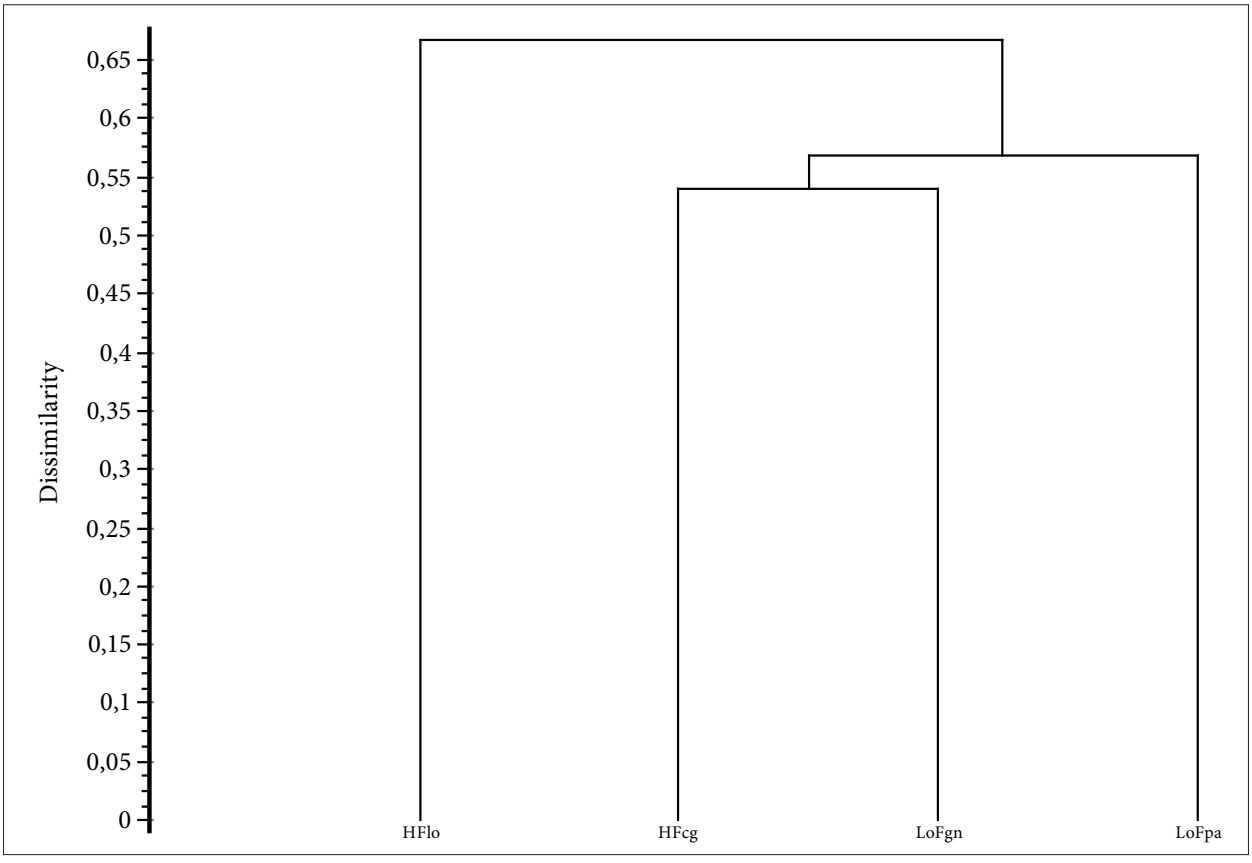

Figure 3: Dendrogram of Fagus sylvatica communities on limestone parent material in southwestern Slovenia (UPGMA, similarity ratio)
Slika 3: Dendogram bukovih združb na karbonatni podlagi v jugozahodni Sloveniji, UPGMA, similarity ratio

HFlo: *Hacquetio-Fagetum lamietosum orvalae*, this article
HFcg *Fagetum submontanum* var. geogr. *Sesleria autumnalis*, Accetto (1989, 1990)
LoFgn *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Geranium nodosum,* Accetto (1989, 1990)
LoFpa *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Pseudofumaria alba*, Accetto (1989, 1990), Dakskobler & Reščič (2015)

scribed by Accetto (1989): *hieracietosum sylvaticae*, *galietosum odorati*, *festucetosum carniolicae*, *mercurialietosum perennis, dryopteridetosum assimilis*). The studied mesophilous beech stands in the Raša Valley are therefore classified into a new subassociation *Hacquetio-Fagetum lamietosum orvalae* subass. nova hoc loco. The differential species of the new subassociation are *Lamium orvala, Galeobdolon flavidum, Aconitum lycoctonum, Scilla bifolia, Corydalis cava* and *Gagea lutea*. The listed species characterise rocky sites with sufficient soil moisture, otherwise more characteristic for the stands of the association *Lamio orvalae-Fagetum*. The differential species of the new subassociation include *Aconitum lycoctonum*, after which Accetto (2015) named the subassociation *Hacquetio-Fagetum aconitetosum lycoctoni*, but the entire species composition and ecology of this subassociation is clearly different from the species composition and ecology of the studied community. The nomenclatural type of the new subassociation, *holotypus* hoc loco, is relevé 26 in Table 1. Within the new subassociation we distinguish also the variant with *Ostrya carpinifolia* on slightly drier sites with shallower soils, predominantly rendzina.

In terms of phytogeography, the stands of the association *Hacquetio-Fagetum* on the northeastern edge of the Karst are classified into the new geographical subvariant *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Helleborus istriacus*, subvar. geogr. nova. Its differential species are taxa *Helleborus odorus* subsp. *istriacus* and *Acer obtusatum*, which do not occur together in other previously described geographical (sub)variants of the association *Hacquetio-Fagetum*. The submontane beech community in the Raša Valley therefore differs from the submontane beech community under Vremščica and on the Ravnik plateau (the latter could be also treated as a new geographical subvariant *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Calamintha grandiflora*) also in terms of phytogeography. It occurs at lower elevations in a warmer climate, and characterises the geographical particularities of the association *Hacquetio-Fagetum* in the Karst. Previously, only the stands of the association *Ornithogalo pyrenaici-Fagetum* (Dakskobler 2006) were known in this area, whereas the stands of this association have not been reported. Košir (2010: 85) briefly mentions a submontane beech forest with *Hacquetia epipactis* and *Ruscus aculeatus*, *Hacqetio-Fagetum* var. asoc. *Ruscus aculeatus* in the littoral part of the High Karst, but his description does not refer to the beech community of the Classic Karst.

4 CONCLUSIONS

Well-preserved beech forests are very rare in the Karst. Until now, our knowledge has been limited to the stands of the associations *Seslerio autumnalis-Fagetum* and *Ornithogalo pyrenaici-Fagetum*. Several years ago, we described the stands of the first also on the northeastern edge of the Karst, on the shady slopes above the Raša Valley. In the same area we also described the stands that can be classified (due to their entire species composition) into the new subassociation *Hacquetio-Fagetum lamietosum orvalae* (the latter indicates a certain similarity with the stands of the association *Lamio orvalae-Fagetum*, but there is no floristic basis for classifying these stands into this association) and the new geographical subvariant *Hacquetio-Fagetum* var geogr. *Sesleria autumnalis* subvar. geogr. *Helleborus istriacus*. The stands of the new syntaxon are sufficiently differentiated not only from their contact stands that belong to the association *Seslerio autumnalis-Fagetum*, but also from the submontane beech forests under Vremščica and on the Ravnik plateau, on the margins of the Karst towards the Pivka Valley and Brkini Hills, known as *Fagetum submontanum* var. geogr. *Sesleria autumnalis* or *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Calamintha grandiflora*. These are managed forests with a pronounced protective function, quite removed from transport routes. They belong to the forest site type Submontane Littoral *Fagus sylvatica* forests on carbonate rocks (Kutnar et al. 2012). Also important is their biotopic function, as they belong to the Natura 2000 habitat type Illyrian *Fagus sylvatica* forests (*Aremonio-Fagion*) and are sites of some taxa that are protected in Slovenia (Anon. 2004): *Cephalanthera longifolia*, *C. damasonium, Convallaria majalis, Cyclamen purpurascens, Erythronium dens-canis*, *Galanthus nivalis, Helleborus odorus* subsp. *istriacus, Lilium martagon, Listera ovata, Neottia nidus-avis.* Some of the floristic features typical for the beech forests in the Raša Valley include several other taxa that are rare in the Karst, such as *Laburnum alpinum, Lathyrus occidentalis* var. *montanus*, *Phyteuma spicatum* subsp. *coeruleum, Veratrum nigrum, Valeriana tripteris, Lonicera alpigena, Tephroseris pesudocrispa* and *Anemone x pittonii*, which indicate the vicinity of the Vipava Valley and high-karst plateaus of

Trnovski Gozd and Nanos. Beech forests in the Raša Valley are threatened by climate change and excessive logging, which could result in regression to sessile oak and hop hornbeam stands.

5 POVZETEK

5.1 Uvod

Reka Raša izvira na Osarskem, v flišnem hribovju, ki ločuje Zgornjo Vipavsko dolino in Senožeško podolje (Radinja 1972). Po združitvi povirnih krakov zapusti flišno območje in po nekaj več kot kilometru teka se ji z leve pridruži potok Ločnik, ki izvira pod Dolenjo vasjo pri Senožečah in ga nekateri tudi štejejo za začetek Raše. V krednem apnencu Krasa je izdolbla sotesko, ki ima smer severovzhod–jugozahod. Pod koto 612 m se reka obrne proti severozahodu in teče naprej po geološki prelomnici. Dolina se nekoliko razširi šele po sotočju z Griškim potokom. Pobočja na obeh straneh soteske so strma, kamnita, z izjemo melišč in skalovja porasla z gozdom. Pobočja nad levim bregom pripadajo Krasu, pobočja nad desnim bregom pa planoti Vrhe. K njej sodi tudi prvi večji desni pritok Raše, Griški potok. Bukev je vsaj posamično prisotna v večjem delu doline Raše (slika 1), a bolj sklenjeni sestoji so le v njenem zgornjem in deloma srednjem delu, do sotočja z Griškim potokom in na osojnih pobočjih tega potoka. Prevladujočo bukovo gozdno združbo v Raši, asociacijo *Seslerio autumnalis-Fagetum*, smo opisali pred leti (Dakskobler 1997). Takrat smo omenili tudi bolj mezofilne bukove sestoje, ki naj bi pripadali še dvema asociacijama (*Hacquetio-Fagetum, Lamio orvalae-Fagetum*) in katerih sestoje smo opazili le na manjših površinah v zgornjem delu doline.

Z dodatnimi fitocenološkimi raziskavami, ki smo jih opravili v letih 2012–2017, smo želeli ugotoviti naslednje:

V koliko asociacij lahko uvrstimo bukove gozdove v dolini Raše?

Kolikšna je podobnost mezofilnih bukovih gozdov v dolini Raše s podgorskimi in gorskimi mezofilnimi bukovimi gozdovi na apnenčasti podlagi drugod v jugozahodni Sloveniji?

5.2 Metode

Gozdove v dolini Raše smo popisovali po srednjeevropski metodi (Braun-Blanquet 1964). Skupno 34 fitocenoloških popisov, v katerih je bila bukev dominantna vrsta drevesne plasti ali je vsaj v njej imela pomemben delež, smo vnesli v podatkovno bazo FloVegSi (T. Seliškar, Vreš & A. Seliškar 2003). Primerjavo floristične podobnosti popisov smo opravili s programom SYN-TAX 2000 (Podani 2001). V ta namen smo kombinirane ocene zastiranja in pogostnosti pretvorili v ordinalne vrednosti od 1–9 (van der Maarel 1979). Popise smo v analitsko preglednico (preglednica 1) uredili na podlagi rezultatov hierarhične klasifikacije z metodo kopičenja na podlagi povezovanja (netehtanih) srednjih razdalj "(Unweighted) average linkage" – UPGMA, kjer smo uporabljali Wishartov koeficient podobnosti (similarity ratio). Isto metodo smo uporabili tudi pri primerjavi floristične sestave mezofilnih bukovih gozdov v dolini Raši s podobnimi bukovimi gozdovi drugod v jugozahodni Sloveniji.

Nomenklaturni viri za imena praprotnic in semenk so Martinčič & al. (2007) razen za ime *Helleborus odorus* subsp. *istriacus* Schiffner, za imena mahov Martinčič (2003, 2011), za imena sintaksonov pa Šilc & Čarni (2012), razen za ime razreda *Querco-Fagetea* Braun-Blanquet et Vlieger in Vlieger 1937.

5.2.1 Ekološka oznaka raziskovanega območja

Prevladujoča geološka podlaga v dolini Raše je kredni apnenec (Jurkovšek et al. 1996), tla so rendzine in rjava pokarbonatna tla. Podnebje v raziskovanem območju je toplo, s povprečno letno temperaturo 10°C –11 °C in z vegetacijsko dobo s povprečno dnevno temperaturo nad 10 °C okoli 180 dni, od (začetka) srede aprila do srede (konca) oktobra (Cegnar 1998). Povprečna letna višina padavin je od 1400 mm do 1500 mm, približno polovica jih pade v vegetacijskem obdobju. Več padavin je spomladi in jeseni, manj pozimi in poleti (Zupančič 1998). Osojna pobočja zgornjega dela doline, ki je zelo ozka, imajo hladnejše krajevno podnebje. Ta del doline je v glavnem gozdnat. Gozdovi so drugotni in so na prisojni strani doline (desni breg) nastali predvsem z zaraščanjem nekdanjih pašnikov, na osojni strani doline (levi breg) pa kot posledica močnih sečenj v prvi polovici 20. stoletja. Prevladujejo sestoji treh hrastovo-črnogabrovih asociacij: *Seslerio autumnalis-Quercetum petraeae, Seslerio autumnalis-Ostryetum* in *Aristolochio luteae--Quercetum pubescentis*, na manjših površinah pa so tudi sestoji asociacij *Seslerio autumnalis-Quercetum cerridis*, *Amelanchiero ovalis-Ostryetum* in *Ornithogalo pyrenaici-Carpinetum betuli* (Dakskobler 1997, 2016, Dakskobler et al. 2017).

5.3 Rezultati in razprava

Fitocenološki popisi s prevladujočo bukvijo v drevesni plasti (slika 1) so se po floristični podobnosti združevali v dve večji skupini (slika 2). Na podlagi dendrograma na tej sliki smo jih tudi uredili v preglednico 1. Trije popisi (v skrajno desnem delu dendrograma in na začetku preglednice 1) so floristično precej odstopali, predvsem zato, ker v njih bukev ni dominantna vrsta drevesne plasti. Popis št. 1 v preglednici 1 označuje razvojno stopnjo bukovega gozda na prodnati uravnavi tik ob reki (potencialno sodi v asociacijo *Hacquetio-Fagetum*), popisa št. 2 in 3 pa degradacijsko stopnjo bukovega gozda na izboklem pobočju (potencialno sodita v asociacijo *Seslerio autumnalis-Fagetum*). Popise v levem delu dendrograma (popis št. 4 –16 v preglednici 1) lahko uvrstimo v asociacijo *Seslerio autumnalis-Fagetum*. Skupina popisov v desnem delu dendrograma je floristično očitno drugačna. Čeprav v njih tudi uspevata obe značilnici asociacije *Seslerio autumnalis-Fagetum*, *Sesleria autumnalis* in *Lathyrus venetus*, njihova celotna vrstna sestava dopušča možnost uvrstitve v druge, bolj mezofilne asociacije. Te popise smo naredili na večinoma vboklih strmih in kamnitih pobočjih z bolj vlažnimi tlemi. Na podlagi terenskih ogledov, videza rastišč, reliefa, skalnatosti in talnih razmer, smo jih do zdaj uvrščali v dve asociaciji: *Hacquetio-Fagetum* in *Lamio orvalae-Fagetum*. Za pravilno presojo naše dosedanje klasifikacije bi bila nujna primerjava z dvema sintaksonoma, ki ju je v tem delu Slovenije odkril in opisal Accetto (1989, 1990): *Fagetum submontanum* var. geogr. *Sesleria autumnalis* (po pravilih Kodeksa, Weber et al. 2000, je veljavno ime tega sintaksona *Hacquetio-Fagetum* Košir 1962 var. geogr. *Sesleria autumnalis* Accetto 1990) in *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis*, ki pa analitskih ali vsaj sinteznih tabel ni nikoli objavil. Najbrž so ohranjene v njegovi zapuščini, a ta za zdaj ni dostopna strokovni javnosti. Pri izdelavi sintezne preglednice (preglednica 2) smo si zato lahko pomagali le z opisi iz elaborata (Accetto 1989) in z objavljeno preglednico, ki pa pokaže le na prisotnost nekaterih vrst (Accetto 1990). Pri sestojih asociacije *Lamio orvalae-Fagetum* smo upoštevali tudi šest naših popisov iz Čičarije (Dakskobler & Reščič 2015). V sintezni preglednici so torej frekvence stalnosti vrst v združbah, ki jih je opisal Accetto, ocenjene, a v grobem ustrezajo stanju na terenu, ob tem, da najbrž nekatere vrste manjkajo.

Primerjava med štirimi sintaksoni: naši popisi iz Raše, popisi sintaksona *Fagetum submontanum* – Vremščica, Ravnik, popisi asociacije *Lamio orvalae-Fagetum*, ločeno iz Vremščice in Ravnika ter Čičarije, pokaže, da so sestoji iz Raše očitno drugačni (slika 3) in da jih ne moremo uvrstiti v dve asociaciji, temveč kvečjemu v eno. V preučenih sestojih so dobro zastopane značilne vrste asociacije *Hacquetio-Fagetum* (bolj kot v sestojih sintaksona *Fagetum submontanum* var. geogr. *Sesleria autumnalis*), a tudi nekatere značilnice asociacije *Lamio orvalae-Fagetum*. Po nekaterih značilnostih rastišča: osojna precej skalnata pobočja, rajava rendzina, rjava pokarbonatna tla, pogostnost gorskega javorja in gorskega bresta v drevesni plasti, spominjajo na sestoje asociacije *Lamio orvalae-Fagetum,* po višinskem pasu uspevanja 350 m – 550 m in pogosti posamični primesi gradna (*Quercus petraea*) v drevesni plasti, pa so nedvomno bolj podobni sestojem asociacije *Hacquetio-Fagetum* s. lat. Med tremi možnostmi, da te mezofilne podgorske sestoje uvrstimo v asociacije *Seslerio autumnalis-Fagetum, Hacquetio-Fagetum* ali *Lamio orvalae-Fagetum*, je na podlagi narejenih analiz in primerjav najbolj utemeljena uvrstitev v asociacijo *Hacquetio-Fagetum*.

Analiza po skupinah diagnostičnih vrst (preglednica 3, upoštevana je prisotnost drevesnih in grmovnih vrst v različnih sestojnih plasteh) kaže na očitne razlike preučenih sestojev proti sestojem asociacije *Seslerio autumnalis-Fagetum*, še posebej v bistveno večjem deležu diagnostičnih vrst zvez *Aremonio-Fagion* in *Tilio-Acerion*, reda *Fagetalia sylvaticae* in razreda *Querco-Fagetea* in v bistveno manjšem deležu vrst reda *Quercetalia pubescenti-petraeae* in razredov *Rhamno-Prunetea* in *Trifolio-Geranietea*. Prirejena sintezna preglednica in njena obdelava (preglednici 2 in 4, drevesne in grmovne vrste so upoštevane le v eni plasti) pa kažeta, da je v sestojih asociacije *Lamio orvalae-Fagetum* v jugozahodni Sloveniji očitno večji delež vrst zveze *Tilio-Acerion* in razredov *Asplenietea trichomanis* ter *Thlaspietea rotundifolii* in manjši delež vrst zveze *Erythronio-Carpinion* in reda *Quercetalia pubescenti-petraeae* kot v sestojih preučevanega bukovja v dolini Raše. Te ugotovitve ne podpirajo uvrstitve preučenih sestojev v asociacijo *Lamio orvalae-Fagetum*.

Med sestoji v dolini Raše in sestoji sintaksona *Fagetum submontanum* var. geogr. *Sesleria autumnalis* z Vremščice in Ravnika so precejšnje ekološke in floristične razlike. Pri slednjih je drugačna že nadmorska višina, od 500 m do 700 m, v njih ni popisana ena od značilnic asociacije *Hacquetio-Fagetum*, vrsta *Hacquetia epipactis*, naših popisov tudi ne moremo uvrstiti v nobeno od subasociacij, ki jih navaja Accetto (1989): *hieracietosum sylvaticae*, *galietosum odorati*, *festucetosum carniolicae*, *mercurialietosum perennis, dryopteridetosum assimilis*. Zato preučene mezofilne bukove sestoje v dolini Raše uvrščamo v novo subasociacijo *Hacquetio-Fagetum lamietosum orvalae* subass. nova hoc loco. Razlikovalnice nove subasociacije so vrste *Lamium orvala, Galeobdolon flavidum, Aconitum lycoctonum, Scilla bifolia, Corydalis cava* in *Gagea lutea*. Naštete vrste označujejo skalnata

rastišča z dovolj talne vlage, ki so sicer bolj značilna za sestoje asociacije *Lamio orvalae-Fagetum*. Med razlikovalnimi vrstami nove subasociacije je tudi vrsta *Aconitum lycoctonum*, po kateri je Accetto (2015) imenoval subasociacijo *Hacquetio-Fagetum aconitetosum lycoctoni*, vendar je celotna vrstna sestava in tudi ekologija te subasociacije očitno različna od vrstne sestave in ekologije preučene združbe. Nomenklaturni tip nove subasociacije, *holotypus* hoc loco, je popis št. 26 v preglednici 1. Znotraj nove subasociacije razlikujemo še varianto z vrsto *Ostrya carpinifolia* na nekoliko bolj sušnih rastiščih s plitvejšimi tlemi, prevladujočo rendzino.

V fitogeografskem smislu sestoje asociacije *Hacquetio-Fagetum* na severovzhodnem robu Krasa uvrščamo v novo geografsko subvarianto *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Helleborus istriacus*, subvar. geogr. nova. Njeni razlikovalnici sta taksona *Helleborus odorus* subsp. *istriacus* in *Acer obtusatum*, ki se v drugih do sedaj opisanih geografskih (sub) variantah asociacije *Hacquetio-Fagetum* ne pojavljata skupaj. Podgorska bukova združba v dolini Raše se torej tudi v fitogeografskem smislu razlikuje od podgorske bukove združbe pod Vremščico in na planoti Ravnik (to bi lahko obravnavali kot novo geografsko subvarianto *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Calamintha grandiflora*). Uspeva na nižji nadmorski višini, v toplejšem podnebju in označujejo geografsko različico asociacije *Hacquetio-Fagetum* na Krasu. V tej pokrajini do zdaj sestojev te asociacije nismo poznali, pač pa le sestoje asociacije *Ornithogalo pyrenaici-Fagetum* (Dakskobler 2006). Košir (2010: 85) sicer zelo kratko omenja podgorsko bukovje s tevjem in bodečo lobodiko *Hacqetio-Fagetum* var. asoc. *Ruscus aculetaus* v litoralnem delu Visokega Krasa, a njegov opis se ne nanaša na bukovo združbo matičnega Krasa.

5.4 Zaključki

Ohranjeni bukovi gozdovi na Krasu so precejšnja redkost. Do zdaj smo poznali le sestoje asociacij *Seslerio autumnalis-Fagetum* in *Ornithogalo pyrenaici-Fagetum*. Sestoje prve smo že pred leti opisali tudi na severovzhodnem robu Krasa, na osojnih pobočjih nad dolino Raše. Tam pa smo popisali tudi sestoje, ki jih po celotni vrstni sestavi lahko uvrstimo v novo subasociacijo *Hacquetio-Fagetum lamietosum orvalae* (ta nakazuje določeno podobnost s sestoji asociacije *Lamio orvalae-Fagetum*, ni pa floristične podlage, da bi jih tudi uvrstili v to asociacijo) in v novo geografsko subvarianto *Hacquetio-Fagetum* var geogr. *Sesleria autumnalis* subvar. geog. *Helleborus istriacus*. Dovolj dobro se razlikujejo ne samo od njim stičnih sestojev asociacije *Seslerio autumnalis-Fagetum,* temveč tudi od podgorskih bukovih gozdov pod Vremščico in na planoti Ravnik, na obrobju Krasa proti Pivški kotlini in Brkinom, ki jo poznamo z imeni *Fagetum submontanum* var. geogr. *Sesleria autumnalis* oz. *Hacquetio-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Calamintha grandiflora*. So gospodarski gozdovi s poudarjeno varovalno vlogo, precej odmaknjeni od voznih poti in sodijo v gozdni rastiščni tip Podgorsko primorsko bukovje na karbonatih (Kutnar et al. 2012). Poudarjena je tudi njihova biotopska vloga, saj sodijo v Natura 2000 habitatni tip: Ilirski bukovi gozdovi (*Aremonio-Fagion*) in so rastišče nekaterih v Sloveniji zavarovanih taksonov (Anon. 2004): *Cephalanthera longifolia*, *C. damasonium, Convallaria majalis, Cyclamen purpurascens, Erythronium dens-canis*, *Galanthus nivalis, Helleborus odorus* subsp. *istriacus, Lilium martagon, Listera ovata, Neottia nidus-avis.* Floristična posebnost bukovih gozdov v dolini Raše so tudi nekateri drugi na Krasu redki taksoni, kot so *Laburnum alpinum, Lathyrus occidentalis* var. *montanus*, *Phyteuma spicatum* subsp. *coeruleum, Veratrum nigrum, Valeriana tripteris, Lonicera alpigena, Tephroseris pesudocrispa* in *Anemone x pittonii*, ki kažejo na bližino Vipavske doline in visokokraških planot Trnovskega gozda in Nanosa. Bukove gozdove v dolini Raše ogrožajo podnebne spremembe in premočne sečnje. Njihova posledica je lahko regresija v sestoje gradna in črnega gabra.

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Figure 4: Stand of the association Seslerio autumnalis-Fagetum in the Raša Valley (early spring aspect)
Slika 4: Sestoj asociacije Seslerio autumnalis-Fagetum v dolini Raše (zgodnji spomladanski videz)

Figure 5: Stand of the association Hacquetio-Fagetum in the Raša Valley (early spring aspect)
Slika 5: Sestoj asociacije Hacquetio-Fagetum v dolini Raše (zgodnji spomladanski videz)

Figure 6: Scilla bifolia, one of the differential species of the subassociation Hacquetio-Fagetum lamietosum orvalae
Slika 6: Dvolistna morska čebulica (Scilla bifolia), ena izmed razlikovalnic subasociacije Hacquetio-Fagetum lamietosum orvala

Figure 7: Helleborus odorus subsp. istriacus, geographical differential species of the association Hacquetio-Fagetum in the Raša Valley
Slika 7: Istrski teloh (Helleborus odorus subsp. istriacus), geografska razlikovalnica asociacije Hacquetio-Fagetum v dolini Raše

Table 3: Groups of dignostic species in the beech forests of the Raša Valley (relative frequencies)
Preglednica 3: Skupine diagnostičnih vrst v bukovih gozdovih v dolini Raše (relativne frekvence)

Successive number (Zaporedna številka)	1	2
Sign for syntaxa (Oznaka združb)	SF	HF
Number of relevés (Število popisov)	13	18
Aremonio-Fagion	2,9	6,1
Erythronio-Carpinion	3,3	4,8
Tilio-Acerion	3,2	9,6
Fagetalia sylvaticae	26,8	36,5
Quercetalia pubescenti-petraeae	27,5	12,8
Quercetalia roboris	1,3	0
Quereco-Fagetea	12,8	17,0
Vaccinio-Piceetea	1,6	0,4
Rhamno-Prunetea	3,0	0,6
Epilobietea angustifolii	0,2	0
Trifolio-Geranietea, Festuco-Brometea	5,2	0,7
Mulgedio-Aconitetea	2,2	1,6
Asplenietea trichomanis, Thlaspietea rotundifolii	1,3	1,5
Mosses and lichens (Mahovi in lišaji)	8,7	8,4
Total (Skupaj)	100	100

Legend - Legenda
SF *Seslerio autumnalis-Fagetum*
HF *Hacquetio-Fagetum*

Table 1: *Fagus sylvatica* communities in the Raša Valley
Preglednica 1: Bukove združbe v dolini Raše

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Database number of relevé (Številka popisa v podatkovni bazi)		273025	251301	235185	232043	232044	232046	232045	232048	232050	232051	232052	232053	232049	251299	251303	273027
Elevation in m (Nadmorska višina v m)		335	285	220	420	410	410	425	400	360	430	380	440	410	285	270	340
Aspect (Lega)		0	NE	NE	NNW	N	N	NW	NNW	N	NE	N	NNE	N	NNW	N	NE
Slope in degrees (Nagib v stopinjah)		0	25	25	25	30	25	30	30	20	25	30	30	30	25	30	30
Parent material (Matična podlaga)		Pr	A	A	A	A,L	A	AR	A	A	A	A	A	A	A	A	A
Soil (Tla)		Re	Cc	Re	Cc	Re	Re	Re	Cc	Cc	Re	Re	Re	Re	Cc	Cc	Cc
Stoniness in % (Kamnitost v %)		5	10	10	10	20	35	30	30	20	30	35	30	40	10	20	70
Cover in % (Zastiranje v %):																	
Upper tree layer (Zgornja drevesna plast)	E3b	80	80	80	90	80	90	80	90	90	90	80	80	80	70	70	30
Lower tree layer (Spodnja drevesna plast)	E3a	20	10	10	10	20	10	20	10	10	10	20	10	10	30	20	
Shrub layer (Grmovna plast)	E2	20	20	20	15	30	20	15	20	10	20	30	40	20	30	20	30
Herb layer (Zeliščna plast)	E1	60	80	70	80	60	70	70	70	70	70	70	60	70	80	70	70
Moss layer (Mahovna plast)	E0	2	10	10	10	5	10	10	5	10	10	10	10	10	10	5	10
Maximum diameter of trees (Največji prsni premer dreves)	cm	50	30	45	40	40	35	45	35	35	35	19	40	35	35	40	30
Maximum height of trees (Največja drevesna višina)	m	22	16	24	19	20	18	20	18	20	18	19	20	18	18	20	18
Number of species (Število vrst)		69	38	75	69	63	52	64	47	44	47	47	49	50	77	68	60
Relevé area (Velikost popisne ploskve)	m^2	400	400	400	200	200	200	200	200	200	200	200	200	200	400	400	400
Date of relevé (Datum popisa)		6/17/1997	4/15/2013	4/6/2010	4/19/1996	4/19/1996	5/14/1996	5/14/1996	10/24/1995	5/14/1996	5/14/1996	5/14/1996	5/14/1996	5/14/1996	4/15/2013	4/18/2013	8/20/1996
Locality (Nahajališče)		Raša-Gorenja Raša	Raša - Dolenja Raša	Raša-Avberska reber	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Griški potok	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Dolenja Raša	Raša-Gorupi	Raša-Gorenja Raša
Quadrant (Kvadrant)		0249/4	0249/2	0249/1	0249/4	0249/4	0249/4	0249/4	0249/2	0249/4	0249/4	0249/4	0249/4	0249/4	0249/2	0249/2	0249/4
Coordinate GK Y (D-48)	m	418768	416640	413691	420895	420422	419800	420123	418262	419167	419326	419559	419549	419905	416530	416301	418565
Coordinate GK X (D-48)	m	5067429	5069534	5072632	5067326	5067086	5066850	5066888	5068212	5067128	5066966	5066889	5066814	5066821	5069833	5069800	5067566
Diagnostic species of the association *Seslerio autumnalis-Fagetum* (Diagnostične vrste asociacije)																	
QP *Sesleria autumnalis*	E1	+	4	3	4	3	3	3	3	4	3	3	3	3	4	4	3
QP *Lathyrus venetus*	E1	1	.	+	.	.	.	r	+	+	.	.	.	.	.	.	+
Diagnostic species of the association *Hacquetio-Fagetum* (Diagnostične vrste asociacije)																	
AF *Hacquetia epipactis*	E1	1	.	1	1	+	+	.	1	.	.	.	.	.	2	+	+
FS *Asarum europaeum subsp. caucasicum*	E1	1	.	+	+	+	1	+	+	+	.	1	.	1	+	+	.
FS *Aposeris foetida*	E1	1	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.
EC *Primula vulgaris*	E1	1	+	1	+	+	.	+	1	+	.	.	.	.	1	1	+
Differential species of the geographical variant (Razlikovalnice geografske variante)																	
EC *Helleborus odorus subsp. istriacus*	E1	1	1	1	1	1	1	1	1	1	+	1	.	.	2	1	1
CO *Acer obtusatum*	E3b	.	+	.	1	+	1	1	+	+	.	+	+	1	.	+	.
CO *Acer obtusatum*	E3a	.	.	.	+	+	+	+	.	.	.	+	.	+	+	.	.
CO *Acer obtusatum*	E2b	.	.	.	+	.	1	+	+	.	+	1	1	1	.	+	r
CO *Acer obtusatum*	E2a	+	.	+	1	+	.	+	+	+	1	1	2	1	+	1	1
CO *Acer obtusatum*	E1	.	.	.	1	1	1	1	1	1	1	1	1	1	+	1	.

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34						
232047	273026	273023	273022	273024	273028	273029	273030	242613	246090	242614	246088	251351	246089	242615	268726	268727	268728						
500	415	420	420	425	360	450	450	460	445	450	460	440	450	445	530	545	530						
NNW	N	NW	NW	NW	N	NW	N	SW	NW	NE	NNW	E	NW	E	NW	NW	NNW						
30	35	25	30	25	30	30	25	25	25	15	30	30	30	1	25	25	25						
A	A	ALR	A	A	A	A	A	A	AF	A	AF	A	AF	A	A	AL	AL						
Re	Re	Cc	Re	Cc	Re	Re	Re	Cc	Cc	Cc	Cc	Cc	Cc	Cc	Cc	Cc	Cc						
30	30	10	20	10	60	40	40	20	20	20	30	5	10	0	20	30	70						
90	80	80	90	90	90	90	90	80	90	70	90	90	80	90	80	90	90						
10	20	20	5	20		10	5	5	10	20	10	5	10	5	10	10	10						
10	10	10	15	10	1	5	5	30	5	30	10	10	5	20	10	5	5						
70	40	40	60	40	60	5	70	80	70	80	70	70	60	70	60	50	60						
5	10	5	5	5	10	65	5	10	20	20	10	5	10	5	5	10	30						
45	35	55	45	35	40	50	45	60	40	35	40	40	40	40	35	40	40						
22	20	22	20	20	22	22	22	28	25	20	25	22	25	24	26	25	24						
42	55	46	56	49	41	32	43	48	75	41	55	65	48	59	40	33	49						
200	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400						
8/20/1996	6/18/1997	5/14/1996	4/19/1996	4/19/1996	5/14/1996	4/19/1996	4/19/1996	6/4/2013	3/22/2012	6/4/2013	3/22/2012	6/4/2013	3/22/2012	3/22/2012	5/22/2017	5/22/2017	5/22/2017						
Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša-Gorenja Raša	Raša -Ločnik	Raša-Ločnik	Raša-Ločnik	Raša-Osarsko	Raša-Ločnik	Raša-Ločnik	Raša-Osarsko	Griški potok-Bukovje	Griški potok-Bukovje	Griški potok-Bukovje						
0249/4	0249/4	0249/4	0249/4	0249/4	0249/4	0249/4	0249/4	0249/2	0249/2	0249/2	0250/1	0249/4	0249/2	0249/2	0249/2	0249/2	0249/2						
421472	420377	420247	421135	420872	419204	421435	421300	421830	421713	421917	422245	421676	421683	421983	419737	419821	419839						
5067412	5067042	5066966	5067437	5067288	5067120	5067467	5067437	5068053	5067920	5068196	5068368	5067768	5067877	5068221	5069392	5069408	5069477						
																		Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
3	2	1	2	1	+	+	+	+	1	4	1	2	1	1	1	1	+	13	100	18	100	34	100
.	+	+	1	1	1	+	1	1	1	2	1	1	+	1	1	+	1	4	31	17	94	23	68
1	+	1	+	1	.	.	.	1	1	1	1	2	2	1	1	1	1	7	54	15	83	24	71
+	1	1	1	.	1	+	.	1	1	1	1	1	1	.	+	+	.	10	77	14	78	26	76
.	+	.	+	+	.	.	.	1	.	1	1	1	+	2	1	1	+	3	23	12	67	16	47
.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	8	62	4	22	15	44
1	+	1	1	1	+	.	.	+	1	1	+	+	1	1	+	+	.	11	85	15	83	29	85
+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	77	2	11	13	38
+	.	+	.	.	r	.	.	.	r	.	.	.	r	.	.	.	+	7	54	6	33	13	38
.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	77	1	6	11	32
.	r	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	12	92	2	11	16	47
r	+	+	+	+	+	.	+	.	.	.	.	r	.	.	+	+	+	12	92	11	61	23	68

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Differential species of tha subassociation (Razlikovalnice subasociacije)																	
AF	*Lamium orvala*	E1	+	.	.	.	.	r	.	.	.	.	.	.	.	.	+	.
FS	*Galeobdolon flavidum*	E1	+	.	.	.	+	+	+	+	.	.	+	.	1	.	+	.
QF	*Scilla bifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MuA	*Aconitum lycoctonum*	E1	+	.	.	+	+	+	+	.	.	+	+	+	.	.	.	.
FS	*Corydalis cava*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
QF	*Gagea lutea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AF	***Aremonio-Fagion***																	
	Cyclamen purpurascens	E1	+	1	1	1	1	+	+	1	1	1	1	1	1	1	.	+
	Cardamine enneaphyllos	E1	1	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.
	Knautia drymeia	E1	.	.	.	r	.	.	.	1	.	.	.	.	.	+	+	.
	Anemone x pittonii	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Geranium nodosum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EC	***Erythronio-Carpinion***																	
	Galanthus nivalis	E1	1	.	1	+	1	.	+	+	.	.	.	.	+	.	.	.
	Erythronium dens-canis	E1	.	.	.	1	1	1	1	.	.	.	.	+	.	.	.	.
	Isopyrum thalictroides	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	r	.	.
	Lonicera caprifolium	E2a	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Crocus vernus subsp. vernus	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Helleborus odorus	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
AI	***Alnion incanae***																	
SP	*Populus nigra*	E3b	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Frangula alnus	E2a	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
MA	*Angelica sylvestris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
TA	***Tilio-Acerion***																	
	Acer pseudoplatanus	E3b	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.
	Acer pseudoplatanus	E3a	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	Acer pseudoplatanus	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acer pseudoplatanus	E2a	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
	Acer pseudoplatanus	E1	.	.	+	+	+	+	1	+	.	.	.	.	.	.	.	.
	Ulmus glabra	E3b	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Ulmus glabra	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ulmus glabra	E2b	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Ulmus glabra	E2a	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ulmus glabra	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Acer platanoides	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acer platanoides	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acer platanoides	E2b	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Acer platanoides	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Tilia platyphyllos	E3b	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.
	Tilia platyphyllos	E3a	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
	Tilia platyphyllos	E2b	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	Tilia platyphyllos	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Tilia platyphyllos	E1	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
	Juglans regia	E2a	+	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.
	Juglans regia	E3b	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.
	Juglans regia	E2b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Aruncus dioicus	E1	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	.
	Thalictrum aquilegiifolium	E1	r	.	.	.	.	.	.	.	.	.	r	.	.	+	+	.
	Adoxa moschatellina	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Geranium robertianum	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Tephroseris pseudocrispa	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
	Corydalis solida	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Phyllitis scolopendrium	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Polystichum aculeatum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FS	***Fagetalia sylvaticae***																	
	Fagus sylvatica	E3b	2	1	2	3	4	3	4	4	5	5	4	4	3	4	4	2
	Fagus sylvatica	E3a	.	.	.	1	1	1	+	.	1	.	.	+	+	+	+	+
	Fagus sylvatica	E2b	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
	Fagus sylvatica	E2b	+	.	.	1	2	1	.	+	1	.	1	1	1	1	+	+
	Fagus sylvatica	E2a	+	.	1	+	+	.	.	+	.	.	+	.	.	1	+	.

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
.	1	+	1	1	1	1	1	3	2	+	1	+	1	2	1	+	2	2	15	17	94	20	59
+	1	+	+	.	+	+	+	+	1	+	+	.	+	.	.	+	1	7	54	14	78	22	65
.	.	+	+	1	+	1	1	+	2	+	1	+	1	1	+	+	+	0	0	16	89	16	47
+	+	+	.	+	.	+	+	.	+	+	3	3	.	.	.	.	.	7	54	10	56	18	53
.	.	.	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	0	0	6	33	6	18
.	.	.	+	+	.	1	1	.	1	.	.	.	.	+	.	.	.	0	0	6	33	6	18
1	+	+	1	1	+	1	1	.	1	+	1	+	1	+	.	.	.	12	92	14	78	29	85
+	1	+	+	.	2	3	2	2	2	.	1	2	+	1	+	.	.	1	8	14	78	17	50
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	0	0	1	6	1	3
.	.	+	1	1	2	1	1	1	1	1	2	1	+	1	+	1	1	5	38	16	89	23	68
+	.	1	+	1	.	+	+	+	.	1	1	+	2	1	.	.	.	5	38	12	67	17	50
.	.	+	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	8	2	11	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
+	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	+	+	3	23	7	39	11	32
.	.	+	.	.	.	+	+	+	.	.	.	r	r	.	.	.	+	1	8	7	39	8	24
.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	0	0	3	17	3	9
.	.	.	.	.	.	.	.	2	1	1	.	.	+	.	.	.	.	1	8	4	22	6	18
1	+	1	+	+	.	+	+	1	1	1	+	.	1	.	+	1	1	5	38	15	83	21	62
.	.	.	.	+	.	+	+	.	+	.	.	.	.	.	.	.	r	1	8	5	28	6	18
r	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	0	0	4	22	4	12
.	.	+	+	+	.	.	.	+	+	.	.	+	.	.	.	.	.	1	8	6	33	7	21
.	.	.	+	.	.	.	.	+	+	.	.	+	.	.	.	.	.	0	0	4	22	5	15
+	.	.	.	.	.	+	+	.	+	.	.	.	.	+	+	+	+	1	8	8	44	9	26
r	.	r	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	0	0	4	22	4	12
.	.	.	.	.	.	r	.	.	.	.	.	+	.	.	.	.	.	0	0	2	11	2	6
.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	8	1	6	2	6
+	.	+	.	.	.	+	+	+	+	.	.	+	+	.	.	.	.	1	8	8	44	9	26
.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	1	8	2	11	4	12
.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1	8	2	11	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	0	0
.	.	.	r	.	.	.	+	.	+	.	.	.	.	.	.	.	.	2	15	3	17	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	3	23	2	11	6	18
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
+	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	.	2	15	4	22	6	18
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	4	12
.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0	0	2	11	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	0	0	1	6	1	3
5	5	4	4	4	5	5	4	5	4	4	5	5	5	3	5	5	5	13	100	18	100	34	100
1	1	2	1	1	+	1	1	+	.	.	+	+	+	+	+	.	1	10	77	15	83	25	74
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
1	1	1	1	1	.	1	1	+	+	1	+	+	.	1	.	+	+	11	85	15	83	27	79
.	.	.	.	.	.	.	.	2	.	1	.	+	+	2	1	+	+	6	46	8	44	16	47

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Fagus sylvatica	E1	+	.	.	+	+	.	+	.	+	+	.	.	+	.	+	.
	Lathyrus vernus	E1	+	.	+	+	+	1	1	1	1	1	1	1	1	1	1	+
	Lilium martagon	E1	+	.	.	1	1	1	+	1	+	+	1	1	1	.	.	.
	Galium laevigatum	E1	.	.	1	+	+	1	+	1	1	+	1	1	1	1	+	+
	Mercurialis perennis	E1	+	.	+	+	+	+	1	+	+	.	1	+	+	+	.	+
	Symphytum tuberosum	E1	+	.	.	+	+	+	+	+	+	.	.	.	+	.	+	.
	Heracleum sphondylium	E1	+	.	+	+	+	1	+	+	+	1	+	1	1	1	+	.
	Euphorbia dulcis	E1	+	.	+	+	+	+	.	+	+	+	.	+	+	1	+	.
	Polygonatum multiflorum	E1	.	.	+	+	1	+	+	.	.	.	.	.	+	1	.	.
	Prenanthes purpurea	E1	.	.	.	1	1	1	1	1	.	1	1	1	1	.	.	.
	Viola reichenbachiana	E1	+	.	+	+	+	+	+	+	.	.	.	.	.	+	.	+
	Dryopteris filix-mas	E1	.	.	.	r	.	.	+	.	.	.	.	.	+	+	.	.
	Daphne mezereum	E2a	.	.	1	+	+	+	.	.	.	+	+	+	+	+	.	+
	Carpinus betulus	E3b	2	.	2	.	.	.	.	.	.	.	.	.	.	1	.	.
	Carpinus betulus	E3a	1	1	.	.	.	.	+	+	.	.	.	.	.	+	+	+
	Carpinus betulus	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Carpinus betulus	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Pulmonaria officinalis	E1	+	r	+	.	r	.	+	.	.	.	.	r	.	1	+	.
	Salvia glutinosa	E1	.	+	+	+	.	+	.	+	.	+	+	+	+	+	+	+
	Campanula trachelium	E1	+	.	+	.	+	.	+	.	.	.	.	.	.	+	.	+
	Actaea spicata	E1	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.
	Cardamine bulbifera	E1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Euphorbia amygdaloides	E1	+	.	.	+	+	1	1	.	.	.	.	.	.	.	.	.
	Laburnum alpinum	E3a	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.
	Laburnum alpinum	E2b	.	.	.	+	.	.	.	.	.	+	+	r	r	.	.	.
	Laburnum alpinum	E2a	.	.	.	.	.	+	.	.	.	+	+	+	.	.	.	.
	Laburnum alpinum	E1	.	.	.	.	r	+	.	.	.	+	+	+	.	.	.	.
	Melica nutans	E1	+	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.
	Sanicula europaea	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Neottia nidus-avis	E1	+	.	.	.	r	.	+	.	.	.	.	.	.	.	.	.
	Phyteuma spicatum subsp. coeruleum	E1	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
	Cephalanthera damasonium	E1	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	+
	Mycelis muralis	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	Sambucus nigra	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sambucus nigra	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Galeobdolon montanum	E1	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.
	Galium odoratum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus avium	E3b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus avium	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus avium	E2a	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus avium	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Allium ursinum	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Brachypodium sylvaticum	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carex sylvatica	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lonicera alpigena	E2a	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
QP	***Quercetalia pubescenti-petraeae***																	
	Fraxinus ornus	E3b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Fraxinus ornus	E3a	1	1	1	+	+	+	+	+	+	1	1	1	1	1	1	+
	Fraxinus ornus	E2b	.	1	.	1	+	1	+	1	+	1	1	+	1	2	1	1
	Fraxinus ornus	E2a	.	.	.	.	.	.	+	1	+	+	1	.	+	1	1	1
	Fraxinus ornus	E1	+	.	.	+	.	.	.	1	+	.	.	.	.	.	.	+
	Ostrya carpinifolia	E3b	.	1	1	.	.	1	+	1	+	.	.	.	2	.	1	.
	Ostrya carpinifolia	E3a	.	1	1	+	+	.	+	.	+	+	+	1	1	1	1	1
	Ostrya carpinifolia	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Tanacetum corymbosum	E1	+	.	.	+	+	+	+	+	1	1	1	+	+	+	+	+
	Melittis melissophyllum	E1	.	.	+	+	+	1	1	1	1	1	1	1	1	1	1	1
	Convallaria majalis	E1	.	.	.	1	1	1	+	+	1	1	1	1	+	+	.	.
	Cornus mas	E2b	+	+	1	+	+	.	+	.	.	.	r	.	+	1	.	1
	Cornus mas	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
	Quercus cerris	E3b	.	2	2	.	r	r	+	+	.	.	r	.	.	1	.	r
	Quercus cerris	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
	Sorbus aria (Aria edulis)	E3b	.	+	+	.	.	+	.	1	+	.	.	.	.	+	1	+

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
+	.	.	.	.	+	.	+	1	+	.	.	.	+	1	1	.	.	7	54	8	44	16	47
1	1	1	+	+	+	+	+	+	.	.	+	1	+	+	+	.	+	13	100	15	83	30	88
1	+	1	+	+	+	1	+	1	1	+	1	+	+	+	+	+	1	10	77	18	100	29	85
+	+	+	+	.	.	.	+	+	.	+	+	+	+	+	+	.	+	13	100	13	72	27	79
+	1	1	+	1	.	+	.	1	1	1	1	+	.	.	+	+	+	11	85	14	78	27	79
.	+	+	1	1	+	+	.	1	1	+	+	+	+	1	+	+	+	8	62	16	89	25	74
+	+	+	.	.	+	.	+	.	+	.	+	+	.	+	.	.	+	12	92	10	56	24	71
+	+	.	+	+	.	.	.	.	+	+	+	+	.	+	.	.	+	10	77	10	56	22	65
+	+	+	1	1	.	+	1	+	+	1	1	+	+	1	.	.	+	6	46	15	83	22	65
1	1	.	.	.	.	+	.	1	+	+	1	1	1	+	1	1	1	9	69	13	72	22	65
+	+	+	1	+	+	.	+	+	+	.	+	.	+	+	.	.	+	7	54	13	72	22	65
+	+	+	+	.	+	+	+	+	1	+	+	1	+	+	+	+	+	4	31	17	94	21	62
+	+	.	+	+	.	+	.	.	+	.	+	+	+	.	.	.	.	9	69	9	50	19	56
.	.	.	+	+	.	.	+	+	2	1	.	r	.	3	.	.	.	1	8	8	44	11	32
.	.	.	+	1	+	.	.	.	1	+	+	+	r	1	.	.	+	5	38	10	56	17	50
.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	2	11	3	9
.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	+	.	.	+	.	.	.	.	+	+	+	+	+	1	.	.	+	5	38	9	50	17	50
.	+	.	+	.	+	.	.	.	.	.	.	.	.	+	.	.	+	10	77	5	28	17	50
+	+	.	+	+	+	.	+	.	+	.	.	.	.	+	.	.	.	4	31	8	44	14	41
.	+	.	.	.	.	+	+	+	+	.	+	+	+	+	.	.	1	2	15	10	56	12	35
.	+	.	.	2	.	1	1	1	+	.	.	.	.	1	.	.	.	0	0	7	39	8	24
+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	2	11	7	21
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	38	0	0	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	4	12
+	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	5	38	2	11	7	21
.	+	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	3	17	7	21
.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	+	+	0	0	5	28	6	18
.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	15	2	11	5	15
.	1	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	2	15	3	17	5	15
.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	3	23	1	6	4	12
.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	8	3	17	4	12
.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	r	.	.	.	.	.	.	+	+	.	r	.	.	.	.	.	.	0	0	4	22	4	12
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	8	1	6	3	9
.	.	.	.	.	.	.	+	2	+	.	.	.	.	.	.	.	.	0	0	3	17	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	r	0	0	2	11	3	9
.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	0	0	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	0	0	2	11	3	9
.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	0	0	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	1	6	2	6
.	.	+	+	+	+	.	.	.	r	.	.	.	r	.	.	.	.	13	100	6	33	22	65
.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	13	100	2	11	16	47
.	.	+	.	.	.	.	.	1	.	+	.	+	r	+	+	.	.	9	69	7	39	16	47
+	.	.	.	.	+	.	+	.	+	.	.	.	+	.	+	1	+	4	31	8	44	13	38
.	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	4	22	12	35
r	1	1	+	+	r	+	1	.	.	.	.	.	.	.	.	.	+	11	85	9	50	22	65
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	+	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.	+	13	100	8	44	22	65
+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	13	100	3	17	17	50
+	+	+	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	11	85	4	22	15	44
.	+	.	+	+	r	.	+	.	.	+	+	.	.	.	.	.	.	7	54	7	39	17	50
.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	3	23	1	6	4	12
.	.	.	.	+	.	.	.	.	r	.	.	.	r	.	.	.	.	7	54	3	17	12	35
+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	8	3	17	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	0	0	8	24

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Sorbus aria	E3a	.	.	.	+	.	.	+	+	.	+	+	+	.	.	1	.
	Sorbus aria	E2b	.	.	.	+	+	.	+	.	.	.	.	.	+	1	+	.
	Sorbus aria	E2a	.	.	.	.	.	+	.	+	.	.	.	.	.	+	1	+
	Sorbus aria	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
	Asparagus tenuifolius	E1	.	.	+	+	.	.	+	.	.	+	+	.	+	+	.	.
	Euonymus verrucosa	E2b	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.
	Euonymus verrucosa	E2a	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.	+
	Cnidium silaifolium	E1	.	.	+	r	.	.	.	.	.	.	.	.	.	+	+	+
	Mercurialis ovata	E1	.	r	+	.	.	.	.	.	.	+	.	.	.	.	+	.
	Cotinus coggygria	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
	Cotinus coggygria	E2a	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	1
	Tamus communis	E1	+	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.
	Orchis purpurea	E1	.	r	+	.	.	.	.	.	.	.	.	.	.	+	.	.
	Acer monspessulanum	E3b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+
	Acer monspessulanum	E3a	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
	Acer monspessulanum	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
	Asparagus acutifolius	E1	.	r	+	.	.	.	.	.	.	.	.	.	.	+	.	.
	Ruscus aculeatus	E2a	.	+	2	.	.	.	.	.	.	.	.	.	.	+	.	.
	Peucedanum austriacum	E1	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.
	Arabis turrita	E1	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
	Clematis recta	E1	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
	Calamintha sylvatica	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Mercurialis x paxii	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Paeonia mascula	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
	Lathyrus niger	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Quercus pubescens	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r
	Sorbus austriaca s.lat.	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r
QR	***Quercetalia roboris***																	
	Serratula tinctoria	E1	.	.	.	+	+	.	.	.	.	+	+	+	.	+	1	+
	Hieracium racemosum	E1	.	.	.	.	.	.	r	.	r	.	.	.	.	.	+	.
	Castanea sativa	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.
	Castanea sativa	E2a	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
QF	***Quereco-Fagetea***																	
	Anemone nemorosa	E1	1	+	1	+	+	+	.	+	.	.	.	.	.	1	+	+
	Carex digitata	E1	+	+	1	+	+	+	+	+	1	+	1	+	+	+	+	+
	Hepatica nobilis	E1	1	1	1	1	+	.	1	1	1	1	1	+	1	1	2	1
	Quercus petraea	E3b	1	3	.	2	2	2	+	1	+	+	2	+	+	+	.	3
	Quercus petraea	E3a	.	.	.	1	+	+	+	+	.	.	.	.	.	+	+	1
	Quercus petraea	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Quercus petraea	E1	.	.	.	+	+	.	+	.	.	.	.	.	+	.	.	+
	Lonicera xylosteum	E2a	.	.	+	+	+	.	+	.	+	+	+	+	.	.	.	.
	Hedera helix	E3a	.	+	1	.	.	.	.	.	.	.	.	.	.	+	+	+
	Hedera helix	E1	+	1	1	.	.	.	.	+	.	.	.	.	.	+	1	.
	Aegopodium podagraria	E1	1	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.
	Corylus avellana	E3a	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Corylus avellana	E2b	1	+	1	+	.	.	.	+	.	.	.	.	.	+	+	+
	Corylus avellana	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Acer campestre	E3b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acer campestre	E3a	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.
	Acer campestre	E2b	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Acer campestre	E2a	.	.	1	.	.	.	.	.	.	.	.	.	.	+	+	.
	Acer campestre	E1	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
	Crataegus laevigata	E2b	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+
	Crataegus laevigata	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
	Veratrum nigrum	E1	+	.	.	+	+	+	+	.	.	.	.	+	1	.	.	.
	Clematis vitalba	E2b	.	.	.	.	+	.	.	+	.	r	+	r	+	.	.	.
	Clematis vitalba	E2a	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Clematis vitalba	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
	Cephalanthera longifolia	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Listera ovata	E1	.	.	r	.	.	.	.	.	.	+	+	+	.	.	.	.
	Rosa arvensis	E2a	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Anemone ranunculoides	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	7	54	1	6	8	24
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	0	0	6	18
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	38	0	0	5	15
.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	0	0	7	21
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	3	9
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	1	6	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	5	15
.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	15	1	6	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	2	6
.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2	15	1	6	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	62	0	0	8	24
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
+	.	+	+	+	.	+	+	1	1	1	2	1	2	2	+	1	1	7	54	16	89	26	76
+	+	+	+	+	.	.	.	+	.	.	.	+	+	+	.	.	.	13	100	9	50	25	74
+	.	.	.	.	.	.	.	1	1	2	1	1	1	1	+	.	+	12	92	10	56	25	74
.	r	+	+	2	.	.	.	.	r	+	.	r	r	+	+	+	.	12	92	11	61	25	74
.	.	.	+	+	r	.	.	.	.	.	.	.	.	.	.	.	.	8	62	3	17	11	32
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	5	38	2	11	7	21
.	.	.	+	+	.	.	.	+	+	1	+	.	r	1	.	.	.	7	54	8	44	16	47
.	.	.	.	.	.	.	.	.	+	.	.	.	r	.	.	.	.	3	23	2	11	7	21
.	.	.	.	.	.	.	.	+	+	+	+	+	.	+	+	+	+	3	23	9	50	15	44
.	+	+	+	.	+	.	.	+	+	.	1	+	+	1	.	.	.	3	23	10	56	14	41
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	+	+	+	.	+	.	.	.	.	.	r	.	.	+	.	.	.	5	38	6	33	14	41
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	+	+	.	.	.	.	.	.	r	.	.	.	.	.	0	0	3	17	4	12
.	.	.	.	1	.	.	.	.	+	.	.	.	r	.	.	.	.	1	8	3	17	5	15
.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	0	0	2	11	3	9
.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	2	15	3	17	6	18
.	.	.	+	+	+	.	.	.	+	+	.	+	.	+	.	.	+	2	15	8	44	11	32
.	.	.	.	1	.	.	+	.	+	1	.	+	.	.	+	.	.	2	15	6	33	10	29
.	.	.	+	.	.	.	.	.	+	1	.	.	.	1	.	.	.	1	8	4	22	5	15
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	1	6	8	24
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	46	0	0	6	18
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	3	23	3	17	6	18
.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	+	.	.	0	0	4	22	5	15
.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	3	23	1	6	5	15
.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	.	.	0	0	4	22	5	15
.	.	.	1	.	.	.	1	+	1	.	.	.	.	.	.	.	.	0	0	4	22	4	12

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Cerastium sylvaticum	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Crataegus curvisepala	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Crataegus curvisepala	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Melica uniflora	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Viola mirabilis	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+
	Viola riviniana	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
	Dactylis polygama	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Malus sylvestris	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Malus sylvestris	E2b	.	+	.	.	.	.	.	.	.	r	.	.	.	.	.	.
	Pulmonaria stiriaca	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
	Pyrus pyraster	E3a	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.
	Pyrus pyraster	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Glechoma hederacea	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Platanthera bifolia	E1	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carex pilosa	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Moehringia trinervia	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ranunculus ficaria	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Festuca heterophylla	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
VP	***Vaccinio-Piceetea***																	
	Solidago virgaurea	E1	.	.	.	.	+	.	.	+	+	+	+	+	.	+	+	.
	Hieracium murorum	E1	.	.	.	.	.	.	+	.	.	+	.	r	.	.	.	+
	Calamagrostis arundinacea	E1	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
	Valeriana tripteris	E1	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
	Maianthemum bifolium	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Oxalis acetosella	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
RP	***Rhamno-Prunetea***																	
	Berberis vulgaris	E2a	.	.	+	+	.	.	+	.	+	+	+	+	.	+	+	.
	Euonymus europaea	E2a	+	.	+	.	.	.	.	.	+	.	.	.	.	+	.	.
	Euonymus europaea	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
	Crataegus monogyna	E3a	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	r
	Crataegus monogyna	E2b	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	+
	Crataegus monogyna	E2a	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
	Crataegus monogyna	E1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.
	Ligustrum vulgare	E2a	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.
	Cornus sanguinea	E2	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+
	Rhamnus catharticus	E2b	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+
	Rosa sp.	E2a	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+
	Robinia pseudoacacia	E3b	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Robinia pseudoacacia	E2b	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Juniperus communis	E2b	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus spinosa	E2a	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Prunus insititia	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
EA	***Epilobietea angustifolii***																	
	Fragaria vesca	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.
	Galeopsis pubescens	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Torilis japonica	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TG	***Trifolio-Geranietea***																	
	Campanula rapunculoides	E1	.	.	+	+	.	1	+	.	+	+	1	+	1	1	+	+
	Vincetoxicum hirundinaria	E1	.	.	+	+	.	+	r	1	1	+	+	.	+	1	1	1
	Iris graminea	E1	.	+	+	+	.	.	.	.	.	+	.	.	.	+	.	+
	Paeonia officinalis	E1	.	.	+	.	.	.	.	.	.	.	+	+	+	.	.	1
	Lilium carniolicum	E1	.	r	.	.	.	+	.	.	.	.	r	.	.	.	.	+
	Laserpitium latifolium	E1	.	.	.	r	.	+	.	.	.	+	.	.	.	.	.	.
	Lilium bulbiferum	E1	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.
	Thalictrum minus	E1	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	+
	Anthericum ramosum	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
	Polygonatum odoratum	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	Euphorbia angulata	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
MuA	***Mulgedio-Aconitetea***																	
	Senecio nemorensis	E1	.	.	+	+	+	+	+	+	.	.	.	.	+	.	+	.
	Lathyrus occidentalis var. montanus	E1	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.
	Senecio ovatus	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
.	.	.	.	.	.	.	+	.	+	.	.	.	.	+	.	.	.	0	0	3	17	4	12
.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	0	0	3	17	3	9
.	.	.	.	+	.	.	.	.	1	.	.	+	.	.	.	.	.	0	0	3	17	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	1	8	2	11	3	9
.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	0	0	2	11	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	0	0
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	8	62	1	6	9	26
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	4	31	1	6	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	62	0	0	9	26
.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	2	15	3	17	7	21
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	8	1	6	2	6
.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	1	6	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	15	1	6	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	+	.	+	.	+	.	.	.	+	.	+	+	+	.	.	.	.	11	85	7	39	19	56
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	85	0	0	12	35
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	6	18
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	5	15
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	+	.	+	.	.	.	.	.	.	.	.	1	+	.	+	7	54	5	28	13	38
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	8	1	6	2	6

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Aconitum degenii subsp. paniculatum	E1	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
FB	***Festuco-Brometea***																	
	Carex humilis	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.
	Brachypodium rupestre	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
AT	***Asplenietea trichomanis, Thlaspietea rotundifolii***																	
	Asplenium trichomanes	E1	.	.	.	.	.	+	r	.	.	.	+	.	+	.	+	.
	Polypodium vulgare	E1	.	+	.	+	.	.	r	.	.	.	.	.	.	+	+	.
	Asplenium ruta-muraria	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
	Moehringia muscosa	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
	Hieracium pospichalii	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
	Hieracium bifidum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ML	**Mosses and lichens (Mahovi in lišaji)**																	
	Isothecium alopecuroides	E0	+	+	.	1	+	1	1	1	1	1	+	1	+	.	.	1
	Ctenidium molluscum	E0	.	+	1	+	+	1	1	+	+	+	+	+	1	+	1	1
	Neckera crispa	E0	.	+	.	1	+	1	+	1	1	+	1	1	1	+	1	1
	Schistidium apocarpum	E0	.	.	.	.	+	.	+	.	+	+	+	.	.	.	+	+
	Porella platyphylla	E0	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.
	Neckera complanata	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+
	Fissidens dubius	E0	.	.	.	.	.	+	.	.	+	+	.	+	+	.	.	.
	Homalothecium sp.	E0	.	.	.	.	.	+	+	.	+	.	.	+	+	.	.	.
	Homalothecium sericeum	E0	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Anomodon attenuatus	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Anomodon viticulosus	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Homalothecium lutescens	E0	.	.	.	+	.	.	.	+	.	+	.	+	.	.	.	.
	Plagiothecium denticulatum	E0	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.
	Tortella tortuosa	E0	.	.	.	.	.	.	.	.	+	.	.	1	.	.	+	.
	Collema sp.	E0	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.
	Peltigera canina	E0	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
	Atrichum undulatum	E0	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	Plagiochila asplenioides	E0	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
	Brachythecium rutabulum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Plagiomnium cuspidatum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Plagiomnium undulatum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Thuidium tamariscinum	E0	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Eurhynchium striatum	E0	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
	Fissidens taxifolius	E0	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	Metzgeria furcata	E0	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
	Hypnum cupressiforme	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	Brachythecium velutinum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Neckera pennata	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Legend - Legenda

Pr. Presence (number of relevés in which the species is presented) - število popisov, v katerih se pojavlja vrsta
Fr. Frequency in % - frekvenca v %
A Limestone - apnenec
F Flysh - fliš
L Marl - laporovec
R Chert - roženec
Re Rendzina - rendzina
Cc Chromic Cambisols - rjava pokarbonatna tla
SP *Salicetea purpureae*
MA *Molinio-Arrhenatheretea*

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Pr. 4_16	Fr.	Pr. 17_34	Fr.	Pr.1 _34	Fr.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	15	0	0	2	6
.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	+	.	+	5	38	6	33	11	32
.	+	.	.	.	.	.	.	.	+	.	+	+	.	.	+	.	.	4	31	5	28	10	29
.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	1	8	3	17	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	0	0	1	6	1	3
+	+	+	1	1	1	+	1	1	1	.	1	+	+	+	+	2	2	11	85	17	94	30	88
.	+	.	.	+	.	.	1	+	2	1	1	1	1	+	+	1	1	13	100	13	72	28	82
1	+	.	.	.	.	.	.	1	.	+	1	+	1	.	+	1	3	13	100	10	56	24	71
+	+	.	.	+	.	.	.	+	+	.	.	.	+	.	.	+	.	7	54	7	39	14	41
.	+	+	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	2	15	8	44	10	29
.	+	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	1	3	23	5	28	8	24
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	5	38	1	6	6	18
+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	38	1	6	6	18
.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	8	3	17	5	15
.	.	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	0	0	4	22	4	12
.	.	.	.	+	.	.	.	1	1	.	.	.	.	.	.	.	1	0	0	4	22	4	12
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	31	0	0	4	12
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2	15	1	6	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	23	0	0	3	9
.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	8	1	6	2	6
+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	1	6	2	6
.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	0	0	2	11	2	6
.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	0	0	2	11	2	6
.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	0	0	2	11	2	6
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	8	0	0	1	3
.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	1	6	1	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0	0	1	6	1	3

Table 2: Synoptic table of the associations *Hacquetio-Fagetum* and *Lamio orvalae-Fagetum* in southwestern Slovenia
Preglednica 2: Sintezna tabela asociacij *Hacquetio-Fagetum* in *Lamio orvalae-Fagetum* v jugozahodni Sloveniji

	Successive number (Zaporedna številka)		1	2	3	4
	Sign for syntaxa (Oznaka združb)		HFlo	HFcg	LoFgn	LoFpa
	Author (Avtor)		ID	MA	MA	IDMA
AF	***Aremonio-Fagion***					
	Lamium orvala	E1	94	10	90	83
	Hacquetia epipactis	E1	83	.	.	.
	Cyclamen purpurascens	E1	78	30	20	67
	Cardamine enneaphyllos	E1	78	70	100	100
	Anemone x pittonii	E1	6	.	.	.
	Geranium nodosum	E1	6	50	70	.
	Calamintha grandiflora	E1	.	60	70	100
	Cardamine trifolia	E1	.	50	70	.
	Vicia oroboides	E1	.	30	20	10
	Aremonia agrimonoides	E1	.	10	70	67
	Rhamnus fallax	E2b	.	10	5	17
EC	***Erythronio-Carpinion***					
	Galanthus nivalis	E1	89	20	.	.
	Helleborus odorus subsp. istriacus	E1	83	.	.	.
	Erythronium dens-canis	E1	67	.	.	.
	Primula vulgaris	E1	22	10	.	10
	Isopyrum thalictroides	E1	11	.	60	.
	Crocus vernus subsp. vernus	E1	.	10	.	10
TA	***Tilio-Acerion***					
	Acer pseudoplatanus	E3a	39	50	50	33
	Aruncus dioicus	E1	22	.	.	10
	Ulmus glabra	E3a	22	30	40	17
	Acer platanoides	E3a	11	.	10	17
	Adoxa moschatellina	E1	11	.	70	.
	Juglans regia	E2a	11	.	.	.
	Tilia platyphyllos	E3b	11	.	.	67
	Polystichum aculeatum	E1	6	30	80	83
	Phyllitis scolopendrium	E1	6	.	70	50
	Corydalis solida	E1	6	.	.	.
	Arum maculatum	E1	.	20	20	.
	Stellaria montana	E1	.	10	70	10
	Geranium robertianum	E1	.	.	60	83
	Polystichum braunii	E1	.	.	50	.
	Euonymus latifolia	E2a	.	.	40	17
	Cardamine impatiens	E1	.	.	.	17
	Chrysosplenium alternifolium	E1	.	.	.	17
FS	***Fagetalia sylvaticae***					
	Fagus sylvatica	E3b	100	100	100	100
	Lilium martagon	E1	100	.	.	.
	Dryopteris filix-mas	E1	94	90	80	100
	Symphytum tuberosum	E1	89	.	.	.
	Lathyrus vernus	E1	83	50	.	33
	Polygonatum multiflorum	E1	83	.	.	67
	Asarum europaeum subsp. caucasicum	E1	78	80	.	100
	Galeobdolon flavidum	E1	78	.	.	17
	Mercurialis perennis	E1	78	30	70	.
	Galium laevigatum	E1	72	.	.	.
	Prenanthes purpurea	E1	72	70	70	33
	Viola reichenbachiana	E1	72	.	.	.
	Aposeris foetida	E1	67	10	.	10
	Actaea spicata	E1	56	70	70	67
	Euphorbia dulcis	E1	56	60	.	.
	Heracleum sphondylium	E1	56	.	.	.
	Daphne mezereum	E2	50	50	50	83
	Pulmonaria officinalis	E1	50	60	.	67
	Campanula trachelium	E1	44	.	.	17

	Successive number (Zaporedna številka)		1	2	3	4
	Carpinus betulus	E3b	44	30	.	33
	Cardamine bulbifera	E1	39	80	80	67
	Corydalis cava	E1	33	10	70	0
	Salvia glutinosa	E1	28	.	.	17
	Sanicula europaea	E1	28	60	10	50
	Sambucus nigra	E2	22	.	40	33
	Galium odoratum	E1	17	40	70	.
	Melica nutans	E1	17	20	20	33
	Mycelis muralis	E1	17	70	70	83
	Phyteuma spicatum subsp. coeruleum	E1	17	.	.	.
	Prunus avium	E3	11	30	10	.
	Euphorbia amygdaloides	E1	11	10	10	.
	Neottia nidus-avis	E1	11	.	.	17
	Allium ursinum	E1	6	20	.	.
	Galeobdolon montanum	E1	6	.	70	83
	Cephalanthera damasonium	E1	6	.	.	.
	Lonicera alpigena	E2a	.	40	50	67
	Tilia cordata	E3	.	30	10	0
	Paris quadrifolia	E1	.	10	70	17
	Scrophularia nodosa	E1	.	10	70	33
	Poa nemoralis	E1	.	10	10	10
	Leucojum vernum	E1	.	10	.	.
	Cardamine pentaphyllos	E1	.	.	50	.
	Festuca altissima	E1	.	.	.	83
	Carex sylvatica	E1	.	.	.	17
QP	***Quercetalia pubescenti-petraeae***					
	Sesleria autumnalis	E1	100	70	60	100
	Lathyrus venetus	E1	94	70	10	33
	Ostrya carpinifolia	E3	50	10	10	50
	Tanacetum corymbosum	E1	44	.	.	.
	Cornus mas	E2	39	10	.	17
	Campanula rapunculoides	E1	39	.	.	.
	Acer obtusatum	E3	33	.	.	.
	Fraxinus ornus	E3	33	10	10	50
	Convallaria majalis	E1	22	.	.	.
	Melittis melissophyllum	E1	17	.	.	.
	Quercus cerris	E3	17	.	.	.
	Arabis turrita	E1	6	10	10	33
	Sorbus aria (Aria edulis)	E3	6	10	10	50
	Euonymus verrucosa	E2	6	10	10	17
	Mercurialis ovata	E1	6	.	.	.
	Acer monspessulanum	E3	6	.	.	.
	Sorbus torminalis	E2	.	10	.	.
	Cnidium silaifolium	E1	.	.	.	17
	Piptatherum virescens	E1	.	.	.	17
QR	***Quercetalia roboris***					
	Veronica officinalis	E1	.	20	.	10
	Hieracium racemosum	E1	.	10	.	.
	Hieracium sabaudum	E1	.	.	.	17
	Rubus hirtus	E2	.	.	.	17
	Pteridium aquilinum	E1	.	.	.	10
QF	***Querco-Fagetea***					
	Anemone nemorosa	E1	89	.	60	17
	Scilla bifolia	E1	89	.	.	.
	Quercus petraea	E3	61	50	.	.
	Hepatica nobilis	E1	56	20	.	17
	Aegopodium podagraria	E1	56	.	.	.
	Hedera helix	E1	50	80	.	100
	Carex digitata	E1	50	.	.	67
	Lonicera xylosteum	E2a	44	50	10	17
	Corylus avellana	E2b	33	40	30	67
	Crataegus laevigata	E2b	33	.	.	.

	Successive number (Zaporedna številka)		1	2	3	4
	Gagea lutea	E1	33	10	.	.
	Cephalanthera longifolia	E1	22	60	.	.
	Anemone ranunculoides	E1	22	.	.	.
	Rosa arvensis	E2	22	.	.	17
	Clematis vitalba	E2	17	50	.	.
	Acer campestre	E3	17	.	.	17
	Melica uniflora	E1	17	.	.	17
	Cerastium sylvaticum	E1	17	.	.	.
	Crataegus curvisepala	E2	17	.	.	.
	Dactylis polygama	E1	11	.	.	.
	Laburnum alpinum	E1	11	.	.	.
	Viola riviniana	E1	11	.	.	.
	Carex pilosa	E1	6	20	.	17
	Festuca heterophylla	E1	6	.	.	.
	Ranunculus ficaria	E1	6	.	.	.
	Listera ovata	E1	6	.	.	.
	Moehringia trinervia	E1	6	.	.	17
	Veratrum nigrum	E1	6	.	.	.
	Galium schultesii	E1	.	50	.	.
	Vinca minor	E1	.	20	.	.
	Cruciata glabra	E1	.	10	.	.
	Platanthera chlorantha	E1	.	.	.	33
	Viburnum opulus	E1	.	.	.	10
VP	***Vaccinio-Piceetea***					
	Hieracium murorum	E1	6	30	10	17
	Oxalis acetosella	E1	6	20	10	83
	Solidago virgaurea	E1	6	20	10	17
	Calamagrostis arundinacea	E1	.	20	10	10
	Avenella flexuosa	E1	.	20	5	.
	Luzula luzuloides	E1	.	30	0	.
	Maianthemum bifolium	E1	.	20	10	10
	Orthilia secunda	E1	.	20	10	.
	Picea abies	E3	.	10	10	10
	Dryopteris expansa	E1	.	5	5	.
	Gymnicarpium dryopteris	E1	.	5	.	.
	Blechnum spicant	E1	.	1	.	.
	Lycopodium annotinum	E1	.	1	.	.
	Rosa pendulina	E2a	.	.	.	50
SSC	***Sambuco-Salicion capreae***					
	Sorbus aucuparia	E2a	.	.	10	50
	Populus tremula	E1	.	.	5	10
RP	***Rhamno-Prunetea***					
	Euonymus europaea	E2	17	.	.	.
	Crataegus monogyna	E3	6	.	.	.
EA	***Epilobietea angustifolii***					
	Rubus idaeus	E2a	.	30	.	17
	Fragaria vesca	E1	.	20	10	10
	Galeopsis speciosa	E1	.	20	.	.
	Solanum dulcamara	E1	.	10	50	50
	Urtica dioica	E1	.	.	40	10
	Sambucus racemosa	E2a	.	.	.	17
MA	*Deschampsia cespitosa*	E1	.	.	.	10
MuA	***Mulgedio-Aconitetea***					
	Aconitum lycoctonum	E1	56	.	60	.
	Senecio nemorensis	E1	28	.	.	.
	Senecio ovatus	E1	6	60	70	17
	Athyrium filix-femina	E1	.	50	70	17
	Saxifraga rotundifolia	E1	.	.	.	33
TR	***Thlaspietea rotundifolii***					
	Hieracium bifidum	E1	6	.	.	.
	Festuca carniolica	E1	.	10	10	10
	Pseudofumaria alba	E1	.	.	.	100
	Geranium lucidum	E1	.	.	.	17

	Successive number (Zaporedna številka)		1	2	3	4
	Gymnocarpium robertianum	E1	.	.	.	10
AT	***Asplenietea trichomanis***					
	Asplenium trichomanes	E1	33	50	70	100
	Polypodium vulgare	E1	28	40	60	83
	Asplenium ruta-muraria	E1	17	40	50	50
	Moehringia muscosa	E1	.	40	60	83
	Cymbalaria muralis	E1	.	.	.	100
	Cystopteris fragilis	E1	.	.	.	17
	Ceterach officinarum	E1	.	.	.	10
ML	**Mosses and lichens (Mahovi in lišaji)**					
	Isothecium alopecuroides	E0	94	20	.	100
	Ctenidium molluscum	E0	72	40	70	83
	Neckera crispa	E0	56	50	70	100
	Porella platyphylla	E0	44	10	50	.
	Schistidium apocarpum	E0	39	.	.	.
	Neckera complanata	E0	28	.	.	50
	Anomodon viticulosus	E0	22	40	.	33
	Anomodon attenuatus	E0	22	.	.	17
	Homalothecium sericeum	E0	17	.	.	.
	Brachythecium rutabulum	E0	11	.	.	17
	Plagiomnium cuspidatum	E0	11	.	30	.
	Plagiomnium undulatum	E0	11	.	30	50
	Atrichum undulatum	E0	6	20	10	17
	Neckera pennata	E0	6	40	60	.
	Peltigera canina	E0	6	.	.	83
	Plagiothecium denticulatum	E0	6	.	.	33
	Brachythecium velutinum	E0	6	.	.	.
	Homalothecium sp.	E0	6	.	.	.
	Plagiochila asplenioides	E0	6	.	.	.
	Homalothecium lutescens	E0	.	40	.	67
	Dicranum scoparium	E0	.	20	20	.
	Fissidens dubius	E0	.	20	50	.
	Polytrichum formosum	E0	.	20	20	67
	Thamnobryum alopecurum	E0	.	10	60	83
	Rhytidiadelphus triquetrus	E0	.	10	5	17
	Leucobryum glaucum	E0	.	1	.	.
	Eurhynchium striatum (inc. E. angustirete)	E0	.	.	60	17
	Homalothecium philippeanum	E0	.	.	.	33
	Cladonia rangiferina	E0	.	.	.	33
	Thuidium tamariscinum	E0	.	.	.	17
	Tortella tortuosa	E0	.	.	.	17

Legend - Legenda

ID Igor Dakskobler; MA Marko Accetto

HFlo *Hacquetio-Fagetum lamietosum orvalae*, this article

HFcg *Fagetum submontanum* var. geogr. *Sesleria autumnalis*, Accetto (1989, 1990)

LoFgn *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Geranium nodosum*, Accetto (1989, 1990)

LoFpa *Lamio orvalae-Fagetum* var. geogr. *Sesleria autumnalis* subvar. geogr. *Pseudofumaria alba*, Accetto (1989, 1990), Dakskobler & Reščič (2015)

MA *Molinio-Arrhenatheretea*

SUCCESSIONAL STAGES IN THE DEVELOPMENT OF FOREST VEGETATION IN CIRQUES OF TWO VALLEYS IN THE JULIAN ALPS (NW SLOVENIA)

SUKCESIJSKE STOPNJE V RAZVOJU GOZDNE VEGETACIJE V KRNICAH DVEH ALPSKIH DOLIN V JULIJSKIH ALPAH (SEVEROZAHODNA SLOVENIJA)

Igor DAKSKOBLER[1]

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ABSTRACT

Successional stages in the development of forest vegetation in cirques of two valleys in the Julian Alps (NW Slovenia)

We investigated different types of vegetation in cirques of two valleys in the Julian Alps, Zadnjica and Kot, which develop on slope screes and are heavily influenced by avalanches that occur here every year. Our phytosociological analysis identified the following shrub-forest developmental stages: *Saliceteum eleagno-purpureae hieracietosum porrifolii* var. *Achnatherum calamagrostis*, *Homogyno sylvestris-Salicetum glabrae, Polysticho lonchitis-Rhamnetum fallacis*, *Rhododendro hirsuti-Laburnetum alpini*, *Rhodothamno-Laricetum deciduae anemonetosum trifoliae* and *Rhododendro hirsuti-Fagetum sylvaticae* var. *Sorbus chamaemespilus*. On unconsolidated fluvio-glacial deposits in the Kot Valley we determined the following successional stages: *Salicetum eleagno-purpurae hieracietosum porrifolii* var. *Pinus mugo, Amelanchiero ovalis-Pinetum mugo laricetosum* and *Rhododendro hirsuti-Fagetum sylvaticae petasitetosum paradoxi*.

Key words: phytosociology, succession, glacial valley, Julian Alps, Natura 2000, Triglav National Park, Slovenia

IZVLEČEK

Sukcesijske stopnje v razvoju gozdne vegetacije v krnicah dveh alpskih dolin v Julijskih Alpah (severozahodna Slovenija)

Raziskali smo različne oblike vegetacije v krnicah dveh dolin v Julijskih Alpah, Zadnjici in Kotu, ki nastajajo na pobočnem grušču in nanje odločilno vplivajo vsakoletni snežni plazovi. S fitocenološko analizo smo lahko prepoznali naslednje grmiščno-gozdne razvojne stopnje: *Saliceteum eleagno-purpureae hieracietosum porrifolii* var. *Achnatherum calamagrostis*, *Homogyno sylvestris-Salicetum glabrae, Polysticho lonchitis-Rhamnetum fallacis*, *Rhododendro hirsuti-Laburnetum alpini*, *Rhodothamno-Laricetum deciduae anemonetosum trifoliae* in *Rhododendro hirsuti-Fagetum sylvaticae* var. *Sorbus chamaemespilus*. Na nesprijetih rečno-ledeniško nanosih v dolini Kot pa smo ugotovili naslednje sukcesijske stopnje: *Salicetum eleagno-purpurae hieracietosum porrifolii* var. *Pinus mugo, Amelanchiero ovalis-Pinetum mugo laricetosum* in *Rhododendro hirsuti-Fagetum sylvaticae petasitetosum paradoxi*.

Ključne besede: fitocenologija, sukcesija, ledeniška dolina, Julijske Alpe, Natura 2000, Triglavski narodni park, Slovenija

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1 INTRODUCTION

In recent years, successional processes and development of forest vegetation in Alpine valleys in Slovenia were studied in particular by M. Zupančič and collaborators (Zupančič & Žagar 2009, Zupančič, Skumavec & Mihorič 2017) as well as several geographers (Lovrenčak 2002, Blatnik & Repe 2013, Geršič et al. 2014). On our sporadic visits to the mountains through the Alpine valleys of Zadnjica in Trenta and Kot in the Upper Sava Valley (both in the Triglav National Park) our attention was drawn to different types of vegetation on slope screes and alluvial fans in their cirques, where annual avalanche activity is obviously one the main ecological factors. The human impact on the natural processes can be seen only in Zadnjica (the vicinity of a marked mountain trail) and is insignificant in the gable end of the Kot Valley (above the Kotarica falls). We made a phytosociological inventory of these, spatially relatively well-delimited shrub and forest communities and tried to classify them into a syntaxonomic system.

2 METHODS

The vegetation of gable ends of the Zadnjica and Kot valleys was inventoried using the Central-European method (Braun-Blanquet 1964). A total of 28 relevés (Figure 1) were entered into the FloVegSi database (T.

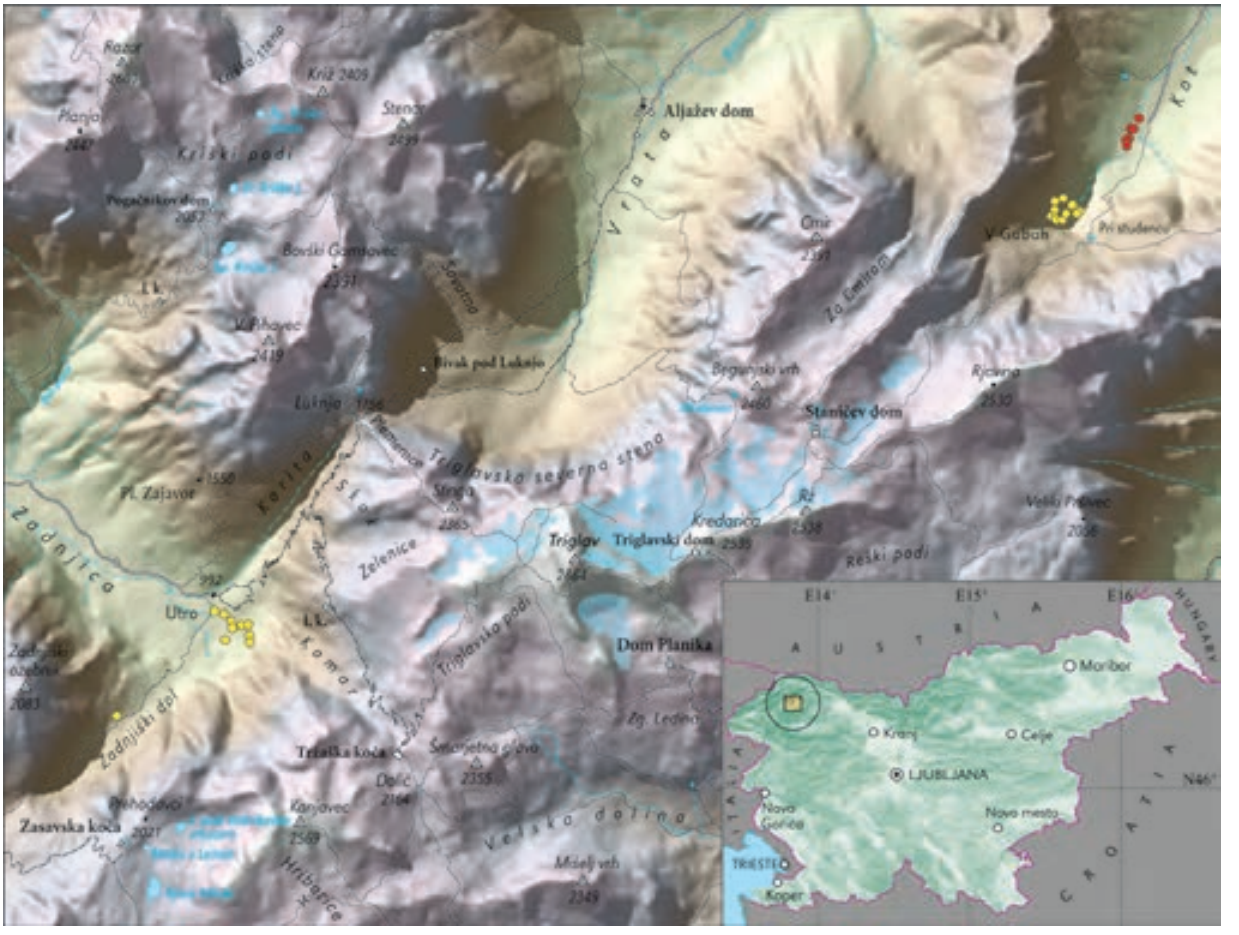

Figure 1: Research area with approximate localities of investigated stands (yellow circles: stands on slope screes, red circles: stands on fluvio-glacial deposits)
Slika 1: Raziskovano območje s približnimi nahajališči preučenih sestojev (rumeni krogci: sestoji na pobočnem grušču, rdeči krogci: sestoji na rečno-ledniških nanosih)

Seliškar, Vreš & A. Seliškar 2003). The relevés were arranged in two tables. Those on slope screes in the cirques of Zadnjica and Kot (above the Kotarica falls) and the relevés on gravelly plains in the upper part of Kot (Klin) were analysed separately. They were mutually compared by means of hierarchical classification, using the (unweighted) average linkage – UPGMA method with Wishart's similarity ratio. For this purpose, we transformed combined cover-abundance values into ordinal values 1– 9 (van der Maarel 1979). We used SYN-TAX 2000 (Podani 2001) software package. The nomenclatural source for the names of vascular plants is Martinčič & al. (2007), except for *Sesleria caerulea* (Aeschimann et al. 2004b). Martinčič (2003, 2011) is the nomenclatural source for the names of mosses and Suppan et al. (2000) for the names of lichens. The nomenclatural source for the names of syntaxa are Šilc & Čarni (2012), except for the name of the class *Querco-Fagetea* Braun-Blanquet et Vlieger in Vlieger 1937.

2.1 Ecological description of the study area

Both cirques, in Zadnjica and Kot, have a predominantly shady aspect (northeast and partly northwest); parent material is unconsolidated moraine (till) and above all slope screes (Jurkovšek 1987 a, b). The elevation of both cirques is similar, spanning 1000 to 1300 m. There are no significant differences in the precipitation volume either, with the average exceeding 2000 mm (B. Zupančič 1998), a large portion of which falls as snow. The mean annual temperature is similar too, ranging between 4 and 6 °C (Cegnar 1998), with the Zadnjica Valley still showing some sub-Mediterranean influence. In recent decades the area has seen a distinctly downward trend in precipitation and higher average temperatures (Dolinar 2018). Both cirques have a characteristically cold local climate and over the winter they receive snow avalanches from their rock walls or steps (Volk Bahun, Zorn & Pavšek 2018). The soil is therefore very shallow, partly colluvial and undeveloped, lithosol and moder rendzina.

3 RESULTS AND DISCUSSION

3.1 Phytosociological analysis of the shrub-forest vegetation sequence on slope screes in the avalanche area in the gable end of the Zadnjica and Kot valleys

Table 1 comprises 22 relevés of stands on slope screes that grouped by floristic similarity as indicated in Figure 2.

In Table 1 we arranged the relevés by taking into account the dominant species of the highest stand layer, which means that our classification does not fully follow the results of hierarchical classification. The most unique form, the community of red and grey willow (*Salicetum eleagno-purpureae hieracietosum porrifolii* var. *Achnatherum calamagrostis*) with *Achnatherum calamagrostis, Athamanta cretensis* and *Petasites paradoxus* dominating the herb layer, was found only along a small torrential brook running from under the waterfall in the Kanjavec rock face down the slope scree until it sinks (relevé 1in Table 1).

Open *Rhamnus fallax* shrub stands were found only in the gable end of Kot, on rather coarse and not entirely consolidated gravel – relevés 3–5 in Table 1. In terms of species composition they obviously belong to the association *Polysticho lonchitis-Rhamnetum fallacis*, which was described a few years ago (Dakskobler, Franz & Rozman 2013) and is more frequent in the Slovene Alps than previously thought (see also Blatnik & Repe 2013). In recent years it was spotted, but not yet inventoried, also in the Krma Valley. The dominant shrub layer species in one of the *Rhamnus fallax* stands in the gable of Kot (relevé 2 in Table 1) is *Salix glabra*, and this stand could be classified also into the association *Homogyno sylvestris-Salicetum glabrae* (comp. Dakskobler & Surina 2017). Similarly, larch dominated the highest stand layers only in the gable end of Kot, on one location on fully consolidated gravel. Its initial stand (relevé 6 in Table 1) can be classified into the association *Rhodothamno-Laricetum*. Although *Anemone trifolia* was not found in the recorded stand, based on the whole floristic composition it should be classified into the subassociation *anemonetosum trifoliae*, which is characterised by abundant *Sesleria caerulea* in the herb layer (comp. Dakskobler, Seliškar & Rozman 2018: 259)

Most relevés on the left side of the dendrogram in Figure 2, i.e. relevés in the central part of Table 1, characterise pioneer shrub communities with *Laburnum alpinum* dominating the highest stand layer. *Laburnum alpinum* is a south-European montane species distributed across most of the Alps (except the Northeastern and partly Central Alps), in the south and central Jura, the north and central Apennines, the Carpathians and the Dinaric Alps (Aeschimann et al.

2004a, Brus 1999, 2005). It occurs on calcareous, mixed and silicate bedrock, in the colline, montane and partly the subalpine belt, mainly on beech forest sites. As a shade-tolerant species it frequently occurs in the lower tree and shrub layer, and establishes itself as a pioneer in windthrow and landslide areas, and on erosion slopes. Figure 3 shows its distribution in Slovenia.

Laburnum alpinum is the most frequent in the stands of associations *Arunco-Fagetum, Ostryo-Fagetum, Seslerio autumnalis-Fagetum, Lamio orvalae-Fagetum, Ranunculo platanifolii-Fagetum, Anemono trifoliae-Fagetum, Homogyno sylvestris-Fagetum, Saxifrago cuneifolii-Fagetum, Rhododendro hirsuti-Fagetum, Polysticho lonchitis-Fagetum, Luzulo-Fagetum sylvaticae, Laburno alpini-Piceetum, Rhodothamno-Laricetum, Saxifrago petraeae-Tilietum, Seslerio albicantis--Ostryetum carpinifoliae, Fraxino orni-Ostryetum carpinifoliae, Rhododendro hirsuti-Ostryetum carpinifoliae, Rhodothamno-Pinetum mugo*, *Amelanchiero ovalis--Pinetum mugo*, but it occurs also in several other forest and shrub communities (source: FloVegSi database, T. Seliškar, Vreš & A. Seliškar, 2003). The highest it was recorded in the association *Rhodothamno-Pinetum mugo* at 1560 m a.s.l. (pasture Stržiškarska Planina under Mt. Poljanski Vrh and Mt. Hohkovbl), in the association *Polysticho lonchitis-Fagetum* at 1570 m (Planinica under Loška Stena rock wall), in the subassociation *Anemono-Fagetum laricetosum* at 1615 m (Pod Pečmi above the Tamar Valley, under Srednja Ponca), in the association *Rhodothamno-Laricetum* at

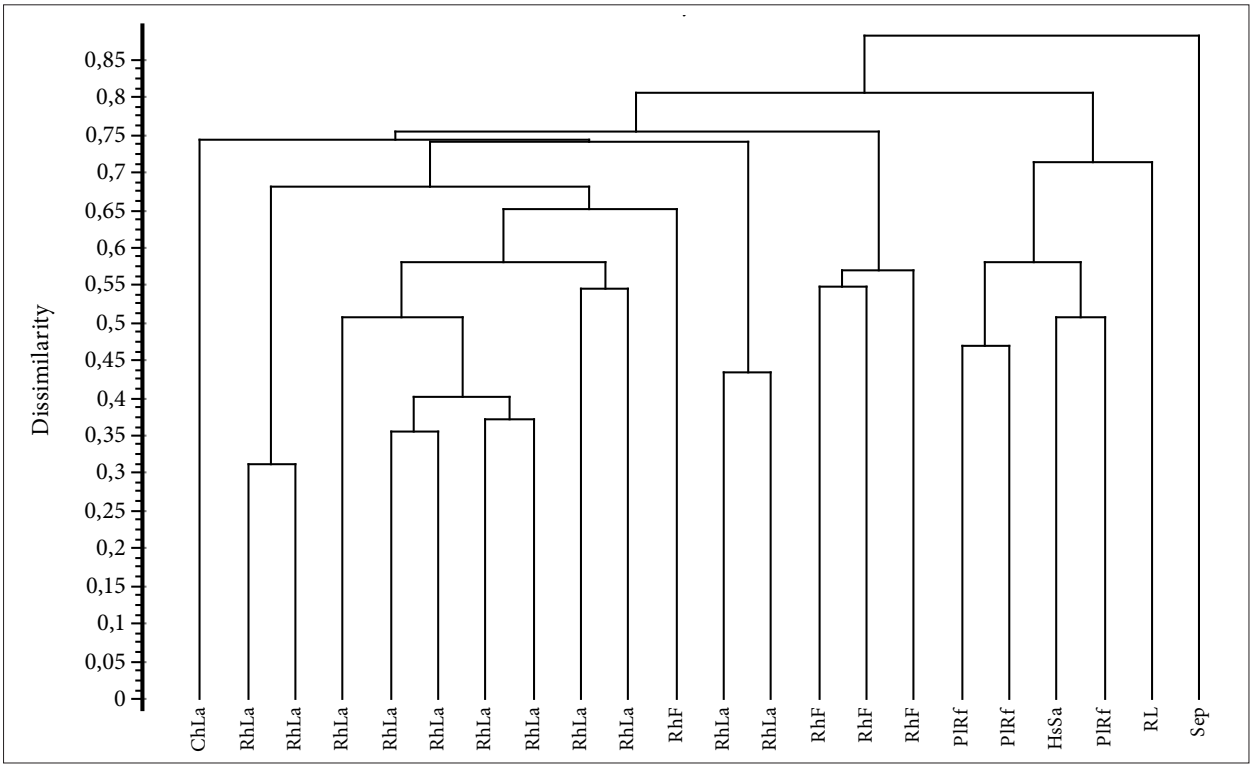

Figure 2: Dendrogram of relevés of shrub- and forest communities on slope screes in cirques of Zadnjica and Kot valleys (UPGMA, similarity ratio)
Slika 2: Dendrogram popisov grmiščnih in gozdnih združb na pobočnem grušč v krnicah dolin Zadnjice in Kota (UPGMA, similarity ratio)

Legend / Legenda
ChLa *Carici humilis-Laburnetum alpini* nom. prov.
RhLa *Rhododendro hirsuti-Laburnetum alpini*
RhF *Rhododendro hirsuti-Fagetum sylvaticae*
PlRf *Polysticho lonchitis-Rhamnetum fallacis*
HsSa *Homogyno sylvestris-Salicetum glabrae*
Sep *Salicetum eleagno-purpureae hieracietosum porrifolii* var. *Achnatherum calamagrostis*

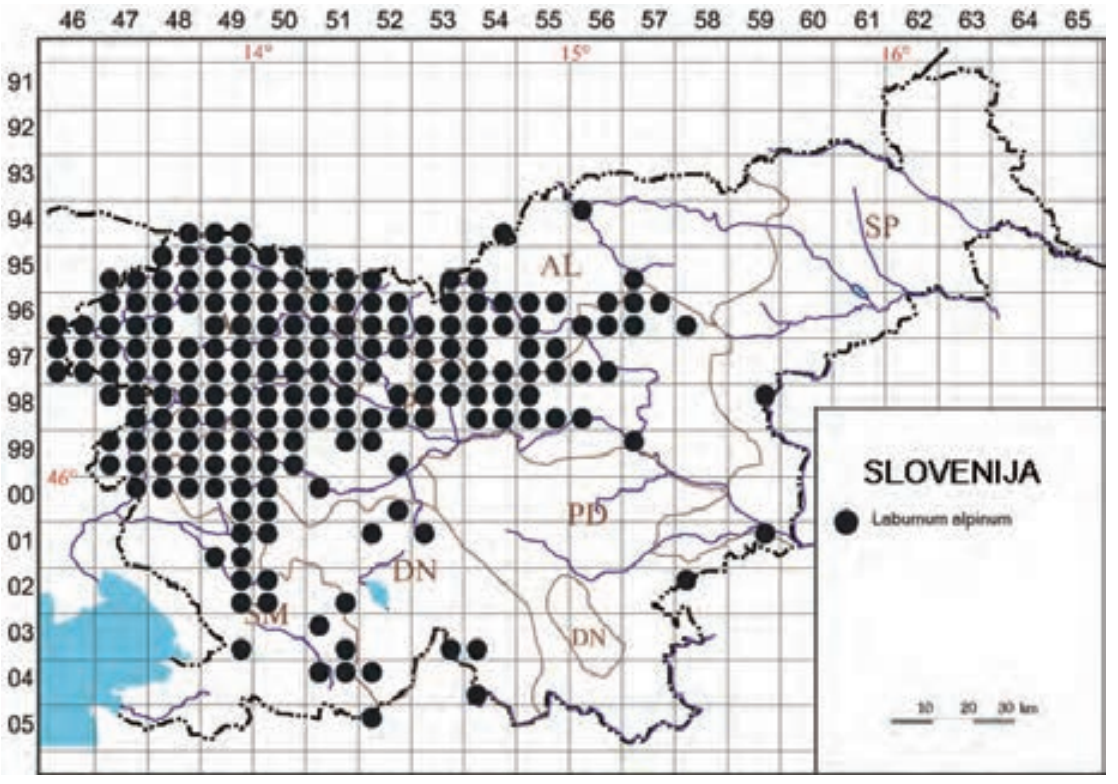

Figure 3: Distribution of Laburnum alpinum in Slovenia, according to the data in the FloVegSi database (authors of the map are I. Dakskobler, B. Anderle, A. Seliškar and B. Vreš)
Slika 3: Razširjenost vrste Laburnum alpinum v Sloveniji po podatkih v bazi FloVegSi (avtorji zemljevida so I. Dakskobler, B. Anderle, A. Seliškar in B. Vreš)

1660 m a.s.l. (Skok above Zadnjica under Mt. Triglav; under the peak Kumlehova Glava above the Suha Pišnica brook). These are the highest elevations of its occurrence known to us in the Julian Alps. Brus (1999: 206, 2005: 241) reports that on southern (the warmest, sunny) slopes this species occurs up to 1900 m a.s.l., which almost certainly does not refer to the Julian Alps, but to the Alps in general, (Brus, in litt.). As a pioneer it establishes itself on windthrow areas, in particular in stands of associations *Anemono trifoliae-Fagetum, Ranunculo platanifolii-Fagetum* and *Rhododendro hirsuti-Fagetum*. In the northern part of the Dinaric Alps we described a successional stage in natural gaps of montane beech and fir-beech forest as the association *Laburno alpini-Rhamnetum fallacis* (Dakskobler, Franz & Rozman 2013). In the Jura, the association *Sorbo mougeotii-Laburnetum alpini* Géhu & Géhu-Franck ex Foucault 2012 is described and designated as the edge shrub community on the sites of thermo-basophilous beech forests (Richard 1968, Géhu & Géhu-Franck 1987, Biondi, Pinzi & Gubellini 2004, Foucault 2012, Theurillat 2019, in litt.). In the Apennines, a successional stage *Geranio nodosi-Laburnetum alpini* Castelli, Biondi & Ballelli 2001 and its subassociation *sorbetosum ariae* Biondi, Pinzi et Gubellini 2004 were described on the sites of beech forests from the association *Cardamino kitaibelii-Fagetum sylvaticae* (Castelli, Biondi & Ballelli 2001, Biondi, Pinzi & Gubellini 2004).

Our relevés are distinctly different from the shrub communities in the Jura and the Apennines. The species shared with the stands of the association *Sorbo mougeotii-Laburnetum alpini* from the Jura are *Laburnum alpinum, Sorbus mougeotii, S. aria, S. chamaemespilus, Salix appendiculata, Fagus sylvatica, Lonicera xylosteum*, *Mercurialis perennis, Acer pseudoplatanus, Polygonatum verticillatum, Fragaria vesca, Rubus idaeus, Lonicera alpigena* and *Aconitum lycoctonum* s. lat. The species shared with the stands of the subassociation *Gerenio nodosi-Laburnetum alpini sorbetosoum ariae* from the Apennines are *Laburnum alpinum, Sorbus aria, Rhamnus fallax, Mercurialis perennis, Fagus sylvatica, Solidago virgaurea*, *Hepatica nobilis, Carex digitata, Ostrya carpinifolia, Fragaria vesca, Thalic-*

trum aquilegiifolium, Euonymus latifolia, Galium album and *Hypericum montanum*. Despite the listed species that they have in common, the studied *Laburnum alpinum* community from the Julian Alps differs from its communities from the Jura and the Apennines mainly with the presence of distinctly frigophilous species characteristic for subalpine beech, larch, spruce and dwarf pine communities, such as *Rhododendron hirsutum, Polystichum lonchitis, Pinus mugo, Clematis alpina, Homogyne sylvestris, Picea abies* and *Larix decidua*. Most of the stands with dominating *Laburnum alpinum* in the highest layer are therefore classified into the new association *Rhododendro hirsuti-Laburnetum alpini*. Its nomenclatural type, *holotypus*, is relevé 16 in Table 1. The diagnostic species of the new association are *Laburnum alpinum, Rhododendron hirsutum, Polystichum lonchitis, Pinus mugo, Gymnocarpium robertianum, Clematis alpina, Homogyne sylvestris, Larix decidua, Sorbus chamaemespilus* and *Salix appendiculata* and its phytogeographical differential species are *Rhodothamnus chamaecistus, Cyclamen purpurascens* and *Anemone trifolia*. The listed species characterise cold, stony sites where beech can still establish itself in favourable conditions (absence of avalanches), as manifested by the entire species composition. The new association is thus classified into the alliance *Aremonio-Fagion*, order *Fagetalia sylvaticae* and class *Querco-Fagetea* (*Carpino-Fagetea*), even though it could also be classified into the classes *Erico-Pinetea* or *Roso pendulinae-Pinetea mugo*.

There are several differences between the stands in the Zadnjica and Kot valleys. The stands in Kot on moister and coarser gravel are characterised in particular by a considerable admixture of sycamore maple (*Acer pseudoplatanus*), so they are described as a new subassociation *aceretosum pseudoplatani* (its nomenclatural type is the same as the nomenclatural type of the new association, relevé 16 in Table 1). The stands in the gable end of the Zadnjica Valley are mainly situated on finer gravel, on slightly drier and warmer sites, and are differentiated by *Ostrya carpinifolia* and *Carex alba*. The nomenclatural type, *holotypus*, of the new subassociation *ostryetosum carpinifoliae* is relevé 11 in Table 1. The most unique among the relevés of this subassociation is relevé 14, where the shrub layer is completely dominated by dwarf pine (*Pinus mugo*). Although this stand could also be classified into the association *Amelanchiero-Pinetum mugo*, it was included in the association *Rhododendro-Laburnetum alpini*, because in terms of entire species composition it grouped with other relevés of the latter association. However, the same cannot apply to relevé 7 in Table 1, which characterises an open *Laburnum alpinum* shrub on the debris cone under Mt. Zadnjiški Ozebnik. It is characterised by character scree and stony grassland species such as *Achnatherum calamagrostis*, *Adenostyles glabra, Calamagrostis varia* and *Carex humilis*. This stand is tentatively classified into the provisional association *Carici humilis-Laburnetum alpini* nom. prov. and is syndynamically related to the stands of the association *Anemono trifoliae-Fagetum*.

The tree layer in the forest stands located on the edge or at the bottom of the studied glacial cirques, in areas that are less exposed to avalanches (relevés 19–22 in Table 1), is dominated by beech. The entire species composition indicates a community on extreme sites, very similar to beech stands on the upper forest line, classified into the association *Polysticho lonchitis-Fagetum*. Also possible is classification into the association *Rhododendro hirsuti-Fagetum*, as these stands comprise almost all of the diagnostic species of this association that otherwise characterises beech sites in the submontane and montane belt up to some 1200 m a.s.l. Given the elevation of our relevés (under 1200 m) the latter association is considered more appropriate, but to demonstrate the similarity with the stands of the first, *Polysticho lonchitis-Fagetum*, it is described as a special altitudinal variant with *Sorbus chamaemespilus* (*Rhododendro hirsuti-Fagetum* var. *Sorbus chamaemespilus*). In the Julian Alps, this species otherwise characterises communities of the altimontane and subalpine belts, and in the (lower) montane belt it is usually limited to frost hollows. In the stands of the association *Rhododendro hirsuti-Fagetum* in the Julian Alps it was reported on only a few occasions (see Dakskobler 2003).

From the relevés in Table 1 we can infer the likely sequence in the development of shrub and forest vegetation on slope screes in avalanche areas in cirques of glacial valleys in the Julian Alps:

Polysticho lonchitis-Rhamnetum fallacis (*Homogyno sylvestris-Salicetum glabrae*) – *Rhododendro hirsuti-Laburnetum alpini* (*Amelanchiero-Pinetum mugo*) – *Rhododendro hirsuti-Fagetum sylvaticae* (*Rhodothamno-Laricetum*).

3.2 Phytosociological analysis of the sequence in shrub-forest vegetation on fluvio-glacial deposits in the Kot Valley (Klin).

In Table 2 we arranged six relevés made on the gravelly plain Klin in the upper part of the Kot Valley. They were mutually compared using hierarchical classification, which produced the dendrogram in Figure 4.

Successional development of vegetation in the upper part of the Kot Valley was studied in detail by Zupančič, Skumavec & Mihorič (2017). They determined and presented with a phytosociological table the sequence of the following plant communities:

Petasitetum paradoxi – Petasiti-Salicetum purpureo-albae – Calamagrostio variae-Pinetum mugo – Dryado-Piceetum – Rhodothamno-Pinetum mugo – Rhododendro-Fagetum – Anemono-Fagetum lycopodietosum.

In this area, i.e. on the gravelly plain under the Kotarica falls, we were interested mainly in beech stands with hairy alpenrose (*Rhododendro hirsuti-Fagetum*), as the findings by Zupančič et al. (ibid.) were new to the forest vegetation in this part of the Julian Alps. We inventoried several typical stands and contact communities of *Pinus mugo* and *Salix eleagnos*. Only six relevés, however, are not sufficient to allow us to infer the right sequence in the development of shrub-forest vegetation. Our goal is therefore not to correct or supplement the findings of the much more detailed recent analysis, but merely to classify our relevés into a syntaxonomic system.

Relevé 1 in Table 1 could be classified also into the association *Salicetum eleagno-purpureae*. Although a comparison with the relevés of this community from the foothills of the Julian Alps, in the Nadiža Valley (Šilc & Čušin 2000) does indicate some distinct differences, also with the variant with *Petasites paradoxus*. Oriolo & Poldini (2002) classify slightly similar

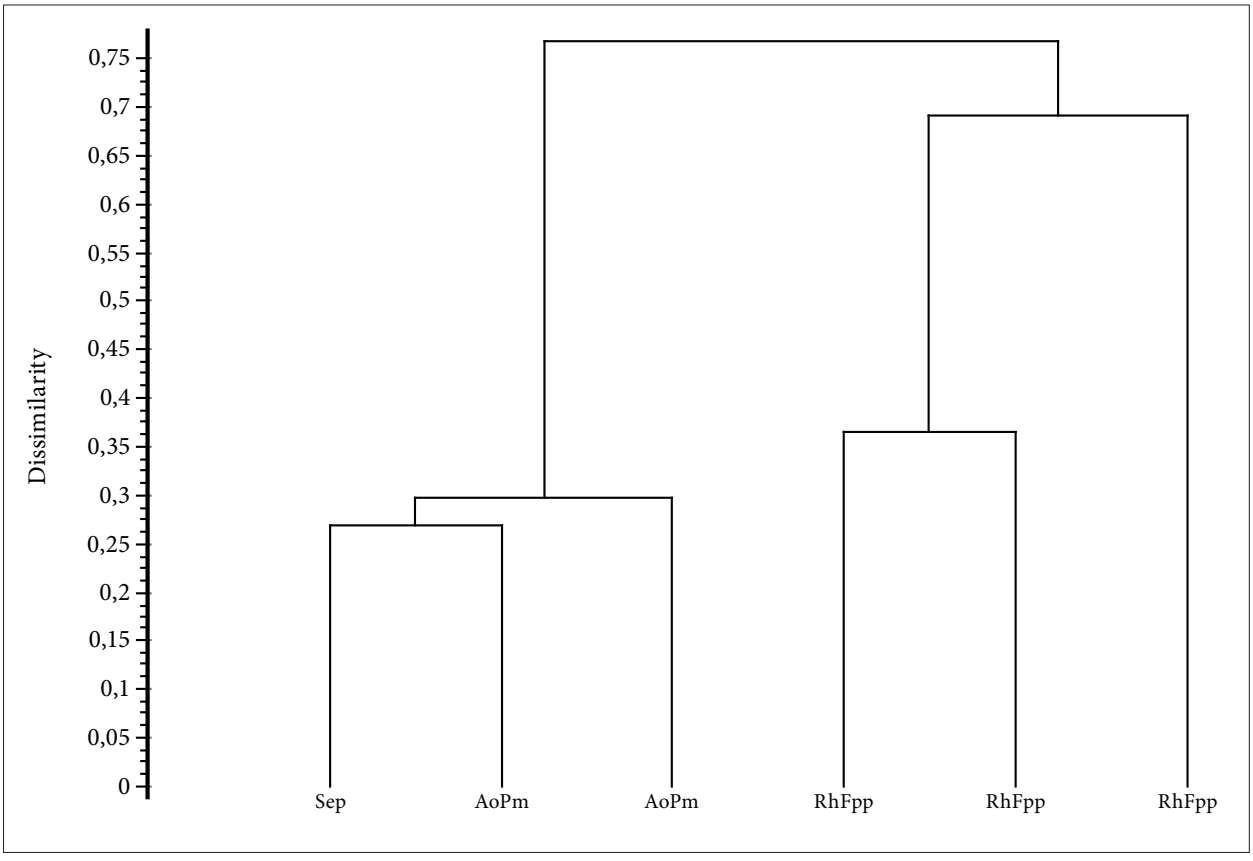

Figure 4: Dendrogram of relevés of shrub and forest vegetation on fluvio-glacial gravel sediments in Klin, in the upper part of the Kot Valley (UPGMA, similarity ratio)
Slika 4: Dendrogram popisov grmiščne in gozdne vegetacije na rečno-ledeniških sedimentih v Klinu v zgornjem delu doline Kot (UPGMA, similarity ratio)

Legend/ Legenda:
Sep *Salicetum eleagno-purpureae hieracietosum porrifolii* var. *Pinus mugo*
AoPm *Amelanchiero ovalis-Pinetum mugo laricetosum* nom. prov.
RhFpp *Rhododendro hirsuti-Fagetum sylvaticae petasitetosum paradoxi*

stands into the montane altitudinal form of the subassociation *typicum*. There is also a certain similarity with relevés of the subassociation *Salicetum eleagno-purpureae hieracietosum porrifolii* described by Čušin & Šilc (2006) on gravel bars of the Soča River near Bovec. The species that differentiate our relevé against the relevés published by Šilc & Čušin (2000) and Oriolo & Poldini (2002) are in particular *Pinus mugo, Hieracium porrifolium, Rhododendron hirsutum, Rhamnus fallax, Salix waldsteiniana, Dryas octopetala*, *Primula clusiana* and many species of the classes *Elyno-Seslerietea* and *Thlaspietea rotundifolii*. Some of the diagnostic species shared with the stands of the subassociation *-hieracietosum porrifolii* are *Hieracium porrifolium, H. piloselloides, Carduus crassifolius, Biscutella laevigata, Campanula cespitosa, Silene vulgaris* subsp. *glareosa, Achnatherum calamagrostis*, *Rumex scutatus, Sesleria caerulea* and *Dryas octopetala*. Our relevé at least slightly resembles also the relevé of the syntaxon *Petasiti-Salicetum purpureo-albae* (Zupančič, Skumavec & Mihorič 2017, relevé 2 in the phytosociological table), but with a significant difference – the dominant species there is *Salix eleagnos* and not *Salix alba* – which is a result of different site conditions (M. Zupančič, in litt.). The above comparisons allow us to classify our relevé into the new variant *Salicetum eleagno-purpureae hieracietosum porrifolii* var. *Pinus mugo* var. nov. The differential species of the new variant are *Pinus mugo, Rhododendron hirsutum, Salix waldsteiniana* and *Potentilla clusiana*.

Relevés 2 and 3 in Table 2 can be classified into the association *Amelanchiero ovalis-Pinetum mugo*, as it comprises several its diagnostic species, but not *Fraxinus ornus* and *Ostrya carpinifolia*. Another option would be classification into the association *Rhodothamno-Pinetum mugo*. Given the elevation of occurrence we prefer (like in the case of similar associations *Rhododendro hirsuti-Fagetum* / *Polysticho lonchitis-Fagetum*) the dwarf pine community of lower altitudes (*Amelanchiero-Pinetum mugo*), indicating its similarity with the stands of the association *Rhodothamno-Pinetum mugo* with the provisional name of the subassociation, *laricetosum*.

Stands in relevés 4–6 can be classified into the association *Rhododendro hirsuti-Fagetum sylvaticae*, as they comprise most of its diagnostic species. However, these stands could also be classified into the association *Polysticho lonchitis-Fagetum*. The species supporting this classification is *Sorbus chamaemepsilus,* so these stands can also be treated within the already mentioned altitudinal variant. On the other hand, the studied stands differ from other previously described forms of the association *Rhododendro hirsuti-Fagetum* with certain ecological characteristics. The stands of this association dominate on steep to precipitous shady slopes, whereas ours were found on levelled terrain and gravel deposits. Based on the above, they can be described and typified as a new subassociation *Rhododendro hirsuti-Fagetum sylvaticae petasitetosum paradoxi* subass. nov. The nomenclatural type, *holotypus*, is relevé 6 in Table 2. The differential species of the new subassociation are *Petasites paradoxus* and *Brachypodium rupestre*.

3.3 An overview of syntax described or discussed in the article:

Salicetea purpureae Moor 1958
Salicetalia purpureae Moor 1958
Salicion eleagno-daphnoidis (Moor 1958) Grass 1993
Salicetum eleagno-purpureae Sillinger 1933
-hieracietosum porrifolii Čušin et Šilc 2006
var. *Pinus mugo* var. nov.
var. *Achnatherum calamagrostis* var. nov.
Querco-Fagetea Br.-Bl. & Vlieg. 1937
Rhamnetali fallacis Fukarek 1969
Seslerio calcariae-Rhamnion fallacis Dakskobler, Franz et Rozman 2013
Polysticho lonchitis-Rhamnetum fallacis Dakskobler, Franz et Rozman 2013
Fagetalia sylvaticae Pawł. in Pawł. & al. 1928
Aremonio-Fagion (Ht. 1938) Borhidi in Török, Podani & Borhidi 1989
Rhododendro hirsuti-Laburnetum alpini ass. nov. hoc loco
-ostryetosum carpinifoliae subass. nov. hoc loco
-aceretosum pseudoplatani subass. nov. hoc loco
Carici humilis-Laburnetum alpini nom. prov.
Rhododendro hirsuti-Fagetum sylvaticae Accetto ex Dakskobler 1998
-petasitetosum paradoxi subass. nov. hoc loco
Vaccinio-Piceetea Br.-Bl. in Br.-Bl., Sissingh et Vlieger 1939
Piceetalia excelsae Pawłowski in Pawłowski et al. 1928
Erico-Pinion mugo Leibundgut 1948
Rhodothamno-Laricetum deciduae Willner et Zukrigl 1999
-anemonetosum trifoliae Dakskobler 2006
Erico-Pinetea Horvat 1959
Erico-Pinetalia Horvat 1959
Fraxino orni-Pinion nigrae-sylvestris Zupančič 2007
Helleboro nigri-Pinenion (Horvat 1959) Zupančič 2007
Amelanchiero-Pinetum mugo Minghetti in Pedrotti 1994

-laricetosum nom. prov.

Rhododendro hirsuti-Ericetea carneae Schubert et al. 2001

Rhododendro hirsuti-Ericetalia carneae Grabherr, Greimler et Mucina 1993

Ericion carneae Rübel ex Grabherr, Greimler et Mucina 1993

Homogyno sylvestris-Salicetum glabrae Dakskobler et Surina 2017

4 CONCLUSIONS

On slope screes and gravel deposits in the gable end of two glacial valleys in the Julian Alps, in Zadnjica and Kot (Triglav National Park), we phytosociologically described several shrub and forest communities whose development is affected not only by the size, consolidation and moisture level of the gravel, but most decisively by avalanches that occur there every year. Only two shrub and one forest community were documented with a sufficient number of relevés. Stands of associations *Polysticho lonchitis-Rhamnetum fallacis* and *Amelanchiero ovalis-Pinetum mugo* are new to the Kot Valley. We described a new association *Rhododendro hirsuti-Laburnetum alpini*, which belongs to the group of shrub-forest communities of the montane-subalpine belt (*Rhododendro hirsuti-Sorbetum aucupariae, Rhododendro hirsuti-Salicetum appendiculatae, Rhododendro hirsuti-Betuletum carpaticae, Alno viridis-Sorbetum aucupariae, Calamagrostio arundinaceae-Sorbetum ariae*) – comp. Dakskobler, Kutnar & Rozman (2016) that are a more or less long-term stages on potential beech sites and their occurrence could, although not necessarily, be associated with human impact or past activities. In our case, the stands of the new association are a stage in development towards beech forest on extreme sites in the montane belt classified into the association *Rhododendro hirsuti-Fagetum*. The stands of this association in the gable ends of Zadnjica and Kot valleys are characterised by their similarity with stands of the association *Polysticho lonchitis-Fagetum* (and are therefore treated as a special altitudinal variant with *Sorbus chamaemespilus*). Its form on fluvioglacial gravel deposits that can be treated as a new subassociation *petasitetosum paradoxi* was found only on levelled terrain in the Kot Valley. Our findings confirm and supplement the findings of Zupančič, Skumavec & Mihorič (2017) on the exceptionally diverse and fascinating shrub-forest vegetation in the gable end of the Kot Valley and its substantial biotic value. Most of this vegetation belongs to Natura 2000 habitat types: 91K0 Illyrian *Fagus sylvatica* forests (*Aremonio-Fagion*), 4070 *Pinus mugo* and *Rhododendrum hirsutum* shrubs (*Mugo-Rhododendretum hirsuti*) and 9420 Alpine *Larix decidua* forests. It comprises several protected (*Cypripedium calceolus* – also a Natura 2000 species, *Gymnadenia odoratissima, G. conopsea, Epipactis helleborine, Dianthus sternbergii, Gentiana clusii, Lycopodium annotinum*), endemic (*Cerastium subtriflorum, Papaver alpinum* subsp. *ernesti-mayeri = P. ernesti-mayeri*) and rare species (*Sorbus mougeotii*). The study area is situated in the inner Triglav National Park area, so human impact on the development of vegetation here (other than increased mountaineering in recent years and human-induced climate changes) is insignificant.

5 POVZETEK

V zatrepu dveh ledeniških dolin v Julijskih Alpah, v Zadnjici in Kotu (Triglavski narodni park), smo na pobočnih gruščih in prodnatih nanosih fitocenološko opisali več grmiščnih in gozdnih združb, na katerih razvoj poleg velikosti in ustaljenosti ter vlažnosti grušča najbolj odločilno vplivajo predvsem vsakoletni snežni plazovi. Z zadostnim številom popisov smo v obeh dolinah dokumentirali le dve grmiščni in eno gozdno združbo. Sestoji asociacij *Polysticho lonchitis-Rhamnetum fallacis* in *Amelanchiero ovalis-Pinetum mugo* so novost v dolini Kota. V obeh raziskovanih dolinah smo našli sestoje subasociacije *Salicetum eleagno-purpureae hieracietosum porrifolii*, ki smo jo do zdaj poznali le v Zgornjem Posočju (Čušin & Šilc 2006). Kot novo smo opisali asociacijo *Rhododendro hirsuti-Laburnetum alpini*, ki sodi v skupino grmiščno-gozdnih združb montansko-subalpinskega pasu (*Rhododendro hirsuti-Sorbetum aucupariae, Rhododendro hirsuti-Salicetum appendiculatae, Rhododendro hirsuti-Betuletum carpaticae, Alno viridis-Sorbetum aucupariae, Calamagrostio arundinaceae-Sorbetum ariae*) – prim. Dakskobler, Kutnar & Rozman

(2016), ki so bolj ali manj dolgotrajen stadij na potencialno bukovih rastiščih in je njihov nastanek lahko, ne pa nujno, povezan tudi s človekovimi vplivi oz. njegovo preteklo dejavnostjo. V našem primeru so sestoji nove asociacije razvojna stopnja proti bukovemu gozdu na skrajnih rastiščih v montanskem pasu, ki jih uvrščamo v asociacijo *Rhododendro hirsuti-Fagetum*. Za sestoje te asociacije v zatrepih dolin Zadnjice in Kota je značilna podobnost s sestoji asociacije *Polysticho lonchitis-Fagetum* (zato jih obravnavamo kot posebno višinsko varianto z vrsto *Sorbus chamaemespilus*). Samo v dolini Kot pa smo doslej našli njeno obliko na rečno-ledeniških prodnatih nanosih, na uravnavi, ki jo lahko vrednotimo kot novo subasociacijo *petasitetosum paradoxi*. Naša spoznanja potrjujejo in dopolnjujejo ugotovitve Zupančiča in sodelavcev (2017) o izredno raznolikem in zanimivem grmiščno-gozdnem rastju v zatrepu doline Kot in o njegovi veliki biotski vrednosti. Večinsko sodi v evropsko varstveno pomembne habitatne tipe: 91K0 Ilirski bukovi gozdovi (*Aremonio-Fagion*), 4070 *Ruševje z dlakavim slečem (*Mugo-Rhododendretum hirsuti*) in 9420 Alpski macesnovi gozdovi. V njem raste več zavarovanih vrst (*Cypripedium calceolus* – tudi Natura 2000 vrsta, *Gymnadenia odoratissima, G. conopsea, Epipactis helleborine, Dianthus sternbergii, Gentiana clusii, Lycopodium annotinum*), endemitov (*Cerastium subtriflorum, Papaver alpinum* subsp. *ernesti-mayeri = P. ernesti-mayeri*) in redkih vrst (*Sorbus mougeotii*). Ker raziskano območje leži v strožje varovanem delu Triglavskega narodnega parka, so človekovi vplivi na tukajšnji razvoj vegetacije (z izjemo povečanega obiska planincev v zadnjih letih in od človeka povzročenih podnebnih sprememb) majhni.

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Figure 5: Stand of the syntaxon Salicetum eleagno-purpureae hieracietosum porrifolii var. Achnatherum calamagrostis in the Zadnjica Valley
Slika 5: Sestoj sintaksona Salicetum eleagno-purpureae hieracietosum porrifolii var. Achnatherum calamagrostis v dolini Zadnjice

Figure 6: Stand of the syntaxon Rhododendro hirsuti-Laburnetum alpini ostryetosum in the Zadnjica Valley
Slika 6: Sestoj sintaksona Rhododendro hirsuti-Laburnetum alpini ostryetosum v dolini Zadnjice

Figure 7: Stand of the association Polysticho lonchitis-Rhamnetum fallacis in the Kot Valley
Slika 7: Sestoj asociacije Polysticho lonchitis-Rhamnetum fallacis v dolini Kot

Figure 8: Successional stages of vegetation on slope screes in the gable end of the Kot Valley (from the left to the right): Rhododendro-Laburnetum – Rhodothamno-Laricetum – Polysticho-Rhamnetum – Rhododendro-Laburnetum – Rhododendro-Fagetum
Slika 8: Sukcesijske stopnje rastja na pobočnem grušču v zatrepu doline kot (od leve proti desni): Rhododendro-Laburnetum – Rhodothamno-Laricetum – Polysticho-Rhamnetum – Rhododendro-Laburnetum – Rhododendro-Fagetum

Figure 9: Stand of the syntaxon Salicetum eleagno-purpureae hieracietosum porrifolii var. Pinus mugo in the Kot Valley
Slika 9: Sestoj sintaksona Salicetum eleagno-purpureae hieracietosum porrifolii var. Pinus mugo v dolini Kot

Figure 10: Stand of the syntaxon Rhododendro hirsuti-Fagetum petasitetosum paradoxi in the Kot Valley
Slika 10: Sestoj sintaksona Rhododendro hirsuti-Fagetum petasitetosum paradoxi v dolini Kot

Table 1: Successional stages of shrub-forest vegetation on slope screes in glacial cirques of Zadnjica and Kot valleys in the Julian Alps
Preglednica 1: Sukcesijski stadiji rastja na pobočnem grušču v krnicah dolin Zadnjice in Kota v Julijskih Alpah

Number of relevé (Zaporedna številka popisa)																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Database number of relevé (Delovna številka popisa)	273163	273181	273178	273180	273184	273186	258936	273144	273164	273145	273146	273148	273147	273161	273177	273182	273171	273183	273162	273149	273185	273176
Elevation in m (Nadmorska višina v m)	1030	1190	1180	1200	1200	1150	1280	1015	1000	1050	1070	1080	1070	1030	1170	1140	1130	1115	1030	1090	1190	1190
Aspect (Lega)	NW	SE	NE	E	SE	E	SEE	NW	NW	W	W	W	NW	NW	NE	SE	NW	N	NW	NW	SE	NE
Slope in degrees (Nagib v stopinjah)	15	35	30	35	40	25	30	15	10	10	15	20	20	25	35	30	40	40	15	45	40	35
Parent material (Matična podlaga)	Gr-Sc											Ta										
		Sc	Sc	Sc	Sc	Sc	Sc	Sc-Mo	Sc-Mo	Sc-Mo	Sc-Mo		Sc-Mo	Sc	Sc	Rs	Sc	Sc	Rs	D	Sc	Sc
Soil (Tla)	Co	Li	Li	Li	Li	Re	Li	Re	Re	Re	Re	Re	Re	Re	Re	Re	Co	Co	Re	Re	Re	Re
Stoniness in % (Kamnitost v %)	40	40	35	50	30	30	30	20	20	20	20	20	20	20	20	30	10	20	30	30	20	20
Cover in % (Zastiranje v %):																						
Upper tree layer (Zgornja drevesna plast)	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	70	80	80	70
Lower tree layer (Spodnja drevesna plast)	E3a	.	.	.	.	.	10	60	70	10	80	70	60	20	60	80	60	80	.	.	.	.
Shrub layer (Grmovna plast)	E2	90	70	70	80	70+40	60	20	20	80+30	50	60+40	40+30	90+50	20+20	30	20+30	20	60+30	15	10	20
Herb layer (Zeliščna plast)	E1	40	50	75	40	50	80	80	80	70	80	80	80	60	60	60	80	70	80	50	50	70
Moss layer (Mahovna plast)	E0	.	5	.	10	5	10	.	5	5	15	10	10	30	10	20	10	10	10	20	5	10
Maximum diameter of trees (Največji prsni premer dreves)	cm	.	.	.	.	.	10	15	10	15	10	15	15	10	15	10	15	15	30	35	50	20
Maximum height of trees (Največja drevesna višina)	m	.	.	.	.	.	10	6	8	5	10	15	6	8	5	6	10	5	16	16	14	10
Number of species (Število vrst)		49	42	57	48	36	52	33	57	45	52	49	50	48	41	42	55	68	52	61	52	51
Relevé area (Velikost popisne ploskve)	m^2	100	200	400	200	100	200	100	400	200	400	400	400	400	200	400	200	200	400	400	400	400
Date of relevé (Datum popisa)		9/19/2018	9/19/2018	9/19/2018	9/19/2018	9/19/2018	9/19/2018	7/3/2015	9/21/2018	9/21/2018	9/21/2018	9/21/2018	9/21/2018	9/21/2018	9/19/2018	9/19/2018	9/19/2018	9/19/2018	9/21/2018	9/19/2018	9/19/2018	9/19/2018
Locality (Nahajališče)		Kot	Kot	Kot	Kot	Kot	Kot	Zadnjiški dol	Zadnjica-Utro	Zadnjica-Utro	Zadnjica-Utro	Zadnjica-Utro	Zadnjica-Utro	Zadnjica-Utro	Kot	Kot	Kot	Kot	Zadnjica-Utro	Kot	Kot	Kot
Quadrant (Kvadrant)		9549/3	9549/3	9549/3	9549/3	9549/3	9549/3	9648/2	9648/2	9648/2	9648/2	9648/2	9648/2	9648/2	9648/2	9648/2	9549/3	9549/3	9648/2	9549/3	9549/3	9549/3
Coordinate GK Y (D-48)	m	408256	414505	414509	414482	414510	414595	407384	408199	408127	408335	408395	408392	408385	408208	414558	414640	414680	414701	408264	414572	414528

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
	Coordinate GK X (D-48)	m	5137338	5140471	5140406	5140416	5140525	5140436	5136616	5137390	5137412	5137304	5137316	5137228	5137308	5137195	5140389	5140501	5140443	5140460	5137291	5137177	5140552	5140385		
	Diagnostic species of the associations and subassociations (Diagnostične vrste asociacij in subasociacij)																								Pr.	Fr.
SP	*Salix purpurea*	E2b	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
SP	*Salix eleagnos*	E2b	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
BA	*Salix glabra*	E2	+	4	.	+	2	.	.	.	.	.	.	+	+	2	2	.	+	+	.	.	+	.	11	50
AF	*Rhamnus fallax*	E2b	.	1	4	4	4	1	.	.	.	.	.	.	.	.	+	1	+	+	.	.	+	+	11	50
AF	*Rhamnus fallax*	E2a	.	.	1	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	5	23
AF	*Rhamnus fallax*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	2	9
EP	*Rhododendron hirsutum*	E2a	+	.	.	+	.	.	.	+	+	3	3	3	3	4	+	2	1	+	2	1	r	1	17	77
VP	*Polystichum lonchitis*	E1	.	.	1	+	+	+	+	+	+	+	.	.	.	.	r	1	+	1	.	1	1	+	15	68
MuA	*Aconitum lycoctonum subsp. ranunculifolium*	E1	+	.	+	.	+	1	.	3	3	2	2	+	+	.	+	2	+	.	+	+	.	.	15	68
TR	*Gymnocarpium robertianum*	E1	+	.	1	.	1	1	1	1	+	1	1	+	1	1	+	2	1	1	1	2	1	1	20	91
FS	*Laburnum alpinum*	E3	.	.	.	.	.	.	4	4	4	4	4	4	4	2	3	4	3	4	1	+	.	.	14	64
FS	*Laburnum alpinum*	E2b	+	+	1	+	+	.	.	.	1	3	.	1	2	+	.	.	1	.	.	+	.	+	13	59
FS	*Laburnum alpinum*	E2a	+	.	+	.	.	+	1	1	.	1	1	.	1	+	+	1	.	+	1	1	+	+	16	73
FS	*Laburnum alpinum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	2	9
EP	*Pinus mugo*	E2b	.	.	.	.	.	1	.	1	2	.	3	3	4	5	+	1	+	+	1	+	.	+	14	64
EP	*Pinus mugo*	E2a	.	.	1	.	.	1	.	.	1	.	.	1	.	1	.	1	.	.	.	.	.	+	7	32
VP	*Clematis alpina*	E1	+	.	.	.	.	.	.	+	.	+	+	+	1	+	.	.	.	.	+	1	.	.	9	41
VP	*Homogyne sylvestris*	E1	.	.	.	.	.	.	.	.	.	+	.	.	r	+	+	.	+	.	1	1	.	1	8	36
BA	*Salix appendiculata*	E2	+	.	.	.	.	.	.	+	.	+	.	.	+	+	.	.	1	+	+	.	.	+	9	41
BA	*Sorbus chamaemespilus*	E2a	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+	.	+	.	+	.	.	+	8	36
VP	*Larix decidua*	E3a	.	.	.	.	.	1	.	.	.	.	.	r	.	+	.	1	+	.	+	r	.	.	7	32
VP	*Larix decidua*	E2b	.	.	+	+	.	4	.	.	.	.	r	.	.	.	.	.	+	+	.	.	.	+	7	32
VP	*Larix decidua*	E2a	.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	.	6	28
EP	*Carex alba*	E1	.	.	.	.	.	.	.	+	+	2	3	3	+	.	.	.	.	.	1	.	.	.	7	32
QP	*Ostrya carpinifolia*	E3	.	.	.	.	.	.	.	+	+	.	+	r	.	.	.	.	.	.	.	+	.	.	5	23
QP	*Ostrya carpinifolia*	E2b	.	.	.	.	.	.	.	.	.	r	.	+	+	+	.	.	.	.	.	r	.	.	5	23
QP	*Ostrya carpinifolia*	E2a	.	.	.	.	.	.	.	r	.	.	+	.	+	.	.	.	.	.	.	r	.	.	4	18
QP	*Ostrya carpinifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	2	9
TA	*Acer pseudoplatanus*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	1	.	.	.	.	3	14
TA	*Acer pseudoplatanus*	E2b	.	+	1	+	1	.	.	.	.	.	.	.	.	.	+	.	+	1	.	.	.	+	8	36
TA	*Acer pseudoplatanus*	E2a	.	.	.	+	.	+	.	+	.	.	+	.	.	.	+	1	1	+	.	.	.	+	9	41
TA	*Acer pseudoplatanus*	E1	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	4	18
FS	*Fagus sylvatica*	E3b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	5	4	4	18
FS	*Fagus sylvatica*	E3a	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	.	.	2	9
FS	*Fagus sylvatica*	E2b	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	1	1	+	.	6	27
FS	*Fagus sylvatica*	E2a	.	.	.	.	.	+	.	+	+	+	.	.	+	.	+	+	.	.	+	+	+	.	10	45
FS	*Fagus sylvatica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	5
EP	*Rhodothamnus chamaecistus*	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	+	+	.	+	7	32
ES	*Carex ferruginea*	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	1	4	18
AT	*Carex brachystachys*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	.	2	9

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
AF	***Aremonio-Fagion***																									
	Cyclamen purpurascens	E1	.	1	1	1	1	+	1	+	1	1	1	1	+	1	1	1	.	.	1	1	1	1	19	86
	Anemone trifolia	E1	.	.	+	.	+	.	.	+	.	1	+	.	+	1	+	1	.	.	1	1	1	+	13	59
	Knautia drymeia	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	+	3	14
	Helleborus niger	E1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Cardamine enneaphyllos	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
TA	***Tilio-Acerion***																									
	Thalictrum aquilegiifolium	E1	.	.	+	+	.	+	.	.	.	.	.	.	.	.	+	.	1	1	.	.	.	.	6	27
	Polystichum aculeatum	E1	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	4	18
	Geranium robertianum	E1	.	.	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	14
	Euonymus latifolia	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	5
	Aruncus dioicus	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	5
FS	***Fagetalia sylvaticae***																									
	Melica nutans	E1	.	.	+	+	+	1	+	2	1	1	1	1	2	1	+	1	+	+	1	1	1	+	20	91
	Mercurialis perennis	E1	+	+	1	.	1	1	2	1	1	1	1	1	+	+	1	+	1	+	.	+	1	+	20	91
	Galium laevigatum	E1	.	.	+	.	.	.	1	.	.	+	1	1	+	+	+	+	+	+	1	1	+	+	15	68
	Daphne mezereum	E2a	.	.	+	.	+	.	.	1	1	1	+	+	+	.	.	.	+	+	.	+	+	+	13	59
	Lonicera alpigena	E2a	.	.	+	+	.	.	.	.	.	1	+	.	+	+	+	+	.	+	1	+	+	.	12	55
	Galeobdolon flavidum	E1	.	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	1	.	7	32
	Dryopteris filix-mas	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	+	+	6	27
	Euphorbia amygdaloides	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	1	5	23
	Mycelis muralis	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	5	23
	Salvia glutinosa	E1	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	5	23
	Actaea spicata	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	2	9
	Brachypodium sylvaticum	E1	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Luzula nivea	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.	.	2	9
	Paris quadrifolia	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	2	9
	Epilobium montanum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5
	Epipactis helleborine	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	5
	Poa nemoralis	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
QP	***Quercetalia pubescenti-petraeae***																									
	Sorbus aria (Aria edulis)	E3a	.	.	.	.	.	.	.	1	1	1	+	.	1	+	.	+	.	.	.	.	+	.	8	36
	Sorbus aria	E2b	.	.	.	.	+	.	.	.	.	1	+	1	+	+	+	.	.	+	1	.	.	.	9	41
	Sorbus aria	E2a	.	.	.	.	+	.	+	+	.	.	1	1	+	.	.	.	.	.	1	2	.	+	9	41
	Sorbus aria	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	2	9
	Primula veris	E1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Hypericum montanum	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Convallaria majalis	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	5
QF	***Querco-Fagetea***																									
	Hepatica nobilis	E1	.	.	.	.	.	.	.	.	.	1	1	1	1	+	.	.	.	.	1	1	.	.	7	32
	Carex digitata	E1	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	5	23
QR	Potentilla erecta	E1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Lonicera xylosteum	E2a	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	2	9
	Platanthera bifolia	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	5
AI	*Dryopteris carthusiana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	1	5

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
VP	***Vaccinio-Piceetea***																									
	Picea abies	E2b	.	.	+	.	.	1	.	.	+	.	.	.	+	.	.	.	+	.	.	.	.	.	5	23
	Picea abies	E2a	.	+	+	r	.	1	.	+	+	+	.	.	.	.	.	+	+	+	.	.	+	.	11	50
	Vaccinium myrtillus	E1	.	.	.	.	.	.	.	.	.	2	+	+	+	.	.	1	.	.	1	+	.	+	8	36
	Maianthemum bifolium	E1	.	.	.	.	.	.	.	+	+	+	+	.	+	.	.	.	.	.	+	.	.	.	6	27
	Valeriana tripteris	E1	.	.	.	.	.	.	.	.	.	1	.	+	.	+	+	.	.	.	+	+	.	.	6	27
	Lonicera nigra	E2a	.	.	.	.	.	.	.	.	.	1	+	.	1	+	.	.	.	.	1	.	.	.	5	23
	Solidago virgaurea	E1	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	+	.	.	4	18
	Vaccinium vitis-idaea	E1	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	1	.	.	.	4	18
	Veronica urticifolia	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	1	+	4	18
	Abies alba	E2b	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	3	14
	Abies alba	E2a	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	3	14
	Gymnocarpium dryopteris	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	3	14
	Oxalis acetosella	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	+	.	3	14
	Calamagrostis villosa	E1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Lycopodium annotinum	E1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	2	9
	Gentiana asclepiadea	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	2	9
	Saxifraga cuneifolia	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	2	9
	Huperzia selago	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	2	9
	Rosa pendulina	E2a	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Phegopteris connectilis	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Aposeris foetida	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	5
	Hieracium murorum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	5
	Luzula pilosa	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	5
	Dryopteris expansa	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	5
	Luzula sylvatica	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	5
EP	***Erico-Pinetea***																									
	Calamagrostis varia	E1	1	1	1	1	1	2	3	1	1	1	2	1	1	+	1	2	1	2	1	2	+	1	22	100
	Molinia arundinacea	E1	+	1	+	+	1	+	.	.	+	+	+	3	3	+	+	.	3	+	.	1	.	1	17	77
	Rubus saxatilis	E1	.	+	+	1	+	+	.	.	.	.	1	1	1	1	+	1	+	+	1	.	+	+	16	73
	Erica carnea	E1	.	.	.	.	.	2	.	+	.	2	2	3	2	3	1	2	.	.	.	+	+	3	12	55
	Peucedanum rablense	E1	.	1	+	.	1	1	.	+	+	.	.	r	.	.	.	1	.	.	.	.	+	.	9	41
	Amelanchier ovalis	E2b	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	3	14
	Amelanchier ovalis	E2a	.	.	.	.	.	r	.	.	.	.	+	1	+	+	.	.	.	.	.	+	.	.	6	27
	Polygala chamaebuxus	E1	.	+	.	.	.	.	.	.	+	.	.	1	+	+	.	.	.	.	.	.	.	.	5	23
	Cotoneaster tomentosus	E2a	.	.	+	.	.	.	.	.	.	.	+	1	.	+	.	.	.	.	.	.	.	.	4	18
	Euphrasia cuspidata	E1	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	4	18
	Asperula aristata	E1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Rhamnus saxatilis	E1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Aquilegia nigricans	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5
BA	***Betulo-Alnetea***																									
	Sorbus mougeotii	E3a	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Sorbus mougeotii	E2b	.	.	.	r	.	.	.	.	.	.	+	+	r	.	.	+	.	.	.	+	.	.	6	27
	Sorbus austriaca subsp. austriaca	E2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	5

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
MuA	***Mulgedio-Aconitetea***																									
	Aconitum degenii subsp. paniculatum	E1	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	+	+	.	.	.	.	4	18
	Chaerophyllum hirsutum	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	+	1	.	.	.	.	4	18
	Athyrium filix-femina	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	4	18
	Polygonatum verticillatum	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	3	14
	Agropyron caninum	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2	9
	Veratrum album	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	2	9
	Viola biflora	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	2	9
	Senecio ovatus	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Phyteuma ovatum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5
	Crepis paludosa	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	5
SSC	***Sambuco-Salicion capreae, Rhamno-Prunetea***																									
	Sorbus aucuparia	E3a	.	.	.	.	.	.	.	+	.	+	.	+	1	.	.	.	+	.	+	.	.	.	6	27
	Sorbus aucuparia	E2b	.	.	.	.	.	.	.	.	+	+	+	+	.	1	.	.	.	.	.	.	.	.	5	23
	Sorbus aucuparia	E2a	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	+	.	.	+	.	4	18
	Sorbus aucuparia	E1	.	.	.	.	.	+	.	.	+	.	+	.	.	+	+	+	.	.	.	+	.	+	8	36
RP	*Juniperus communis*	E2b	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
RP	*Juniperus communis*	E2a	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	r	.	.	2	9
	Betula pendula	E3a	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
EA	***Epilobietea angustifolii***																									
	Fragaria vesca	E1	1	.	.	.	.	.	+	1	+	+	+	+	.	.	+	1	.	.	+	.	.	+	11	50
	Rubus idaeus	E2a	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	2	9
TG	***Trifolio-Geranietea***																									
	Vincetoxicum hirundinaria	E1	+	+	+	.	.	+	+	2	2	.	+	.	.	.	.	+	.	.	.	+	+	.	11	50
	Viola hirta	E1	.	+	.	+	+	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	7	32
	Anthericum ramosum	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	3	14
	Clinopodium vulgare	E1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Hypericum perforatum	E1	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Laserpitium siler	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Polygonatum odoratum	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Laserpitium latifolium	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Valeriana wallrothii (V. collina)	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
FB	***Festuco-Brometea***																									
	Buphthalmum salicifolium	E1	.	.	1	1	+	1	1	+	.	.	+	1	.	+	+	+	+	1	+	+	+	+	17	77
	Stachys recta agg,	E1	.	1	+	1	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	r	.	.	7	32
	Galium lucidum	E1	.	1	.	1	+	1	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	1	.	7	32
	Cirsium erisithales	E1	+	.	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	5	23
	Brachypodium rupestre	E1	.	.	.	.	.	.	.	3	3	+	+	.	.	.	.	.	.	.	.	.	.	.	.	4	18
	Carex humilis	E1	.	.	.	.	.	.	2	.	.	.	+	.	.	.	.	.	.	.	.	.	1	1	.	4	18
	Prunella grandiflora	E1	.	+	+	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	18
	Pimpinella saxifraga	E1	+	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	14
	Carlina acaulis	E1	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Euphorbia cyparissias	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	2	9
	Linum catharticum	E1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Gentianella ciliata	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
	Arabis hirsuta	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Hippocrepis comosa	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Teucrium montanum	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Gymnadenia conopsea	E1	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Briza media	E1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
MA	***Molinio-Arrhenatheretea***																									
	Galium album	E1	.	.	.	.	.	.	1	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	5	23
PaT	*Ranunculus nemorosus agg.*	E1	.	.	.	.	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	4	18
	Achillea millefolium	E1	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Lathyrus pratensis	E1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Trifolium pratense	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
CD	***Caricetalia davallianae***																									
	Parnassia palustris	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2	9
	Tofieldia calyculata	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	5
ES	***Elyno-Seslerietea***																									
	Betonica alopecuros	E1	.	2	1	1	1	2	2	+	+	1	1	2	1	1	1	1	1	1	+	1	1	1	21	95
	Laserpitium peucedanoides	E1	+	+	+	.	.	1	1	+	+	+	.	+	.	+	+	.	.	+	.	+	+	+	15	68
	Sesleria caerulea	E1	.	1	+	+	.	2	+	.	.	.	+	1	.	+	+	1	+	.	.	+	.	+	13	59
	Scabiosa lucida subsp. stricta	E1	+	.	1	+	+	1	.	.	.	.	+	.	.	.	.	+	1	1	.	.	+	.	10	45
	Carduus crassifolius	E1	1	1	+	+	1	1	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	8	36
	Thymus praecox subsp. polytrichus	E1	.	1	+	.	+	+	+	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	8	36
	Linum julicum	E1	.	+	+	+	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	6	27
	Festuca calva	E1	.	.	.	.	.	+	.	+	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	5	23
	Rhinanthus glacialis	E1	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	18
	Lotus corniculatus s. lat. (L. alpinus ?)	E1	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	3	14
	Carex mucronata	E1	.	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	14
	Helianthemum nummularium subsp. grandiflorum	E1	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	3	14
	Phyteuma orbiculare	E1	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	3	14
	Aster bellidiastrum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	2	9
	Thesium alpinum	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Dryas octopetala	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Achillea clavenae	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Acinos alpinus	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Alchemilla alpigena	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Carex sempervirens	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Euphrasia picta	E1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Juncus monanthos	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Astrantia bavarica	E1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Arabis vochinensis	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	5
	Globularia nudicaulis	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	5
	Selaginella selaginoides	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	5
TR	***Thlaspietea rotundifolii***																									
	Astrantia carniolica	E1	+	+	.	+	+	1	.	.	.	.	.	.	.	.	+	.	2	2	.	2	1	+	11	50
	Valeriana montana	E1	.	2	1	1	2	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	+	7	32
	Adenostyles glabra	E1	+	.	+	.	.	+	2	.	.	.	.	.	.	.	.	.	.	2	.	+	.	.	6	27

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
	Achnatherum calamagrostis	E1	3	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	5	23
	Biscutella laevigata	E1	.	+	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	5	23
	Campanula cespitosa	E1	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	5	23
	Festuca nitida	E1	.	.	1	+	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	5	23
	Aquilegia einseleana	E1	+	.	.	+	.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	4	18
	Gypsophila repens	E1	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	18
	Hieracium bifidum	E1	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	4	18
	Rumex scutatus	E1	+	.	+	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	18
	Trisetum argenteum	E1	.	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	4	18
	Scrophularia juratensis	E1	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	3	14
	Asplenium fissum	E1	.	.	1	+	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	14
	Arabis alpina	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	9
	Hieracium porrifolium	E1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Silene vulgaris subsp. glareosa	E1	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Viola pyrenaica	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	9
	Athamanta cretensis	E1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Petasites paradoxus	E1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Hieracium piloselloides	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Leontodon hyoseroides	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Heliosperma alpestre	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	5
	Dianthus sternbergii	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	5
	Cerastium subtriflorum	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5
	Cystopteris montana	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	5
	Soldanella alpina	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	5
AT	***Asplenietea trichomanis***																									
	Asplenium viride	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+	+	7	32
	Paederota lutea	E1	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	5	23
	Asplenium trichomanes	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	4	18
	Kernera saxatilis	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	2	9
	Moehringia muscosa	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	2	9
	Asplenium ruta-muraria	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2	9
	Cystopteris regia	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2	9
	Cystopteris fragilis	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	2	9
ML	**Mosses and lichens (Mahovi in lišaji)**																									
	Ctenidium molluscum	E0	.	.	1	1	.	1	.	.	.	1	1	1	1	+	1	.	1	1	.	1	1	1	14	64
	Tortella tortuosa	E0	+	.	.	.	1	1	.	+	.	1	1	1	.	.	+	1	1	+	+	.	.	.	12	54,5
	Hylocomium splendens	E0	.	.	+	.	.	1	.	.	.	.	+	1	+	1	+	+	.	.	+	+	.	1	11	50
	Rhytidiadelphus triquetrus	E0	.	.	.	.	.	1	.	+	.	1	1	2	1	2	1	1	.	.	1	.	.	+	11	50
	Fissidens dubius	E0	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	1	1	.	.	.	1	5	23
	Dicranum scoparium	E0	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	3	14
	Peltigera canina	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	3	13,6
	Homalothecium lutescens	E0	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	2	9
	Conocephalum conicum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	2	9
	Schistidium apocarpum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	2	9
	Mnium thomsonii	E0	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	5

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Pr.	Fr.
Plagiochila porelloides	E0	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	5
Plagiomnium undulatum	E0	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	5
Mnium sp.	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	5
Polytrichum formosum	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	5
Neckera crispa	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	1	5

Legend - Legenda

Pr. Presence (number of relevés in which the species is presented) - število popisov, v katerih se pojavlja vrsta
Fr. Frequency in % - frekvenca v %
Gr Gravel - prod
Sc Scree - grušč
Mo Moraine (Til) - morena (til)
Ta Talus - vršaj
Rs Rockslide - podorno skalovje
D Dolomite - dolomit
Co Colluvial soil - koluvialna tla
Li Lithosols - kamnišče
Re Rendzina - rendzina
QR *Quercetalia roboris*
AI *Alnion incanae*
PaT *Poo alpinae-Trisetetalia*

Table 2: Succession of vegetation on fluvial-glacial gravel sediments of the Kotarica in Klin (the Kot Valley), the Julian Alps
Preglednica 2: Sukcesijski razvoj rastja na rečno-ledeniških prodnatih nanosih Kotarice v Klinu v dolini Kot, Julijske Alpe

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6		
	Database number of relevé (Delovna številka popisa)		273197	273196	273194	273191	273190	273192		
	Elevation in m (Nadmorska višina v m)		990	990	990	980	990	980		
	Aspect (Lega)		NE	NE	NE	NE	NE	NE		
	Slope in degrees (Nagib v stopinjah)		1	1	1	1	1	1		
	Parent material (Matična podlaga)		Gr	Gr	Gr	Gr	Gr	Gr		
	Soil (Tla)		Li	Li	Re	Re	Re	Re		
	Stoniness in % (Kamnitost v %)		60	20	5	5	0	0		
	Cover in % (Zastiranje v %):									
	Upper tree layer (Zgornja drevesna plast)	E3b				60	60	60		
	Lower tree layer (Spodnja drevesna plast)	E3a			5	10	20	10		
	Shrub layer (Grmovna plast)	E2	20+60	70+20	80	30+30	20+20	40+60		
	Herb layer (Zeliščna plast)	E1	30	70	90	90	95	90		
	Moss layer (Mahovna plast)	E0	20	5		10	5	5		
	Maximum diameter of trees (Največji prsni premer dreves)	cm			20	35	35	35		
	Maximum height of trees (Največja drevesna višina)	m			15	22	20	19		
	Number of species (Število vrst)		50	73	69	54	60	47		
	Relevé area (Velikost popisne ploskve)	m^2	100	200	200	400	400	400		
	Date of taking relevé (Datum popisa)		9/19/2018	9/19/2018	9/19/2018	9/19/2018	9/19/2018	9/19/2018		
	Locality (Nahajališče)		Kot-Klin	Kot-Klin	Kot-Klin	Kot-Klin	Kot-Klin	Kot-Klin		
	Quadrant (Kvadrant)		9549/3	9549/3	9549/3	9549/3	9549/3	9549/3		
	Coordinate GK Y (D-48)	m	415054	415051	415090	415145	415070	415105		
	Coordinate GK X (D-48)	m	5140955	5140996	5141082	5141160	5141009	5141081		
	Diagnostic species of the associations (Diagnostične vrste asociacij)								Pr.	Fr.
SP	*Salix eleagnos*	E3a	.	1	+	.	.	.	2	33
SP	*Salix eleagnos*	E2b	1	+	.	.	.	.	2	33
SP	*Salix eleagnos*	E2a	4	.	+	.	.	.	2	33
SP	*Salix eleagnos*	E1	2	.	.	.	.	.	1	17
SP	*Salix purpurea*	E2b	+	.	.	.	.	.	1	17
TR	*Petasites paradoxus*	E1	3	+	+	1	+	+	6	100
EP	*Pinus mugo*	E2b	+	4	4	.	1	1	5	83
EP	*Pinus mugo*	E2a	+	1	1	+	+	.	5	83
EP	*Pinus mugo*	E1	+	.	+	.	.	.	2	33
EP	*Amelanchier ovalis*	E2b	.	+	.	.	.	.	1	17
EP	*Amelanchier ovalis*	E2a	.	+	r	.	r	.	3	50
TR	*Hieracium porrifolium*	E1	1	1	+	.	.	.	3	50
FS	*Fagus sylvatica*	E3b	.	.	.	3	3	4	3	50
FS	*Fagus sylvatica*	E3a	.	.	.	1	1	.	2	33
FS	*Fagus sylvatica*	E2b	.	+	.	+	1	1	4	67
FS	*Fagus sylvatica*	E2a	.	.	+	+	1	1	4	67
FS	*Fagus sylvatica*	E1	+	+	1	+	.	+	5	83
FS	*Laburnum alpinum*	E3a	.	.	+	+	1	r	4	67
FS	*Laburnum alpinum*	E2b	1	.	+	+	1	+	5	83
FS	*Laburnum alpinum*	E2a	.	+	.	+	1	+	4	67
EP	*Rhododendron hirsutum*	E2a	+	1	+	3	2	1	6	100
VP	*Clematis alpina*	E1	.	.	.	1	1	1	3	50
FB	*Brachypodium rupestre*	E1	.	.	.	1	1	+	3	50
VP	*Homogyne sylvestris*	E1	.	.	.	+	.	+	2	33
EP	***Erico-Pinetea***									
	Calamagrostis varia	E1	1	1	+	2	3	3	6	100
	Erica carnea	E1	+	4	4	4	4	4	6	100
	Molinia arundinacea	E1	1	2	4	+	1	1	6	100
	Carex alba	E1	.	+	+	1	2	1	5	83
	Euphrasia cuspidata	E1	+	1	1	.	.	.	3	50
	Rubus saxatilis	E1	.	.	.	1	1	1	3	50
	Allium ericetorum	E1	.	+	.	.	+	.	2	33
	Aquilegia nigricans	E1	.	+	.	.	+	.	2	33

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	Pr.	Fr.
	Asperula aristata	E1	.	+	+	.	.	.	2	33
	Carex ornithopoda	E1	1	+	.	.	.	.	2	33
	Polygala chamaebuxus	E1	.	1	1	.	.	.	2	33
	Rhodothamnus chamaecistus	E1	.	+	1	.	.	.	2	33
	Crepis slovenica	E1	.	+	.	.	.	.	1	17
	Gymnadenia odoratissima	E1	.	.	r	.	.	.	1	17
	Cotoneaster tomentosus	E2a	.	.	.	.	r	.	1	17
AF	***Aremonio-Fagion***									
	Helleborus niger	E1	.	1	1	2	1	1	5	83
	Cyclamen purpurascens	E1	.	+	+	+	1	1	5	83
	Anemone trifolia	E1	.	+	+	+	+	1	5	83
	Rhamnus fallax	E2a	+	.	.	.	.	.	1	17
	Rhamnus fallax	E2b	r	.	.	.	.	.	1	17
TA	***Tilio-Acerion***									
	Acer pseudoplatanus	E3b	.	.	.	1	1	+	3	50
	Acer pseudoplatanus	E3a	.	.	.	+	1	+	3	50
	Acer pseudoplatanus	E2b	.	.	.	.	.	+	1	17
	Acer pseudoplatanus	E2a	.	+	.	.	.	.	1	17
	Acer pseudoplatanus	E1	+	+	+	+	1	1	6	100
FS	***Fagetalia sylvaticae***									
	Melica nutans	E1	.	.	+	1	1	+	4	67
	Daphne mezereum	E2a	.	.	.	1	1	1	3	50
	Lonicera alpigena	E2a	.	.	.	2	1	+	3	50
	Galium laevigatum	E1	.	.	.	+	+	+	3	50
	Euphorbia amygdaloides	E1	.	+	.	+	.	.	2	33
	Cypripedium calceolus	E1	.	.	r	+	.	.	2	33
	Mercurialis perennis	E1	.	.	.	+	.	+	2	33
	Prenanthes purpurea	E1	.	.	.	.	+	+	2	33
	Galeobdolon flavidum	E1	.	.	.	.	+	.	1	17
	Dryopteris filix-mas	E1	.	.	.	.	.	+	1	17
QP	***Quercetalia pubescenti-petraeae***									
	Sorbus aria (Aria edulis)	E3a	.	.	.	.	.	+	1	17
	Sorbus aria (Aria edulis)	E2b	.	.	.	1	1	.	2	33
	Sorbus aria (Aria edulis)	E2a	+	+	+	1	1	+	6	100
	Sorbus aria (Aria edulis)	E1	.	+	+	.	.	.	2	33
QF	***Querco-Fagetea***									
QR	*Potentilla erecta*	E1	.	.	1	1	+	1	4	67
	Hepatica nobilis	E1	.	+	+	1	.	.	3	50
	Viola riviniana	E1	.	+	.	r	.	.	2	33
AI	*Frangula alnus*	E2a	.	.	.	.	+	.	1	17
VP	***Vaccinio-Piceetea***									
	Picea abies	E3b	.	.	.	+	1	1	3	50
	Picea abies	E3a	.	.	+	+	r	+	4	67
	Picea abies	E2b	1	.	+	+	1	+	5	83
	Picea abies	E2a	.	.	+	+	+	+	4	67
	Picea abies	E1	+	.	.	.	.	.	1	17
	Pyrola rotundifolia	E1	.	+	+	2	1	1	5	83
	Larix decidua	E3b	.	.	.	r	+	+	3	50
	Larix decidua	E3a	.	1	+	.	.	.	2	33
	Larix decidua	E2b	1	+	+	.	+	.	4	67
	Larix decidua	E2a	.	+	+	+	+	.	4	67
	Larix decidua	E1	+	+	.	.	.	.	2	33
	Vaccinium myrtillus	E1	.	.	+	3	3	3	4	67
	Vaccinium vitis-idaea	E1	.	.	+	2	2	2	4	67
	Lonicera nigra	E2a	.	.	.	1	1	+	3	50
	Orthilia secunda	E1	.	.	.	1	+	+	3	50
	Lycopodium annotinum	E1	.	.	.	+	+	+	3	50
	Gentiana asclepiadea	E1	.	+	.	.	+	.	2	33
	Veronica urticifolia	E1	.	.	.	+	.	.	1	17
	Hieracium murorum	E1	.	.	.	+	.	.	1	17
	Lonicera caerulea	E2a	.	.	.	r	.	.	1	17
	Maianthemum bifolium	E1	.	.	.	.	+	.	1	17

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	Pr.	Fr.
	Abies alba	E2a	.	.	.	.	+	.	1	17
	Aposeris foetida	E1	.	.	.	.	+	.	1	17
	Solidago virgaurea	E1	.	.	.	.	+	.	1	17
	Luzula pilosa	E1	.	.	.	.	.	+	1	17
BA	***Betulo-Alnetea***									
	Salix appendiculata	E2b	.	+	+	.	.	.	2	33
	Salix appendiculata	E2a	2	.	+	.	+	.	3	50
	Salix appendiculata	E1	1	.	.	.	.	.	1	17
	Juniperus sibirica	E2a	.	.	.	.	r	r	2	33
	Sorbus chamaemespilus	E2a	.	.	+	.	+	+	3	50
	Salix waldsteiniana	E2a	+	.	.	.	.	.	1	17
	Salix glabra	E2a	.	+	.	.	.	.	1	17
MuA	***Mulgedio-Aconitetea***									
	Polygonatum verticillatum	E1	.	.	.	.	+	.	1	17
	Athyrium filix-femina	E1	.	.	.	.	.	+	1	17
EA	***Epilobietea angustifolii***									
	Fragaria vesca	E1	.	.	.	+	+	+	3	50
SSC	***Sambuci-Salicion capreae, Rhamno-Prunetea***									
	Sorbus aucuparia	E3a	.	+	.	+	.	+	3	50
	Sorbus aucuparia	E2b	.	.	.	+	.	.	1	17
	Sorbus aucuparia	E1	.	.	+	+	+	+	4	67
RP	*Berberis vulgaris*	E2a	.	.	.	.	.	r	1	17
FB	***Festuco-Brometea***									
	Buphthalmum salicifolium	E1	+	+	1	+	+	.	5	83
	Galium lucidum	E1	+	+	+	.	+	.	4	67
	Carlina acaulis	E1	.	+	+	.	+	.	3	50
	Cirsium erisithales	E1	+	+	.	.	.	.	2	33
	Hippocrepis comosa	E1	.	1	+	.	.	.	2	33
	Prunella grandiflora	E1	.	+	1	.	.	.	2	33
	Gentianella ciliata	E1	.	1	.	.	+	.	2	33
	Festuca rupicola	E1	+	.	.	.	.	.	1	17
	Coronilla vaginalis	E1	.	+	.	.	.	.	1	17
	Stachys recta s. lat.	E1	.	+	.	.	.	.	1	17
	Gymnadenia conopsea	E1	.	.	+	.	.	.	1	17
TG	*Viola hirta*	E1	.	.	+	.	.	.	1	17
PaT	***Poo alpinae-Trisetetalia, Molinio-Arrhenatheretea***									
MA	*Angelica sylvestris*	E1	.	+	r	.	.	.	2	33
	Campanula scheuchzeri	E1	.	.	.	+	.	.	1	17
	Ranunculus nemorosus	E1	.	.	.	r	.	.	1	17
ES	***Elyno-Seslerietea***									
	Laserpitium peucedanoides	E1	.	+	1	+	1	+	5	83
	Dryas octopetala	E1	1	3	2	+	.	.	4	67
	Lotus corniculatus s. lat. (L. alpinus)	E1	.	+	1	+	+	.	4	67
	Betonica alopecuros	E1	.	+	1	.	1	+	4	67
	Aster bellidiastrum	E1	+	1	2	.	.	.	3	50
	Carex mucronata	E1	+	1	+	.	.	.	3	50
	Globularia cordifolia	E1	+	1	+	.	.	.	3	50
	Carex firma	E1	+	+	1	.	.	.	3	50
	Senecio abrotanifolius	E1	.	+	+	+	.	.	3	50
	Scabiosa lucida subsp. stricta	E1	.	+	1	.	+	.	3	50
	Carduus crassifolius	E1	+	+	.	.	.	.	2	33
	Sesleria caerulea	E1	+	.	+	.	.	.	2	33
NS	*Antennaria dioica*	E1	.	+	+	.	.	.	2	33
CD	*Tofieldia calyculata*	E1	.	+	+	.	.	.	2	33
	Achillea clavenae	E1	+	.	.	.	.	.	1	17
	Phyteuma orbiculare	E1	+	.	.	.	.	.	1	17
	Globularia nudicaulis	E1	.	+	.	.	.	.	1	17
	Thymus praecox subsp. polytrichus	E1	.	+	.	.	.	.	1	17
	Arctostaphylos alpinus	E1	.	.	+	.	.	.	1	17
	Gentiana clusii	E1	.	.	+	.	.	.	1	17
	Rhinanthus glacialis	E1	.	.	+	.	.	.	1	17
	Thesium alpinum	E1	.	.	+	.	.	.	1	17

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	Pr.	Fr.
	Ranunculus carinthiacus	E1	.	.	.	.	.	+	1	17
TR	***Thlaspietea rotundifolii***									
	Campanula cespitosa	E1	1	1	+	.	+	.	4	67
	Astrantia carniolica	E1	+	+	+	.	+	.	4	67
	Heliosperma alpestre	E1	2	+	+	.	.	.	3	50
	Dianthus sternbergii	E1	+	+	+	.	.	.	3	50
	Hieracium bifidum	E1	+	+	+	.	.	.	3	50
	Adenostyles glabra	E1	.	+	+	+	.	.	3	50
	Gymnocarpium robertianum	E1	.	.	.	1	1	+	3	50
	Achnatherum calamagrostis	E1	+	+	.	.	.	.	2	33
	Biscutella laevigata	E1	+	+	.	.	.	.	2	33
	Hieracium piloselloides	E1	+	+	.	.	.	.	2	33
	Rumex scutatus	E1	+	+	.	.	.	.	2	33
	Trisetum argenteum	E1	+	+	.	.	.	.	2	33
	Valeriana montana	E1	+	.	.	1	.	.	2	33
	Silene vulgaris subsp. glareosa	E1	1	.	.	.	.	.	1	17
	Minuartia austriaca	E1	+	.	.	.	.	.	1	17
	Papaver alpinum subsp. ernesti-mayeri	E1	+	.	.	.	.	.	1	17
	Scrophularia juratensis	E1	+	.	.	.	.	.	1	17
	Linaria alpina	E1	.	+	.	.	.	.	1	17
AT	***Asplenietea trichomanis***									
	Potentilla clusiana	E1	+	.	.	.	.	.	1	17
	Campanula thyrsoides	E1	.	+	.	.	.	.	1	17
ML	**Mosses and lichens (Mahovi in lišaji)**									
	Tortella tortuosa	E0	2	+	1	.	+	.	4	67
	Hylocomium splendens	E0	.	.	+	1	.	+	3	50
	Rhytidiadelphus triquetrus	E0	.	.	+	1	.	.	2	33
	Dicranum scoparium	E0	.	.	.	+	.	+	2	33
	Cladonia rangiferina	E0	.	.	+	.	.	.	1	17

Legend - Legenda

Pr. Presence (number of relevés in which the species is presented) - število popisov, v katerih se pojavlja vrsta
Fr. Frequency in % - frekvenca v %
Gr Gravel - prod
Li Lithosols - kamnišče
Re Rendzina - rendzina
QR *Quercetalia roboris*
AI *Alnion incanae*
TG *Trifolio-Geranietea*
NS *Nardetea strictae*
CD *Caricetalia davallianae*

PHYTOSOCIOLOGICAL DESCRIPTION OF SITES OF *SALVIA HISPANICA* L. (*LAMIACEAE*) ON RIVERINE GRAVEL TERRACES IN WESTERN SLOVENIA

FITOCENOLOŠKI OPIS RASTIŠČ VRSTE *SALVIA HISPANICA* (*LAMIACEAE*) NA PRODIŠČIH V ZAHODNI SLOVENIJI

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ABSTRACT

Phytosociological description of sites of *Salvia hispanica* L. (*Lamiaceae*) on riverine gravel terraces in western Slovenia

In late summer and autumn (late August, beginning of November) of 2018 we observed a mass occurrence (more than 500 specimens) of *Salvia hispanica,* commonly known as chia, on gravel bars of several rivers in western Slovenia (the Soča and the Sava river basins). It was blooming on many sites in the first half of November, but low daily temperatures in the second half of the month prevented seed development. This Central-American (Mexico, Guatemala) species, which is distributed as a crop also outside its native range, grew mainly in initial plant communities of riverine gravel terraces classified into associations *Polygono lapathifoliae-Salicetum eleagni* (described as new), *Chaerophyllo-Petasitetum officinalis* and *Bidenti frondosae-Panicetum barbipulvinati* nom. prov. The dominating species in these associations are perennials or hemicryptophytes (50%) and annual plants – therophytes (32%). The proportion of alien species (neophytes) is 22% and the proportion of species originating in America is 10%. The warmer climate with less precipitation and less frequent high waters in the last decade, combined with the fact that chia seeds are a commercially available food product or an ingredient in various foods (nutrients), increases the likelihood of successful seed production in chia plants and their distribution in nature. The threat of *Salvia hispanica* becoming an invasive species is therefore serious.

Key words: Chia, alien (adventive) species, plant communites, riverine gravel terraces, syntaxonomy, Slovenia

IZVLEČEK

Fitocenološki opis rastišč vrste *Salvia hispanica* (*Lamiaceae*) na prodiščih v zahodni Sloveniji

V poznem poletju in v jeseni (druga polovica avgusta-prva polovica novembra 2018) smo na prodiščih nekaterih rek v zahodni Sloveniji (povodji Soče in Save) ugotovili množično pojavljanje vrste *Salvia hispanica*, poznamo jo pod imenom čija (skupno več kot 500 primerkov). Na precej nahajališčih je v prvi polovici novembra tudi cvetela, razvoj semen pa zaradi bolj hladnih dni v drugi polovici tega meseca ni bil več mogoč. Srednjeameriška vrsta (Mehika, Gvatemala), ki je kot kulturna rastlina že precej razširjena tudi zunaj svoje domovine, je rasla predvsem v inicialnih združbah prodišč, ki jih uvrščamo v asociacije *Polygono lapathifoliae-Salicetum eleagni* (opisali smo jo kot novo), *Chaerophyllo-Petasitetum officinalis* in *Bidenti frondosae-Panicetum barbipulvinati* nom. prov. V njih ob trajnicah oz. hemikriptofitih (50 %) prevladujejo enoletnice – terofiti (32 %). Delež tujerodnih vrst (neofitov) je 22 %, delež vrst, ki so doma v Ameriki, pa 10 %. Zaradi toplejšega podnebja z manj padavinami in redkejšimi visokimi vodami v zadnjem desetletju in ker so semena čije v prosti prodaji ali kot sestavina različnih živil (hranil), je večja možnost za uspešno semenitev rastlin in njeno širjenje v naravi. Obstaja resna nevarnost, da bo vrsta *Salvia hispanica* v prihodnjih letih postala invazivka.

Ključne besede: čija, tujerodne vrste, prodišča, rastlinske združbe, Slovenija

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1 INTRODUCTION

The centre of origin of *Salvia hispanica* (family *Lamiaceae*) is in mountain areas of central and southern Mexico and Guatemala, in the tropical and subtropical climate, at elevations between 400 to 2500 m a.s.l. The plant is intolerant to freezing (frost) in all development stages. It grows in environments where minimum temperatures rarely drop below 11 °C and the maximum temperature does not exceed 36 °C, with an optimum range of 16 to 26 °C. Being a short-day plant (12 to 13 hours), its period of growth and flowering depends on the latitude of its location. In the Northern Hemisphere chia begins to flower in October. Its seeds were one of the four staple foods in the diet of Central American civilizations in the pre-Columbian era (Baginsky et al. 2017). Due to the composition of its seeds (fats, carbohydrates and proteins) – see Costantini et al. (2014), chia is cultivated not only in both countries of origin, but also in Paraguay, Bolivia, Colombia, Peru, Argentina and Australia. Seeds are exported from Mexico also to the United States of America, Japan and Europe (Baginsky et al. 2017). Chia seed has been allowed as an ingredient of food products in the market of the European Union since 2009, or 2013 (Commission Decision 2009/827/EC (2) of 13. 10. 2009; Commission Implementing Decision of 22. 1. 2013). More recently, since 2012, certain European countries have reported its subspontaneous occurrence, in particular on gravel terraces and ruderal sites (Verloove 2015, Verloove et al. 2018, Sauberer & Till 2015, Hohla 2016, Aymerich 2016, Kaplan et al. 2018, Shah & Coulson 2018, Martini, in litt.). In this articles *Salvia hispanica* is mainly considered a casual alien species that does not form self-sustaining populations in the natural environment. Experiments in Slovenia several years ago (2013) in Novo Mesto also demonstrated that the tested samples of chia did not bloom and produce seeds, despite vigorous growth (180 cm), which was attributed to photoperiodism, as it is not adapted to the length of our days (or nights) – Kreft, in litt.

Salvia hispanica was first photographed in Slovenia on 23 August 2018 on gravel terraces of the Bača River near the village of Koritnica (photo I. Dakskobler). We identified it as an alien species, a member of the mint family (*Lamiaceae*), at the excavation site on a conglomerate embankment at Tolmin in mid-September 2018 (leg. I. Dakskobler), and determined it when the plant developed buds (det. B. Vreš, 21 October 2018). On the gravel terraces along the Bača, Tolminka and Soča rivers it flowered in the first half of November 2018 (photo I. Dakskobler), at about the same time as the specimen collected on the gravel terrace and cultivated at home (photo B. Vreš) – Dakskobler et al. (2018). Its occurrence was monitored simultaneously with phytosociological research of gravel terraces in western Slovenia. As phytosociological conditions on subspontaneous localities of this Central-American species in Europe have not yet been studied in more detail, this paper provides an insight into its localities in Slovenia.

2 METHODS

Vegetation of gravel terraces along the rivers in western and partly central Slovenia (the Soča, Tolminka, Idrijca, Bača, Nadiža, Sava Bohinjka, Sava) was studied applying the Braun-Blanquet (1964) method. The relevés were entered into the FloVegSi database (Fauna, Flora, Vegetation and Paleovegetation of Slovenia) of the Jovan Hadži Institute of Biology at ZRC SAZU (T. Seliškar, Vreš & A. Seliškar 2003) and arranged into Table 1 based on hierarchical classification. We transformed the combined cover-abundance values with numerical values (1–9) according to van der Maarel (1979). Numerical comparisons were performed with the SYN-TAX 2000 program package (Podani 2001). The relevés were compared by means of "(unweighted) average linkage method" – UPGMA, using Wishart's similarity ratio. The nomenclatural source for the names of vascular plants are the Mala flora Slovenia (MFS – Martinčič et al. 2007), Flora alpina (Aeschimann et al. 2004a,b) and Gallaso et al. (2018). The names of syntaxa follow Theurillat (2004), Šilc & Čarni (2012) and Mucina et al. (2016). In the classification of species into phytosociological groups (groups of diagnostic species) we mainly refer to the Flora alpina (Aeschimann et al. 2004 a,b). The geographic coordinates of relevés from Slovenia are determined according to the Slovenian geographic coordinate system D 48 (5th zone) on the Bessel ellipsoid and with Gauss-Krüger projection.

The study area is geologically very diverse (Buser 2009), which is reflected in variegated pebbles, especially along the Bača and Idrijca rivers (limestone and dolomite as well as marlstone, chert, claystone, tuff).

Limestone pebbles dominate along the Soča, Tolminka, Nadiža and Sava Bohinjka. The climate in the lower, partly also in the central areas of the Bača and Idrijca valleys, as well as in the Soča Valley downstream from Tolmin, is relatively warm. Mean annual temperature is (9) 10 –11 °C (Cegnar 1998). A slightly lower (9 °C –10 °C) mean annual temperature is along the Soča between Tolmin and Kobarid, and along the Nadiža, whereas mean annual temperature in the stretch along the upper Bača, the Soča between Srpenica and Žaga, and along the Sava Bohinjka between Soteska and Nomenj is (7) 8 – (8) 9 °C (Cegnar, ibid.). Mean annual precipitation volume is 1800 to 3000 mm (Zupančič 1998). Rivers are torrential and release large amounts of sediments every year (Bača around 700 m^3/ km^2 of sediments – Paulič, 1995). A distinct absence of previously almost annual heavy rainfall in spring and autumn months that we have witnessed in the last decade has led to low water levels and exposed gravel terraces (Dolinar 2018, Hrvatin & Zorn 2018). This became especially obvious in the warm, although not droughty year of 2018, when there was no substantial rainfall between April and November.

3 RESULTS AND DISCUSSION

3.1 Distribution of *Salvia hispanica* in Slovenia and the most frequent accompanying species

The distribution of *Salvia hispanica* in Slovenia was determined based on 68 relevés and 7 floristic records (Figure 1).

The localities are situated at 70 to 480 m a.s.l., in the Alpine, pre-Alpine and sub-Mediterranean phytogeographical region of Slovenia. Most of them are along the Bača River and along the Tolminka River near Tolmin (Figure 2).

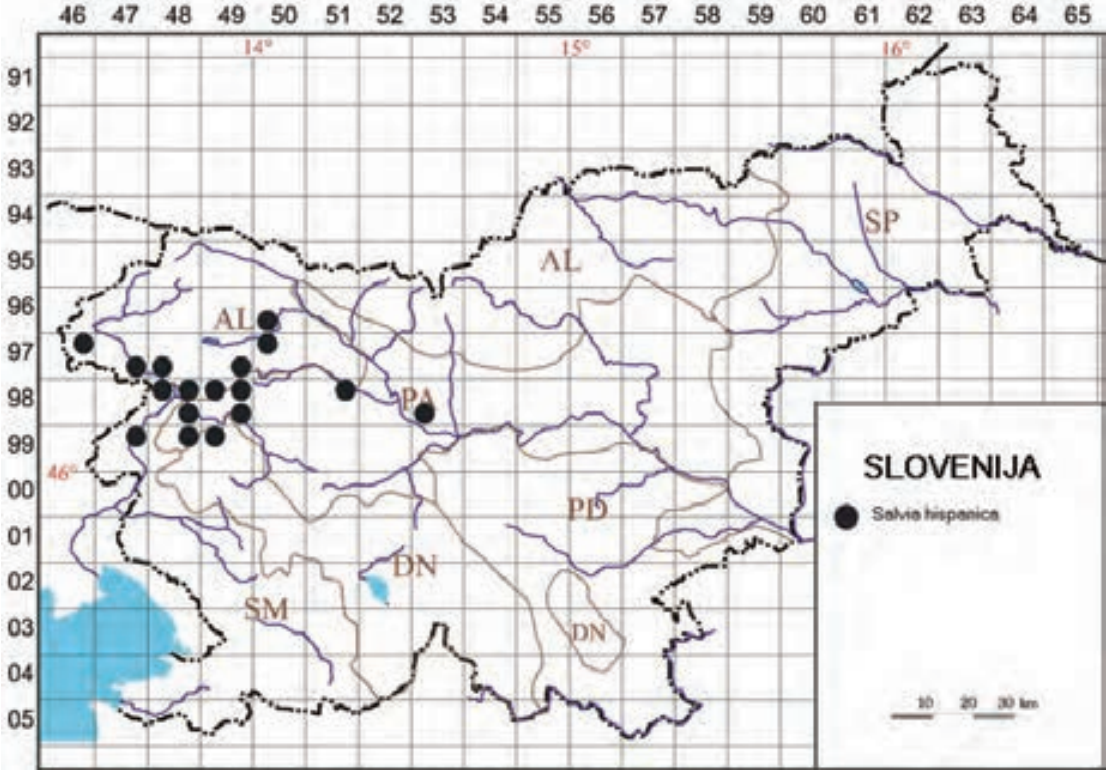

Figure 1: Distribution of Salvia hispanica in Slovenia, according the data obtained from September to November 2018
Slika 1: Razširjenost vrste Salvia hispanica v Sloveniji po podatkih iz obdobja od septembra do novembra 2018

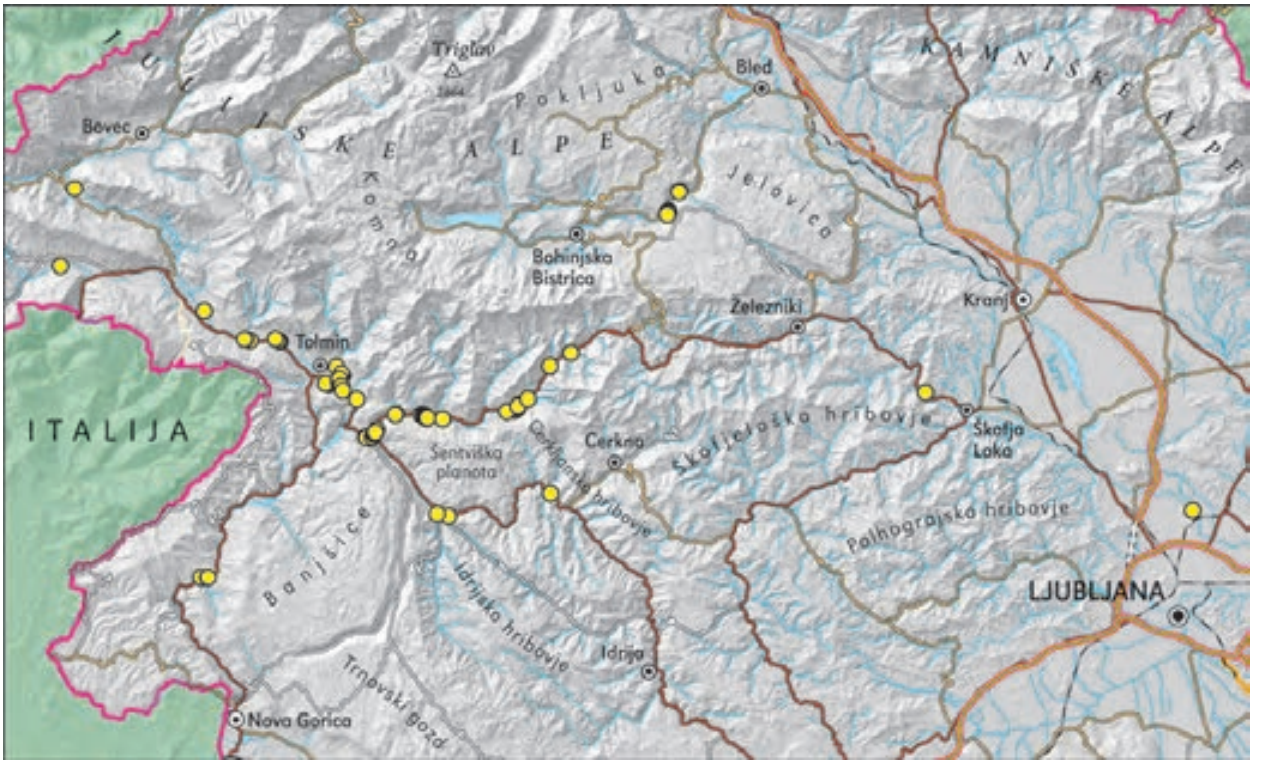

Figure 2: Localities of Salvia hispanica in western and partly central Slovenia, according to the data in autumn 2018
Slika 2: Nahajališča vrste Salvia hispanica v zahodni in deloma osrednji Sloveniji, stanje jeseni 2018

Based on the analysis of 68 relevés in Table 1 we can determine which species occur the most frequently on the sites of *Salvia hispanica*. More than 48 relevés (70% of all relevés) comprise *Plantago major* s. str., *Salix eleagnos*, *Taraxacum* sect. *Ruderalia*, *Melilotus albus*, *Polygonum mite, P. lapathifolium*, *Panicum barbipulvinatum* (*P. capillare* subsp. *barbipulvinatum,* syn. *P. riparium*), *Setaria pumila*, *Artemisia vulgaris*, *Myosoton aquaticum*, *Mentha longifolia* s. lat., *Saponaria officinalis*, *Sonchus asper*, *Agrostis stolonifera*, *Petasites hybridus* and *Poa annua*. Among a total of 356 determined taxa, 77 (22 %) were alien species or cultivated species that had escaped from gardens, including 35 (10%) American species. With the exception of the stretch along the Bača and Idrijca downstream from the confluence with the Bača, and in Tolmin (on the gravel below the cemetery at Sv. Urh and along the Tolminka), the number of chia specimens detected at individual localities was small (from one to not more than ten). The total number of observed plants in the relevés is nevertheless estimated to be more than 500.

3.2 Phytosociological description of sites of *Salvia hispanica* in Slovenia

Using hierarchical classification we compared 68 relevés of communities that comprised the studied species (Figure 3).

Based on the obtained dendrogram we arranged the relevés into Table 1. The group of five relevés in the right part of the dendrogram (Figure 3) and Table 1 stands out the most, with relevé 64 characterising an open stand of a grey willow shrub community (*Salicetum eleagno-purpureae*) and relevé 65 characterising an atypical ruderalised community on the embankment of the Sava River, where the underlying bedrock is admixed with claystone. Relevés 66 and 67 with dominant taxa *Bidens frondosa* and *Panicum barbipulvinatum* are classified into the provisional new association *Bidenti frondosae-Panicetum barbipulvinati* nom. prov. (*Salsonion ruthenicae, Digitario sanguinalis-Eragrostietea minoris*). Relevé 68 characterises a ruderal community with dominant *Ranunculus repens* and *Artemisia verlotiorum* (*Dauco-Melilotion, Artemisietea vulgaris*).

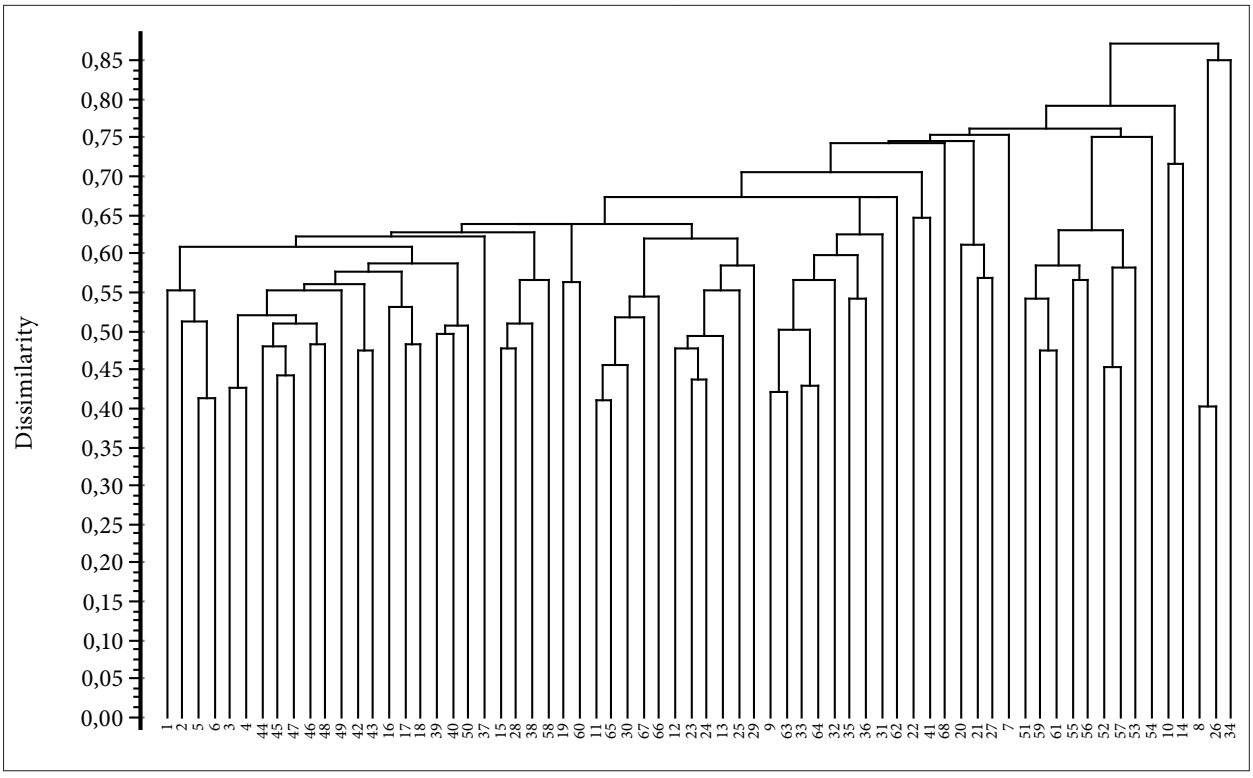

Figure 3: Dendrogram of stands with Salvia hispanica in western and central Slovenia, UPGMA, 1-similarity ratio
Slika 3: Dendrogram sestojev z vrsto Salvia hispanica v zahodni in osrednji Sloveniji, UPGMA, 1-similarity ratio

All other relevés characterise initial plant communities of riverine gravel terraces. So far, in western Slovenia phytosociological research of such initial plant communities has been conducted only for the gravel terraces along the Soča near Bovec (T. Wraber 1965: *Leontodonti berinii-Chondrilletum*; Čušin & Šilc 2006: *Salici-Myricarietum*), the Nadiža (Čušin 2001: *Epilobio-Scrophularietum caninae*) and along the Idrijca (Dakskobler 2010: *Chaerophyllo-Petasitetum officinalis*). Petkovšek (1966) described a similar initial community of gravel terraces and river embankments along the central and lower courses of rivers in central, eastern and southwestern Slovenia and classified it into the association *Calistegio-Salicetum purpureae*. In order to compare the relevés with *Salvia hispanica* with stands of the last three associations (initial plant communities on gravel terraces near Bovec are quite different) we made a synoptic table (Table 2) comprising the following syntaxa (which were named after we had conducted the comparisons):

PlSe *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 1–27 in Table 1;

PlSe–Sa *Polygono lapathyfoliae-Salicetum eleagni*, this article, relevés 28–38 in Table 1 (relevés from the Soča Valley between Volarje and Žaga and from the Sava Bohinjka Valley);

ChPo-Ba *Chaerophyllo-Petasitetum officinalis*, this article, relevés 39–46 in Table 1 (the upper part of the Bača Valley from the hamlet Humar to Podbrdo);

PlSe-ne *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 47–54 in Table 1 (atypical relevés from the valleys of the Soča, Bača, Nadiža and Sava Bohinjka);

PLSe-To, *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 55–63, initial plant community on gravel terraces of the Tolminka River near Tolmin;

ESc-Na *Epilobio-Scrophularietum caninae*, the Nadiža Valley, Čušin (2001, Table 1);

ChPo-Id *Chaerophyllo-Petasitetum officinalis*, the Idrijca Valley, Dakskobler (2010, Table 1);

CsSp *Calystegio-Salicetum purpureae*, central and southeastern Slovenia, Petkovšek (1966)

The listed syntaxa were mutually compared using hierarchical classification, which produced the dendrogram in Figure 4:

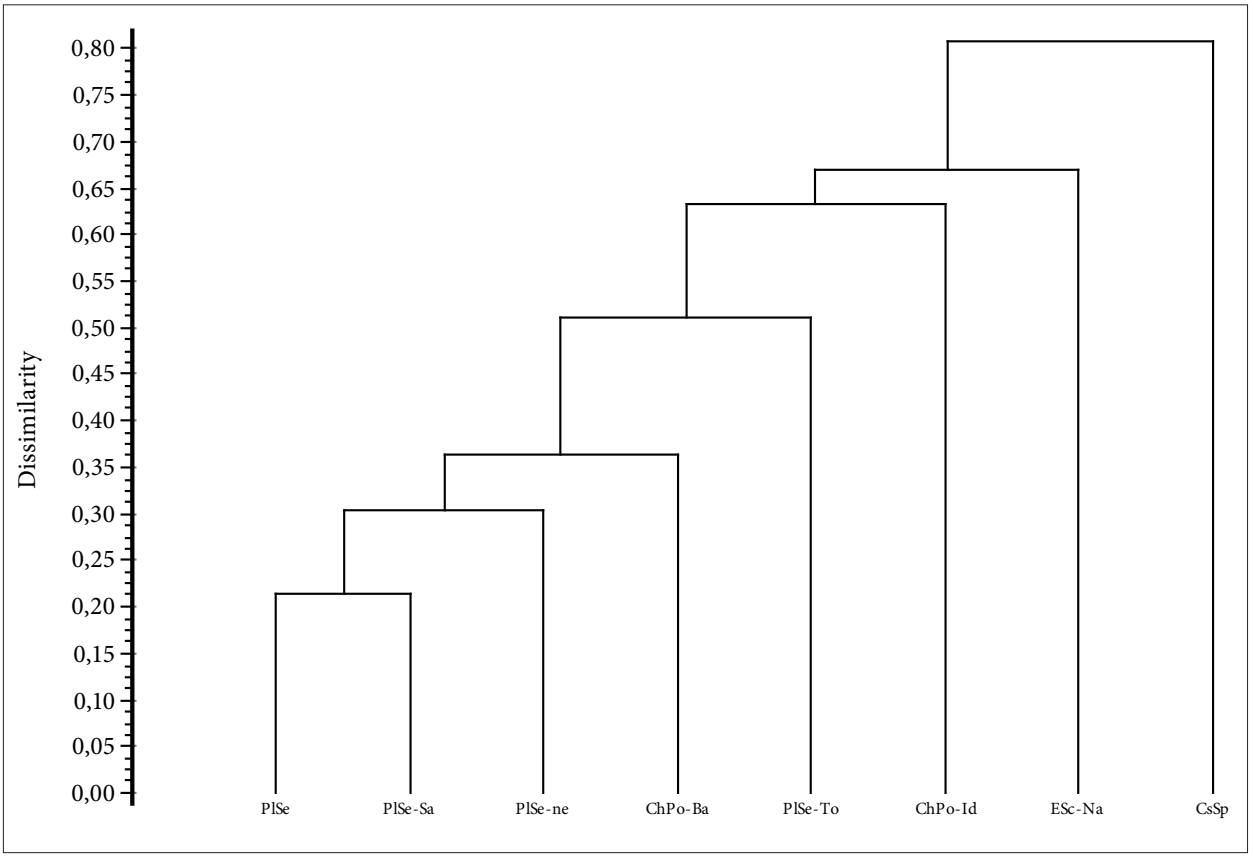

Figure 4: Dendrogram of various forms of gravel terraces communities in Slovenia (UPGMA, 1-similarity ratio)
Slika 4: Dendrogram različnih oblik prodiščnih združb v Sloveniji (UPGMA, 1-similarity ratio)

The comparison shows that gravel site stands with *Salvia hispanica* are floristically very different from the stands of associations *Epilobio-Scrophularietum caninae* and *Calystegio-Salicetum purpureae*. Floristic similarity with the stands of the association *Chaerophyllo-Petasitetum officinalis* is slightly higher and this association could also comprise stands along the upper course of the Bača between Humar and Podbrdo. While *Petasites hybridus* usually occurs also in other relevés, in places even with higher coverage, other diagnostic species of the association, such as *Chaerophyllum hirsutum, Filipendula ulmaria* and *Aegopodium podagraria,* and in particular the diagnostic species of the class *Mulgedio-Aconitetea,* into which this association is classified (Šilc & Čarni 2012, Mucina et al. 2016), are very rare. The stands along the lower course of the Tolminka near Tolmin are the most initial, but cannot be classified into any of the three associations described above because they do not comprise enough character species of any of said associations. The analysis by groups of diagnostic species and life forms (Tables 3 and 4) also shows differences between the compared syntaxa. The proportion of diagnostic species of the class *Thlaspietea rotundifolii* in the stands of the association *Epilobio-Scrophularietum caninae* is about 15%, and only 5% or less in the studied communities. Initial gravel terraces along the Nadiža have a significantly smaller proportion – less than 15% – of ruderal and segetal annuals from classes *Papaveretea rhoeadis* (*Stellarietea mediae*), *Sisymbrietea* and *Digitario sanguinalis-Eragrostietea*, whereas other compared communities always comprise more than 20% of these species. Characteristic for the stands of the association *Epilobio-Scrophularietum* is the absence of species of the class *Bidentetea tripartiti* (summer-annual pioneer vegetation of seasonally flooded nutrient-rich river alluvia, lacustrine banks and heavily nutrient-loaded anthropogenic habitats of boreotemperate Europe and North Africa) and a relatively high relative proportion of species of dry grasslands and thermophilous fringe communities (nearly 15%). In terms of life forms the community is dominated by

hemicryptophytes (almost 60%), whereas the proportion of therophytes is smaller than in any other compared community.

Characteristically, stands of the association *Chaerophyllo-Petasitetum officinalis* in the Idrijca Valley have comparatively the highest proportion of species of classes *Bidentetea* and *Filipendulo-Convolvuletea* (semi-natural fringe vegetation on banks of rivers and other water bodies of temperate Europe and the Mediterranean), and comparatively the highest proportion of species of the class *Mulgedio-Aconitetea* and alliances *Tilio-Acerion* and *Alnion incanae*. In terms of life forms this community comprises comparatively the highest proportion of geophytes.

Stands of the association *Calystegio-Salicetum purpureae* comprise a very small proportion of scree species of the class *Thlaspietea rotundifolii* and its lower syntaxonomic units; also relatively small is the proportion of species of the class *Papaveretea rhoeadis* (*Stellarietea mediae*), whereas comparatively the highest is the proportion of species of classes *Salicetea purpureae, Artemisietea vulgaris, Galio-Urticetea* and in particular of classes *Filipendulo-Convolvuletea* and *Phragmiti-Magnocaricetea*, and order *Agropyretalia intermedio-repentis*. Compared to our relevés, life forms comprise a slightly higher proportion of hemicryptophytes and a slightly smaller proportion of therophytes.

The studied gravel bar communities in which *Salvia hispanica* germinated and flowered in late summer and autumn 2018 are characterised by a predominating proportion of ruderal and segetal annuals and tall herbs of ruderal and semi-ruderal sites on nutrient-rich soil and a relatively small proportion of species characteristic for gravel terraces of mountain rivers. The predominating life forms are hemicryptophytes and therophytes. Pebbles in the studied gravel terraces, in particular those along the Bača River, are often mixed with sand. This is partly due to the geological composition of the area where this river flows, i.e. frequent admixtures of claystones, marlstone and chert in the predominantly calcareous bedrock, and partly due to the anthropogenic impact on the river course and partial transformation of the river bed that started already 120 years ago with the construction of the railway line and continued to the present day with various interventions, including construction of embankments and small hydroelectric power plants.

Analyses and comparisons that have been conducted demonstrate the complexity of classification of the studied communities into a syntaxonomic system. In terms of development, in favourable conditions the community of grey and red willow (*Salicetum eleagno-purpureae*) develops on these gravel terraces. It is marked by the presence of saplings and in places also low shrubs of grey willow (*Salix eleagnos*), partly also red willow (*Salix purpurea*) and black poplar (*Populus nigra*). If, for already stated reasons, the community is not named after the butterbur (*Petasites hybridus*), priority should be given to the species that can form the next development stage, even though that stage frequently does not develop. In the studied community it is the willows and black poplar that indicate at least a probability of higher permanence. However, at the same time we also have to take into consideration a frequently transitory nature of the studied community, which is a result of the weather conditions and occasionally also of direct human interventions. One of the species that are common in the studied gravel terraces, both in terms of constancy and medium coverage, and manifest this transitory nature is *Polygonum lapathifolium*. It is a character species of the class *Bidentetea*. In the studied community it indicates nutrient-rich gravel terraces and its seasonal, late summer-autumn peak of development.

In terms of site ecology (gravel deposits and river banks), the studied gravel bar communities are rather similar to those classified by Petkovšek (1966) into the association *Calystegio-Salicetum purpureae*. The species he identified as character species and are frequent in our relevés include *Saponaria officinalis, Rubus caesius, Solanum dulcamara* and *Agrostis stolonifera*, partly also *Lycopus europaeus*, whereas *Typhoides arundinacea* (*Phalaris arundinaceae*), *Calystegia sepium* and *Anthriscus sylvestris* are very rare and *Silene baccifera* (*Cucubulus baccifer*) completely absent. Petkovšek (ibid.) classified his association into the class *Bidentetea*. A character species of this class that is common to both communities is *Polygonum mite*, but *Polygonum lapathifolium* and *Bidens frondosa* are missing in Petkovšek's relevés, while *Bidens tripartita* is missing in ours. Frequent in both compared communities are also *Polygonum persicaria, Erigeron annuus, Chenopodium album, C. polyspermum, Urtica dioica, Artemisia vulgaris, Myosoton aquaticum, Conyza canadensis, Agropyron repens, Galeopsis pubescens, Solidago gigantea, Impatiens glandulifera, Scrophularia canina, Microrrhinum minus*, *M. littorale, Tanacetum vulgare* and *Equisetum arvense*. Both communities also comprise certain willows, with *Salix eleagnos* much more frequent in our relevés and *Salix purpurea* in Petkovšek's. *Populus nigra* is absent in his relevés, whereas our relevés are without *Salix fragilis* and *S. alba* as well as *Alnus glutinosa*. Some species diagnostic for our community are missing in Petkovšek's relevés, such as *Petasites hybridus, P. paradoxus, Silene vulgaris*

and *Scrophularia nodosa,* as well as certain very frequent species such as *Mentha longifolia, Barbarea vulgaris, Brachypodium sylvaticum, Plantago lanceolata, P. major, Solanum nigrum, Taraxacum* sect. *Ruderalia, Sonchus asper, Poa annua, Cerastium sylvaticum, Medicago lupulina, Galium mollugo, Leontodon hispidus, Daucus carota, Rumex obtusifolius, Cirsium oleraceum, Epilobium parviflorum, Verbascum thapsus, Ballota nigra, Geranium robertianum* and several others, whereas *Echinocystis lobata, Lysimachia vulgaris* and *Gratiola officinalis* are missing in our relevés. Due to low floristic similarity our stands cannot be classified into the association *Calystegio-Salicetum purpureae*, despite similar ecology and certain shared species.

We therefore decided to describe a new association *Polygono lapathifoliae-Salicetum eleagni,* into which we classify communities rich in (semi)ruderal and segetal annuals and tall herbs on relatively nutrient-rich gravel terraces along the middle course of mountain rivers that are a successional stage towards shrub communities of willows and black poplar (*Salicetum eleagno-purpureae, Salicetum albae*). The diagnostic species of the new association are *Salix eleagnos, Polygonum lapathifolium, Myosoton aquaticum, Petasites hybridus, Agrostis stolonifera, Melilotus albus, Scrophularia nodosa, Solanum dulcamara, Silene vulgaris* and *Petasites paradoxus*. They indicate a transitional form of gravel bar communities between the stands of associations *Epilobio-Scrophularietum caninae* and *Chaerophyllo-Petasitetum officinalis*, and demonstrate a significant ecological, and to a lesser extent floristic similarity with stands of the association *Calystegio-Salicetum purpureae*. The nomenclatural type of the new association, *holotypus* hoc loco, is relevé 5 in Table 1.

The new association can be classified into two different higher syntaxonomic units. In terms of site characteristics, this is the vegetation of gravel terraces of mountain rivers and could therefore be classified into the alliance *Epilobion fleischeri* (syn. *Salicion incanae*), order *Epilobietalia fleischeri* and class *Thlaspietea rotundifolii*. The problem with such classification is that most of the diagnostic species of the alliance and order are either very rare in the studied community or have not been recorded at all. Another option is to consider the entire species composition of the community and the predominating proportion of species that belong to various types of anthropogenic vegetation. We propose a new alliance *Polygono miti-Salicion eleagni* all. nov. (initial communities of nutrient-rich gravel terraces along the middle and lower course of mountain rivers with willows and short-lived annuals) into which we classify also the association *Calystegio-Salicetum purpureae* Petkovšek 1966. Diagnostic species of the new alliance are *Salix eleagnos, Salix purpurea, Polygonum mite, P. lapathifolium, P. persicaria, Diplotaxis tenuifolia, Artemisia vulgaris, Galeopsis pubescens, Myosoton aquaticum* and *Saponaria officinalis*. The new alliance is classified into the order *Convolvuletalia sepium* and class *Epilobietea angustifolii*. According to the analysis of groups of diagnostic species such classification is more appropriate than classification into the class *Bidentetea*. The nomenclatural type of the new alliance, *holotypus* hoc loco, is the association *Polygono lapathifoliae-Salicetum eleagni*.

3.3 Review of the studied syntaxa

Digitario sanguinalis-Eragrostietea minoris Mucina, Lososová et Silc in Mucina et al. 2016
Eragrostietalia J. Tx. ex Poli 1966
Salsolion ruthenicae Philippi ex Oberd. 1983
Bidenti frondosae-Panicetum barbipulvinati nom. prov.
Artemisietea vulgaris Lohmeyer et al. in Tx. Ex von Rochow 1951
Onopordetalia acanthii Br.-Bl. et Tx. ex Klika et Hadač 1944
Dauco-Melilotion Görs ex Rostański et Gutte 1971
Ranunculus repens-Artemisia verlotiorum community prov.
Epilobietea angustifolii Tx. et Preising ex von Rochow 1951
Convolvuletalia sepium Tx. ex Moor 1958
Poygono miti-Salicion eleagni all. nov.
Polygono lapathifoliae-Salicetum eleagni ass. nov.
Mulgedio-Aconitetea Hadač et Klika in Klika et Hadač 1944
Petasito-Chaerophylletalia Morariu 1967
Petasition officinalis Sillinger 1933
Chaerophyllo-Petasitetum officinalis Kaiser 1926
Salicetea purpureae Moor 1958
Salicetalia purpureae Moor 1958
Salicion eleagno-daphnoidis (Moor 1958) Grass 1993
Salicetum eleagno-purpureae Sillinger 1933

3.4 Assessment of invasiveness of *Salvia hispanica* in Slovenia

The plants we saw flowering in 2018 were unable to successfully develop seeds. The abundant occurrence of *Salvia hispanica* on gravel terraces of rivers in western Slovenia may be at least partly attributed to weather conditions (very warm autumn, low water levels).

Many foods and foodstuffs used in Slovenia already comprise chia seeds and these have obviously made their way to nature.

Two predictions can be made:

- *Salvia hispanica* will occasionally occur on gravel terraces and similar ruderal sites, gravelly and talus slopes and embankments, in the colline and submontane belt, but the population will not persist in the same localities for consecutive years.

- Gradually, a stable population will develop that will be able to successfully complete the entire development cycle on certain localities. As a result, chia will invade riverine plant communities, not only on gravel terraces, but also on embankments and in open gaps in riverine stands as well as on other ruderal and segetal sites in the colline and submontane belt.

4 CONCLUSIONS

The Central-American species *Salvia hispanica* (Mexican chia) is a crop whose seeds are used in certain foods that have become popular and freely available in recent years also throughout Europe. In recent years, several European countries have reported its subspontaneous occurrence on ruderal sites, embankments and river gravel terraces. In Slovenia it germinated, grew and even flowered in late summer and autumn of 2018 quite abundantly (at least 500 specimens), mainly on gravel terraces along the middle and lower course of torrential mountain rivers in western, and partly the central part of the country, and completed its development cycle (except for seeds) in the period between mid-August and mid-November. The weather conditions were extremely favourable, with warm autumn, little rainfall and very few days with temperatures near frost. *Salvia hispanica* was, in particular along the Bača River, one of the most constant species in the relatively nutrient-rich gravel bar community that we classify into the association *Polygono lapathifoliae-Salicetum eleagni* and is a developmental stage towards the community of grey and red willow (*Salicetum eleagno-purpureae*). Stands of the association *Polygono lapathifoliae-Salicetum eleagni* frequently comprises also other short-lived annuals, character species of various groups of anthropogenic vegetation. These include a number of alien species, including those considered invasive in Slovenia (*Erigeron annuus, Ambrosia artemisiifolia, Impatiens glandulifera, Helianthus tuberosus, Solidago gigantea, Bidens frondosa, Panicum barbipulvinatum*, *Buddleja davidii, Senecio inaequidens, Artemisia verlotiorum* and others). For now, *Salvia hispanica* does not have the status of an invasive species in Europe as it is assumed unable to self-sustain and spread further into local plant communities. Its occurrence therefore depends on seeds that are introduced into these communities via foods in various ways, but always with indirect human intervention. Based on the phytosociological analysis of the communities in which this Central-American species grew in western Slovenia in autumn 2018, climate prognoses as well as its increased cultivation and use, and taking into account possible development of adapted genotypes we estimate that the threat of this species becoming invasive in Central and Southern Europe is serious.

5 POVZETEK

Srednjeameriška vrsta *Salvia hispanica* (mehiška čija) iz družine *Lamiaceae* je tudi kulturna rastlina, katere semena so vsebovana v nekaterih živilih, ki so v zadnjih letih v pogosti prodaji in uporabi tudi v Evropi. V zadnjih letih v nekaj evropskih državah opažajo njeno subspontano pojavljanje na ruderalnih rastiščih, brežinah in prodiščih rek. V Sloveniji je v poznem poletju in jeseni 2018 precej množično (najmanj 500 primerkov) vzklila, zrasla in v novembru celo cvetela predvsem na prodiščih srednjega in spodnjega teka gorskih hudourniških rek v zahodnem in deloma osrednjem delu države (Nadiža, Soča, Tolminka, Bača, Idrijca, Sava Bohinjka, Selška Sora, Sava), in ves razvojni cikel (razen semen) naredila v času od srede avgusta do srede novembra. Vremenske razmere so bile zelo ugodne, topla jesen z malo padavinami in zelo redkimi dnevi s temperaturami blizu slane. Še posebej ob reki Bači je bila v tem letu ena izmed najbolj stalnih vrst v s hranili razmeroma bogati prodiščni združbi, ki je razvojna stopnja proti združbi sive in rdeče vrbe (*Salicetum eleagno-purpureae*) in jo uvrščamo v novo asociacijo *Polygono lapathifoliae-Salicetum eleagni*. V tej združbi so pogoste tudi druge kratkožive enoletnice, značilnice različnih skupin antropogene vegetacije. Med njimi je precej tujerodnih

vrst, tudi take, ki jih v Sloveniji obravnavamo kot invazivke (*Erigeron annuus, Ambrosia artemisiifolia, Impatiens glandulifera, Helianthus tuberosus, Solidago gigantea, Bidens frondosa, Panicum barbipulvinatum, Buddleja davidii, Senecio inaequidens, Artemisia verlotiorum* idr.). Nekatere prodiščne sestoje, v katerih se pojavlja vrsta *Salvia hispanica* v zgornjem delu doline Bače med domačijo Humar in Podbrdom in kjer je v zeliščni plasti pogost navaden repuh (*Petasites hybridus*), uvrščamo v asociacijo *Chaerophyllo-Petasitetum officinalis*. Na dveh krajih, pri sotočju Idrijce in Trebušice in ob Savi pri Ježici (tam manj očitno), smo oljno kaduljo (čijo) popisali v zelo vrzelastih grmiščnih sestojih z vrbami (*Salicetum eleagno-purpureae* s. lat.). Pri Tolminu pa smo jo opazili tudi v bolj ruderalni združbi na izkopu konglomeratne brežine, v kateri sta prevladovali vrsti *Bidens frondosa* in *Panicum barbipulvinatum* in jo začasno uvrščamo v asociacijo *Bidenti frondosae-Panicetum barbipulvinati* nom. prov., in v še bolj ruderalni združbi na peščenih tleh, s prevladujočima vrstama *Ranunculus repens* in *Artemisia verlotiorum*.

Vrsta *Salvia hispanica* za zdaj v Evropi še nima statusa invazivke, saj predpostavljamo, da se ni sposobna sama ohranjati in se naprej širiti v tukajšnje rastlinske združbe, torej je njeno pojavljanje vezano na semena, ki iz živil na različne načine, a vedno s posrednim človekovim posredovanjem, pridejo vanje. Na podlagi fitocenološke analize združb, v katerih je jeseni leta 2018 uspevala v zahodni Sloveniji, podnebnih prognoz in povečane gojitve in uporabe, z možnostjo razvoja prilagojenih genotipov, ocenjujemo, da je resna nevarnost, da ta srednjeameriška vrsta v srednji in južni Evropi postane invazivna.

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Figure 5: Stand of the association Bidenti frondosae-Panicetum barbipulvinati at Tolmin
Slika 5: Sestoj asociacije Bidenti frondosae-Panicetum barbipulvinati pri Tolminu

Figure 6: Stand of the association Chaerophyllo hirsuti-Petasitetum officinalis at Podbrdo
Slika 6: Sestoj asociacije Chaerophyllo hirsuti-Petasitetum officinalis pri Podbrdu

Figure 7: Stand of the association Polygono lapathifoliae-Salicetum eleagni at Bača pri Modreju
Slika 7: Sestoj asociacije Polygono lapathifoliae-Salicetum eleagni pri Bači pri Modreju

Figure 8: Salvia hispanica on gravel bars of Bača at Bača pri Modreju in the first half of November 2018
Slika 8: Oljna kadulja (Salvia hispanica) na prodiščih Bače pri Bači pri Modreju v začetku novembra 2018

Table 1: Communities with *Salvia hispanica* in Slovenia
Preglednica 1: Združbe z vrsto *Salvia hispanica* v Sloveniji

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)			272214	272215	272227	272228	272220	272221	272778	272780	272782	272781	272783	272784	272763	272770
Elevation in m (Nadmorska višina v m)			350	214	338	346	175	175	206	206	210	210	210	210	206	206
Aspect (Lega)			NW	0	0	0	0	0	0	0	0	0	0	0	0	0
Slope in degrees (Nagib v stopinjah)			2	0	0	0	0	0	0	0	0	0	0	0	0	0
Parent material (Matična podlaga)			Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Soil (Tla)			Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl
Stoniness in % (Kamnitost v %)			100	100	100	100	100	100	100	100	100	100	100	100	100	50
Cover of tree layer in % (Zastiranje drevesne plasti v %):	E3															
Cover of shrub layer in % (Zastiranje grmovne plasti v %):	E2															
Cover of herb layer in % (Zastiranje zeliščne plasti v %):	E1		70	50	70	70	45	50	35	40	35	60	50	65	40	50
Number of species (Število vrst)			45	59	106	84	90	60	62	53	58	96	88	68	52	48
Relevé area (Velikost popisne ploskve)		m^2	50	50	100	100	100	100	100	100	100	100	100	100	100	100
Date of the relevé (Datum popisa)			8/23/2018	8/24/2018	8/23/2018	8/23/2018	8/24/2018	8/24/2018	9/29/2018	9/29/2018	9/29/2018	9/29/2018	9/29/2018	9/29/2018	9/29/2018	9/29/2018
Locality (Nahajališče)			Humar-Bača	Slatne-Bača	Humar-Bratina-Bača	Humar-Bača	Lušin-Bača	Lušin-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača	Klavže-Bača
Quadrant (Kvadrant)			9849/1	9849/1	9849/1	9849/1	9848/2	9848/2	9848/2	9848/2	9848/2	9848/2	9848/2	9848/2	9848/2	9848/2
Coordinate GK Y (D-48)		m	415346	410138	415134	415411	406874	406819	408816	408873	408963	408893	409018	409059	408694	408626
Coordinate GK X (D-48)		m	5113947	5113273	5113856	5114013	5113638	5113588	5113583	5113527	5113337	5113401	5113321	5113360	5113578	5113579
Diagnostic species of the associations (Diagnostične vrste asociacij)																
SP	Fa	*Salix eleagnos*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SP	Fa	*Salix eleagnos*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SP	Fa	*Salix eleagnos*	E1	1	1	.	.	2	1	3	2	+	1	2	1	2	2
AV	He	*Melilotus albus*	E1	1	.	1	1	1	1	1	1	1	1	1	1	+	.
BT	Te	*Polygonum lapathifolium*	E1	1	+	2	1	2	1	+	1	2	2	1	2	1	+
FP	He	*Myosoton aquaticum*	E1	1	1	1	1	+	1	+	1	1	.	1	+	+	+
GU	Ge	*Petasites hybridus*	E1	2	3	2	2	+	+	2	1	1	1	2	2	2	3
PP	He	*Agrostis stolonifera*	E1	.	+	+	+	+	+	+	+	+	+	+	+	+	+
FS	Ge	*Scrophularia nodosa*	E1	+	1	+	1	1	+	+	+	+	+	1	1	.	+
AI	Ha	*Solanum dulcamara*	E1	.	+	+	+	+	.	.	+	+	+	+	+	+	+
FB	He	*Silene vulgaris*	E1	+	+	+	+	+	+	+	.	+	+	.	.	.	.
PeP	Ge	*Petasites paradoxus*	E1	.	+	+	.	+	1	+	.	+	.	.	+	.	.
FP	Ha	*Mentha longifolia*	E1	1	+	+	+	1	+	.	1	+	1	1	+	+	1

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	40	41	42	43	44
272539	272540	272541	272755	272756	272788	272753	272538	272715	272754	272799	272641	272801	272501	272812	272721	272816	272814	272521	272698	272699	272522	272700	272718	272475	272807	272724	272808	272723	272751
149	149	149	160	160	160	162	156	155	160	160	224	160	470	475	480	480	480	157	170	175	157	175	330	360	346	415	362	415	445
0	0	0	0	0	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl
70	100	100	40	30	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	80	80	60
						30																						20	
70	40	40	60	70	50	35	30	25	40	30	30	35	40	40	40	50	50	25	30	35	25	40	35	70	70	70	70	690	60
66	68	69	74	76	52	75	47	36	59	44	60	67	40	63	60	79	54	68	65	73	80	91	92	53	59	35	47	27	37
50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	50	50	50	50	50	20
10/14/2018	10/14/2018	10/14/2018	9/30/2018	9/30/2018	9/30/2018	9/30/2018	10/14/2018	9/7/2018	9/30/2018	10/22/2018	10/4/2018	10/22/2018	10/15/2018	10/15/2018	10/18/2018	10/18/2018	10/18/2018	5/1/2009	10/10/2018	10/10/2018	5/1/2009	10/10/2018	10/16/2018	10/1/2018	10/20/2018	10/20/2018	10/20/2018	10/20/2018	11/8/2018
Most na Soči-Idrijca	Most na Soči-Idrijca	Most na Soči-Idrijca	Bača pri Modreju	Bača pri Modreju	Bača pri Modreju	Bača pri Modreju	Bača pri Modreju	Bača pri Modreju	Bača pri Modreju	Tolmin-Tolminka	Reka-Kurnik	Tolmin-Tolminka	Soteska-Sava Bohinjka	Soteska-Sava Bohinjka	Soteska-Nomenj-Sava	Soteska-Nomenj-Sava	Soteska-Nomenj-Sava	Volarje-Soča	Ladra-Soča	Volarje-Kamno-Soča	Volarje-Soča	Volarje-Kamno-Soča	Žaga-Soča	Humar-Bača	Humar-Bača	Znojile,pri Honzu-Bača	Znojile,pri Honzu-Bača	Znojile,pri Honzu-Bača	Podbrdo-Mahorc-Bača
9848/4	9848/4	9848/4	9848/4	9848/4	9848/4	9848/2	9848/4	9848/4	9848/4	9848/1	9849/4	9848/1	9650/3	9650/3	9750/1	9750/1	9750/1	9748/3	9747/4	9747/4	9748/3	9747/4	9746/2	9849/1	9849/1	9849/2	9849/1	9849/2	9749/4
404755	404781	404814	405354	405398	405416	405477	405073	405209	405320	402852	417723	403030	426785	426764	426006	426032	426022	398712	393388	396599	398576	396286	384276	415523	415435	417678	416131	417669	419166
5112025	5111992	5111977	5112262	5112315	5112349	5112467	5111938	5112005	5112223	5115827	5108047	5115566	5129284	5129206	5127908	5127737	5127837	5118698	5120842	5118767	5118774	5118851	5129454	5114252	5114160	5116978	5114680	5116963	5117901
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1	1	2	1	1	1	+	+	+	+	.	1	+	+	+	1	.	+	+	+	+	+	+	1	+	+	+	+	.	2
.	1	2	1	1	1	+	1	+	1	1	.	1	1	1	1	1	2	+	+	+	+	+	+	.	+	.	1	1	+
1	+	+	+	+	+	.	+	+	+	.	+	+	1	2	1	1	1	1	+	+	1	+	+	1	1	1	1	.	+
+	+	+	1	+	1	2	+	1	+	.	1	+	+	+		1	+	+	.	.	.	.	+	2	2	4	3	2	3
.	+	+	+	+	+	+	.	.	+	+	+	+	+	+	+	+	+	1	+	+	1	+	+	1	1	1	1	1	1
+	+	+	+	+	.	+	.	+	+	.	+	+	1	1	+	1	+	1	1	1	1	+	+	+	1	.	+	.	+
+	.	1	+	+	+	+	+	+	+	+	+	.	+	+	1	1	.	r	+	+	+	+	+	+	+	.	.	.	1
+	+	+	.	+	+	+	+	+	+	+	+	+	.	+	+	+	+	r	+	+	+	+	+		+	.	+	.	.
.	.	.	1	2	1	1	.	.	1	+	+	+	+	+	+	.	+	1	1	1	1	2	1	+	.	+	.	1	.
1	1	1	1	1	+	+	.	+	+	+	+	+	+	+	1	1	1	+	1	1	.	1	+	1	1	3	2	2	1

			Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Mo	He	*Cirsium oleraceum*	E1	.	.	+	+	.	+	.	r	.	.	+	+	.	.
Am-N	BT	Te	*Bidens frondosa*	E1	.	.	+	.	+	+	.	.	.	+	+	+	+	.
Am-N	SM	Te	*Panicum barbipulvinatum (P. riparium)*	E1	+	.	+	.	1	+	+	+	+	1	+	.	+	+
Am-N	FC	Ge	*Helianthus tuberosus*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	+
As-E	AV	He	*Artemisia verlotiorum*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	MA	He	*Ranunculus repens*	E1	+	.	.	.	.	.	.	.	.	.	+	+	.	.
	EF		***Epilobion fleischeri***															
		He	*Scrophularia canina*	E1	.	.	.	.	+	.	+	.	.	+	+	+	+	.
As-E		Fa	*Buddleja davidii*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Erucastrum gallicum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Hieracium piloselloides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Equisetum ramosissimum*	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.
	Stc		*Stipion calamagrostis*															
		He	*Calamintha einseleana*	E1	.	+	+	+	+	+	+	+	+	+	+	.	.	+
		Te	*Microrrhinum litorale*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
		He	*Equisetum variegatum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Chamaenerion palustre*	E1	.	.	r	.	.	.	.	.	.	.	.	.	.	.
		He	*Peucedanum verticillare*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Achnatherum calamagrostis*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
		Te	*Galeopsis angustifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PeP		***Petasition paradoxi***															
		He	*Arabis alpina*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Gypsophila repens*	E1	.	.	.	.	+	.	.	.	.	.	r	.	.	.
		He	*Hieracium porrifolium*	E1	.	.	.	.	.	.	.	.	.	.	r	.	.	.
		He	*Aquilegia einseleana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Aurinia petraea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Campanula cespitosa*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Cerastium subtriflorum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Leontodon hispidus subsp. hyoseroides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	GA		***Galeopsietalia segetum***															
		He	*Epilobium collinum*	E1	.	.	r	.	.	.	.	.	.	.	.	.	.	.
	TR		*Thlaspietea rotundifolii*															
		He	*Hieracium bifidum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Af-S		Ha	*Senecio inaequidens*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	AT		***Asplenietea trichomanis***															
		He	*Cymbalaria muralis*	E1	+	.	+	+	.	.	.	.	+	+	+	.	.	.
		Te	*Sedum hispanicum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Moehringia muscosa*	E1	.	.	r	.	.	.	.	.	.	.	.	.	.	.
		He	*Sedum album*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Hieracium glaucum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Micromeria thymifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	MuA		***Mulgedio-Aconitetea***															
		He	*Senecio ovatus*	E1	.	.	.	+	+	.	.	.	.	.	+	.	.	.
		He	*Silene dioica*	E1	.	.	.	.	+	+	.	.	.	.	.	+	.	.
		Fa	*Salix appendiculata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	SP		***Salicetea purpureae***															
		Fa	*Populus nigra*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Populus nigra*	E2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Populus nigra*	E1	.	.	.	.	.	.	.	.	.	.	.	.	1	+
		Fa	*Salix purpurea*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Humulus lupulus*	E1	.	.	.	.	.	r	+	.	.	.	.	.	.	.
		Fa	*Salix daphnoides*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Salix alba*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	BT		***Bidentetea***															
		Te	*Polygonum mite*	E1	.	.	+	.	1	.	1	2	1	2	2	2	1	2
		Te	*Rorippa palustris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Polygonum hydropiper*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	SM		***Papaveretea rhoeadis (Stellarietea mediae)***															
		He	*Plantago major*	E1	.	+	+	+	+	+	+	+	+	+	+	+	+	+
		He	*Taraxacum sect. Ruderalia*	E1	+	1	1	1	1	2	+	1	1	1	1	.	1	+
		Te	*Sonchus asper*	E1	+	+	1	1	1	1	+	+	+	+	+	+	1	+
		Te	*Poa annua*	E1	+	.	+	.	+	+	+	1	+	+	+	1	+	+

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	40	41	42	43	44
.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.	+	.	+	+	+	.	+	+	+	+	.	.	+	.
.	+	+	+	+	+	+	.	.	.	.	+	.	.	.	.	.	.	+	+	+	+	+	1	.	.	.	.	.	.
+	+	+	1	1	1	+	.	r	+	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	+	+	+	.	.
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.	.	.	+	r	.	.	.	.	.	.	.	r	.	.	.	.	+	+	+	.	1	+	.	.	.	.	.	.	.
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		Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Te	*Solanum nigrum subsp. nigrum*	E1	.	+	+	.	1	+	+	+	+	+	+	.	+	+
Am-C,S	Te	*Solanum lycopersicum*	E1	.	+	+	1	+	+	.	+	+	+	+	.	+	.
Am-N	Te	*Erigeron annuus subsp. annuus*	E1	.	+	.	+	+	+	.	.	.	+	.	+	+	+
	Te	*Microrrhinum minus*	E1	.	+	+	1	+	+	+	.	+	.	+	.	+	.
Am-S	Te	*Galinsoga ciliata*	E1	.	+	+	.	+	+	.	+	.	.	+	+	.	.
	Te	*Polygonum persicaria*	E1	1	2	1	1	1	1	+	1	+	1	.	+	1	+
	Te	*Stellaria media*	E1	+	+	+	+	+	.	.	+	.	+	+	+	.	.
	He	*Cardamine hirsuta*	E1	.	+	.	.	.	.	.	.	+	.	.	.	.	.
	Te	*Oxalis fontana*	E1	.	.	+	+	+	+	+	.	+	+	+	.	.	.
	Te	*Rorippa sylvestris*	E1	+	.	+	+	.	.	+	+	.	+	+	+	+	+
AS-Ce	Te	*Veronica persica*	E1	.	.	.	.	+	+	.	.	.	+	+	.	.	.
	Te	*Polygonum aviculare*	E1	+	.	+	.	+	.	.	+	+	.	+	.	.	.
	Te	*Capsella bursa-pastoris*	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	.
AM-S	Te	*Galinsoga parviflora*	E1	+	1	+	+	1	1	+	.	+	+	+	.	.	.
	Te	*Senecio vulgaris*	E1	.	+	.	.	.	.	.	.	.	+	+	+	.	.
	He	*Chelidonium majus*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Am-N	Te	*Helianthus annuus*	E1	1	+	2	2	1	+	.	.	.	.	.	.	.	.
	Te	*Sonchus oleraceus*	E1	.	.	+	.	.	+	.	.	.	+	.	.	+	.
	Te	*Lamium purpureum*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Med	Te	*Satureja hortensis*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
E-Af	Te	*Guizotia abyssinica*	E1	.	.	.	.	+	.	.	.	.	.	.	+	.	.
Med	Te	*Matricaria chamomilla*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AS	Te	*Cucumis sativus*	E1	.	.	+	.	+	+	.	.	.	+	.	.	.	.
Am-N	Te	*Cucurbita pepo*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	Te	*Cerastium glomeratum*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	te	*Euphorbia helioscopia*	E1	.	.	+	+	+	.	.	.	.	.	.	.	.	+
	Te	*Fallopia convolvulus*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	+
	He	*Mentha arvensis*	E1	.	.	.	.	.	.	+	.	.	.	.	+	.	.
Goj.	He	*Viola x wittrockiana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med	Te	*Beta vulgaris subsp. vulgaris*	E1	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Goj.	Te	*Lactuca sativa*	E1	.	+	+	.	.	.	.	.	.	.	.	.	.	.
Goj.	Te	*Linum usitatissimum*	E1	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Am-C,S	Te	*Tagetes erecta*	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Am-S	He	*Verbena bonariensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med.	Te	*Calendula officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Brassica napus subsp. napus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
As-E	Te	*Callistephus chinensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-C,S	Te	*Cleome spinosa*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
As-W	Te	*Consolida ajacis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Myosotis arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med	Te	*Papaver rhoeas*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aus-Nz	Te	*Tetragonia tetragonoides*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	Te	*Veronica arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	te	*Vicia hirsuta*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Eu-SE	He	*Antirrhinum majus*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Am-S	Te	*Bidens bipinnata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eu-W- med	Te	*Brassica oleracea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Brassica sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Cichorium sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	GE	*Convolvulus arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med-As-W	Te	*Avena sativa*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	te	*Euphorbia platyphyllos*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	Te	*Galium aparine*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Goj.	Te	*Papaver somniferum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
As-SW	Te	*Secale cereale*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Med	Te	*Sinapis arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Sonchus asper subsp. glaucescens*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	Te	*Veronica sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N	He	*Viola sororia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SI		***Sisymbrietea***															
	He	*Diplotaxis tenuifolia*	E1	+	+	.	1	+	.	1	.	+	+	+	+	+	.
	Te	*Anagallis arvensis*	E1	.	.	+	.	+	+	.	.	+	+	+	.	.	.

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			Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Te	*Lactuca serriola*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-S		He	*Physalis peruviana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Atriplex patula*	E1	.	.	+	.	+	+	+	.	.	+	.	+	.	.
		He	*Cichorium intybus*	E1	.	.	.	+	.	.	.	.	.	.	.	+	.	.
		he	*Crepis taraxacifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med-As		Te	*Euphorbia lathyris*	E1	.	.	+	.	.	.	.	.	.	.	.	.	+	.
		Te	*Geranium purpureum*	E1	.	.	+	.	+	.	.	.	.	.	+	.	.	.
Am-N		Te	*Lepidium virginicum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Solanum nigrum subsp. schultesii*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Am-C,S		Te	*Datura stramonium*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
EU-S		Te	*Iberis umbellata*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
		Te	*Potentilla norvegica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Sisymbrium officinale*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	DE		***Digitario sanguinalis-Eragrostietea minoris***															
		Te	*Setaria pumila*	E1	1	1	1	1	1	1	+	+	+	+	+	+	+	+
		Te	*Digitaria sanguinalis*	E1	.	.	.	.	+	1	.	.	.	+	+	.	+	+
Am-N		Te	*Conyza canadensis*	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Ambrosia artemisiifolia*	E1	.	.	+	+	+	.	.	.	.	+	+	+	.	.
		Te	*Echinochloa crus-galli*	E1	.	+	.	.	+	+	+	.	.	+	.	.	+	+
		Te	*Chenopodium album*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
		Te	*Chenopodium polyspermum*	E1	.	.	+	+	+	.	.	.	.	.	.	.	+	.
Am-N,C		Te	*Amaranthus powellii*	E1	.	.	.	.	+	.	.	.	.	.	.	+	.	.
Am-N,C		Te	*Amaranthus cruentus*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
		Te	*Digitaria ischaemum*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
As-E		Te	*Setaria faberi*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Am-N		Te	*Acalypha virginica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Amaranthus blitum (A. lividus)*	E1	.	.	.	.	.	.	+	.	.	.	+	.	.	.
		Te	*Euphorbia peplus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Med		Te	*Eragrostis cilianensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Euphorbia marginata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Am-S		Te	*Conyza sumatrensis*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
As-S		He	*Abutilon theophrasti*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
As-S		Te	*Amaranthus caudatus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Amaranthus retroflexus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		te	*Setaria italica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Euphorbia nutans*	E1	.	.	.	.	.	+	.	.	.	.	.	.	.	.
	AV		***Artemisietea vulgaris***															
Am-C,S		Te	*Salvia hispanica*	E1	+	+	3	2	2	+	+	+	+	1	1	+	+	r
		He	*Artemisia vulgaris*	E1	1	1	2	1	+	+	+	1	1	1	+	1	1	+
		He	*Rumex obtusifolius*	E1	+	.	+	+	.	+	.	.	+	+	+	+	.	.
		He	*Ballota nigra subsp. meridionalis*	E1	.	.	.	.	+	+	+	+	.	+	+	+	+	.
		Te	*Silene latifolia subsp. alba*	E1	.	.	.	1	+	.	.	.	.	.	.	.	+	.
		He	*Tanacetum vulgare*	E1	+	.	.	.	.	.	.	.	.	.	+	.	.	.
As-E		Te	*Fallopia japonica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+
		He	*Arctium minus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Dipsacus fullonum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Picris hieracioides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Apen-S		Ha	*Cerastium tomentosum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		he	*Cirsium vulgare*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
		He	*Linaria vulgaris*	E1	.	.	+	.	.	.	.	.	.	+	.	.	.	.
Med		He	*Melissa officinalis*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Mentha spicata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Reseda lutea*	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.
		Ha	*Artemisia absinthium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Mentha x villoso-nervata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Oenothera glazioviana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		G	*Phytolacca americana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eu-se/As		He	*Tanacetum parthenium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum densiflorum*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	GU		***Galio-Urticetea***															
		He	*Urtica dioica*	E1	+	+	+	+	.	.	+	1	+	1	1	1	+	+
		Te	*Geranium robertianum*	E1	+	+	+	1	+	.	+	+	.	+	.	+	+	+

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			Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Te	*Galeopsis pubescens*	E1	+	+	1	1	1	+	.	.	+	+	.	+	+	+
As		Te	*Impatiens glandulifera*	E1	+	+	1	r	+	.	+	2	+	+	.	+	.	.
Am.N		He	*Solidago gigantea*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	+
AS-E		Te	*Impatiens parviflora*	E1	+	.	+	1	1	+	.	.	.	+	+	.	.	.
As-E		Te	*Commelina communis*	E1	.	.	+	.	+	.	.	+	.	.	+	.	+	.
		Te	*Aethusa cynapium*	E1	.	+	+	.	+	.	.	.	.	.	+	.	+	.
		He	*Aegopodium podagraria*	E1	.	.	+	+	.	.	.	.	+	+	+	+	.	.
		He	*Lamium maculatum*	E1	.	.	.	.	.	.	.	.	.	+	+	.	.	.
		Te	*Lapsana communis*	E1	.	.	+	.	.	.	.	.	.	.	+	.	.	+
		He	*Alliaria petiolata*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Glechoma hederacea*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
As		Te	*Impatiens balfourii*	E1	.	.	+	r	.	.	.	.	.	.	.	.	.	.
		He	*Parietaria officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Anthriscus sylvestris*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Chaerophyllum sp.*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Geum urbanum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Solidago canadensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Torilis japonica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	FP		***Filipendulo-Petasition***															
		He	*Symphytum officinale*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Lythrum salicaria*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Stachys palustris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	FC		***Convolvuletalia sepium***															
		He	*Saponaria officinalis*	E1	+	.	1	1	1	1	1	+	+	1	+	+	1	+
		He	*Epilobium parviflorum*	E1	.	+	+	+	+	.	.	+	.	+	+	.	.	+
		He	*Epilobium hirsutum*	E1	.	.	+	.	.	.	.	.	.	.	+	.	.	.
		Ge	*Calystegia sepium*	E1	.	.	r	+	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Aster lanceolatus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Aster novi-belgii*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Galega officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	EA		***Epilobietea angustifolii***															
		He	*Eupatorium cannabinum*	E1	+	1	1	+	1	1	1	1	1	1	1	1	1	1
		He	*Verbascum thapsus*	E1	.	.	.	.	.	.	+	+	+	+	+	+	.	.
		Te	*Galeopsis speciosa*	E1	+	+	.	1	1	.	.	+	+	+	.	+	.	.
		He	*Atropa bella-donna*	E1	.	.	.	.	.	.	+	.	.	+	.	.	.	+
		He	*Verbascum nigrum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Arctium nemorosum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Fragaria vesca*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
		He	*Stachys sylvatica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum lanatum*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
	PM		***Phragmiti-Magnocaricetea***															
		Hi	*Veronica beccabunga*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	+
		Hi	*Nasturtium officinale*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
		He	*Lycopus europaeus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Typhoides arundinacea*	E1	.	.	.	.	.	.	.	+	.	+	.	.	.	.
		He	*Galium palustre*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Hi	*Veronica anagallis-aquatica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Carex elata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	IN		***Isoëto-Nanojuncetea***															
		He	*Juncus articulatus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Mentha pulegium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Cyperus fuscus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ca		***Calthion, Molinion***															
	Mo	He	*Centaurea carniolica*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
		He	*Angelica sylvestris*	E1	.	.	.	+	.	.	.	.	.	.	+	+	.	.
		Ge	*Scirpus sylvaticus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Myosotis palustris (M. scorpioides)*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	PP		***Potentillo-Polygonetalia***															
		He	*Barbarea vulgaris*	E1	+	+	.	+	+	.	.	+	+	+	+	.	+	+
		He	*Rumex crispus*	E1	.	.	+	+	.	.	.	.	.	+	.	+	.	.
		Te	*Verbena officinalis*	E1	.	.	.	.	.	.	.	+	.	+	.	.	.	.
		He	*Carex hirta*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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		Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	He	*Juncus inflexus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AR		***Agropyretalia intermedio-repentis***															
	Ge	*Tussilago farfara*	E1	+	+	1	1	1	+	+	+	1	+	.	.	+	.
	Ge	*Equisetum arvense*	E1	.	+	1	+	+	.	+	+	.	+	+	+	+	.
	He	*Agropyron repens*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	He	*Poa compressa*	E1	.	.	+	.	.	.	.	.	.	.	+	.	.	.
MA		***Molinio-Arrhenatheretea***															
	He	*Galium mollugo*	E1	1	+	+	1	1	1	+	+	+	+	+	+	+	+
	he	*Plantago lanceolata*	E1	+	+	+	+	+	+	+	+	+	+	+	.	+	.
	He	*Leontodon hispidus*	E1	.	.	.	+	+	+	.	.	+	+	+	.	.	.
	Te	*Daucus carota*	E1	.	.	+	+	+	+	+	+	+	+	+	+	+	+
	He	*Trifolium pratense*	E1	+	+	+	+	+	.	.	.	.	.	.	+	.	.
	He	*Achillea millefolium*	E1	.	+	+	+	.	.	.	.	.	+	+	.	.	.
	He	*Leucanthemum vulgare*	E1	.	+	+	+	.	.	+	.	+	.	.	.	.	.
	He	*Pastinaca sativa*	E1	+	+	+	+	+	.	+	.	+	.	+	.	+	.
	he	*Deschampsia cespitosa*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
	He	*Dactylis glomerata s.str.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+	.
	Ha	*Prunella vulgaris*	E1	.	.	.	.	.	+	+	.	.	+	+	.	.	.
	He	*Trifolium repens*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	He	*Ranunculus nemorosus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	+
	He	*Pimpinella major*	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.
	He	*Rumex acetosa*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Ranunculus acris*	E1	+	.	r	.	.	.	.	.	.	.	.	.	.	.
	He	*Vicia cracca*	E1	+	.	.	.	.	+	.	.	.	.	.	.	.	+
	He	*Lotus corniculatus*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	He	*Poa trivialis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Centaurea jacea*	E1	.	.	+	+	.	.	.	.	.	.	.	.	.	.
	He	*Cerastium holosteoides*	E1	+	.	.	+	.	.	.	.	.	.	.	.	.	.
	He	*Lychnis flos-cuculi*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Vicia sepium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Arrhenatherum elatius*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Bellis perennis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Leontodon autumnalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Potentilla reptans*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
KC		***Koelerio-Corynephoretea***															
	Te	*Echium vulgare*	E1	.	.	+	+	+	.	+	.	.	.	+	.	.	.
	Te	*Arenaria serpyllifolia agg.*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.	.
	He	*Cardaminopsis arenosa*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
	He	*Petrorhagia saxifraga*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Medicago minima*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
FB		***Festuco-Brometea***															
	He	*Medicago lupulina*	E1	.	+	+	.	+	+	+	.	.	.	.	+	.	.
	He	*Sanguisorba minor*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	He	*Buphthalmum salicifolium*	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.
	He	*Pimpinella saxifraga*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Brachypodium rupestre*	E1	.	.	.	r	.	.	.	.	.	.	.	.	.	.
	He	*Campanula rotundifolia*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	He	*Centaurea fritschii*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Euphorbia cyparissias*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Euphrasia stricta*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	He	*Galium corrudifolium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Plantago media*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Salvia pratensis*	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.
	He	*Scabiosa triandra*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Stachys recta*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TG		***Trifolio-Geranietea***															
	He	*Hypericum perforatum (subsp. veronense)*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
	He	*Verbascum austriacum*	E1	.	.	.	+	.	+	.	.	.	.	.	.	.	.
	He	*Lathyrus sylvestris*	E1	.	.	r	.	.	.	.	.	.	.	.	.	.	.
	He	*Astragalus glycyphyllos*	E1	.	.	+	.	+	.	.	.	.	.	.	.	.	.
	He	*Clinopodium vulgare*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Coronilla varia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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			Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		He	*Digitalis grandiflora*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Inula conyza*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
		He	*Libanotis sibirica subsp. montana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Peucedanum venetum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Trifolium aureum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum lychnitis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	SC		***Sambuco-Salicion capreae***															
Am-N		Fa	*Robinia pseudoacacia*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Fa	*Robinia pseudoacacia*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Fa	*Robinia pseudoacacia*	E1	.	+	.	.	+	+	+	.	+	+	+	+	.	+
As-E		Fa	*Ailanthus glandulosa (A. altissima)*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Betula pendula*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
		Fa	*Salix caprea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	RP		***Rhamno-Prunetea***															
		Fa	*Cornus sanguinea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		NFa	*Rubus fruticosus agg.*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Berberis vulgaris*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Med-As w		Fa	*Ficus carica*	E1	.	.	.	.	.	.	.	.	+	.	.	.	.	.
As-E		Fa-vzp.	*Lonicera japonica*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aa-E		Nfa	*Lonicera nitida*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Platanus x hispanica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	TA		***Tilio-Acerion***															
		He	*Cardamine impatiens*	E1	.	.	.	.	.	.	+	+	+	.	.	.	.	.
		Fa	*Ulmus glabra*	E1	.	+	.	.	1	+	.	+	.	+	+	.	+	.
		He	*Aruncus dioicus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Lunaria rediviva*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.	.
	AI		***Alnion incanae***															
		NFa	*Rubus caesius*	E1	+	.	+	.	+	.	+	.	.	+	.	.	.	+
		He	*Festuca gigantea*	E1	+	+	+	+	.	.	.	+	.	.	+	.	.	+
		Fa	*Frangula alnus*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.	.
		Ha	*Chaerophyllum hirsutum*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	.
		He	*Agropyron caninum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Alnus incana*	E1	.	.	+	.	.	.	.	.	.	.	.	+	.	.
Goj.		Fa-vzp	*Vitis vinifera*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Am-N		Fa	*Acer negundo*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Circaea intermedia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		te	*Impatiens noli-tangere*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
	FS		***Fagetalia sylvaticae***															
		He	*Brachypodium sylvaticum*	E1	.	+	+	+	+	+	+	+	+	+	.	+	.	.
		He	*Salvia glutinosa*	E1	.	+	+	+	.	+	+	.	.	+	+	+	+	.
		He	*Mycelis muralis*	E1	.	+	+	+	.	.	+	+	.	+	+	+	.	.
		He	*Myosotis sylvatica agg.*	E1	.	+	+	+	.	.	.	.	.	.	.	.	.	.
		Fa	*Carpinus betulus*	E1	.	.	.	.	.	.	+	.	.	+	.	.	.	.
		He	*Galium laevigatum*	E1	.	.	.	.	.	.	.	.	+	.	+	.	.	.
		He	*Campanula trachelium*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Carex sylvatica*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.	.
		He	*Heracleum sphondylium*	E1	.	.	r	+	.	.	.	.	.	.	.	.	.	.
		Ge	*Circaea lutetiana*	E1	.	.	.	r	.	.	.	.	.	.	.	.	.	.
		Fa	*Laburnum alpinum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Ranunculus lanuginosus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Sambucus nigra*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Viola reichenbachiana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Aposeris foetida*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	QP		***Quercetalia pubescenti-petraeae***															
		He	*Arabis turrita*	E1	.	.	.	+	+	.	.	.	+	.	.	+	.	.
		He	*Calamintha sylvatica*	E1	.	.	.	.	.	.	+	.	.	.	.	.	.	.
		Fa	*Ostrya carpinifolia*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Ostrya carpinifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	QF		***Querco-Fagetea***															
		Fa-vz	*Clematis vitalba*	E1	.	+	.	+	+	+	1	+	+	+	+	+	.	+
		He	*Cerastium sylvaticum*	E1	.	.	.	.	.	.	.	+	.	+	+	.	.	.
		Me	*Moehringia trinervia*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.	.

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		Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Fa	*Ulmus minor*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Fa-vzp	*Hedera helix*	E1	.	.	.	.	.	.	.	+	.	+	.	.	.	.
	Fa	*Corylus avellana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Fa	*Quercus robur*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
EP		***Erico-Pinetea***															
	He	*Carex ornithopoda*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Me	*Molinia arundinacea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Aquilegia nigricans*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Calamagrostis varia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ha	*Chamaecytisus hirsutus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
O		**Other species (Druge vrste)**															
	He	*Cerastium sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Crepis sp.*	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	40	41	42	43	44
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Number of relevé (Zaporedna številka popisa)				45	46	47	48	49	50	51	52	53	54	55	56	57
Database number of relevé (Delovna številka popisa)				272752	272722	272806	272694	272757	272817	272673	272685	272712	272234	272792	272800	272804
Elevation in m (Nadmorska višina v m)				445	445	150	260	160	480	80	82	180	320	160	160	150
Aspect (Lega)				0	SSE	0	0	0	0	SW	0	SW	0	0	SE	0
Slope in degrees (Nagib v stopinjah)				0	5	0	0	0	0	3	0	2	0	0	1	0
Parent material (Matična podlaga)				Pr	Gr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr
Soil (Tla)				Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl
Stoniness in % (Kamnitost v %)				40	80	40	80	40	100	100	100	100	20	100	100	100
Cover of tree layer in % (Zastiranje drevesne plasti v %):			E3													
Cover of shrub layer in % (Zastiranje grmovne plasti v %):			E2							20			10			
Cover of herb layer in % (Zastiranje zeliščne plasti v %):			E1	60	30	60	30	60	40	35	60	35	80	60	60	35
Number of species (Število vrst)				34	50	77	45	78	43	21	47	47	44	34	51	48
Relevé area (Velikost popisne ploskve)			m^2	20	20	100	100	100	50	100	200	100	50	50	50	50
Date of the relevé (Datum popisa)				11/8/2018	10/20/2018	10/13/2018	10/9/2018	9/30/2018	10/18/2018	10/8/2018	10/8/2018	9/7/2018	8/23/2018	10/22/2018	10/22/2018	10/13/2018
Locality (Nahajališče)				Podbrdo-Mahorc-Bača	Podbrdo-Mahorc-Bača	Modrejce-Soča	Borjana-Nadiža	Bača pri Modreju	Soteska-Nomenj-Sava	Deskle-Soča	Anhovo-Soča	Dolenja Trebuša-Oblaz-Idrijca	Klonte-Koritnica-Bača	Tolmin-Tolminka	Tolmin-Tolminka	Tolmin-Tolminka
Quadrant (Kvadrant)				9749/4	9749/4	9848/2	9746/2	9848/2	9750/1	9947/2	9947/2	9948/2	9849/1	9848/1	9848/1	9848/1
Coordinate GK Y (D-48)			m	419155	419132	404112	383288	405520	425931	393158	393671	409745	414643	402910	402902	403132
Coordinate GK X (D-48)			m	5117897	5117886	5114652	5123999	5112552	5127604	5102132	5102139	5106605	5113797	5116098	5116079	5115240
Diagnostic species of the associations (Diagnostične vrste asociacij)																
SP	Fa	*Salix eleagnos*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.
SP	Fa	*Salix eleagnos*	E2a	.	.	.	.	.	.	+	.	.	.	.	.	.
SP	Fa	*Salix eleagnos*	E1	.	1	1	1	1	.	+	1	1	1	.	1	1
AV	He	*Melilotus albus*	E1	+	2	+	+	1	+	+	2	1	+	.	.	.
BT	Te	*Polygonum lapathifolium*	E1	+	1	.	.	.	.	.	1	+	1	+	+	+
FP	He	*Myosoton aquaticum*	E1	.	.	.	.	+	.	.	+	+	1	.	.	+
GU	Ge	*Petasites hybridus*	E1	3	1	1	.	+	.	.	+	+	+	.	.	+
PP	He	*Agrostis stolonifera*	E1	1	1	1	+	.	+	.	.	.	.	.	+	.
FS	Ge	*Scrophularia nodosa*	E1	.	+	+	.	+	+	.	.	.	.	.	+	.
AI	Ha	*Solanum dulcamara*	E1	+	+	+	+	+	+	.	+	+	.	.	.	.
FB	He	*Silene vulgaris*	E1	.	.	.	+	+	1	.	.	+	.	+	+	+
PeP	Ge	*Petasites paradoxus*	E1	.	.	.	1	1	+	.	+	+	.	.	.	+
FP	Ha	*Mentha longifolia*	E1	+	1	2	.	1	.	.	+	+	+	.	.	.
Mo	He	*Cirsium oleraceum*	E1	.	+	.	+	+	.	.	.	.	.	.	.	.
Am-N	BT	*Bidens frondosa*	E1	.	.	1	.	+	.	.	+	.	.	.	.	+
Am-N	SM	*Panicum barbipulvinatum (P. riparium)*	E1	+	+	+	+	+	.	+	+	+	+	2	1	+

		58	59	60	61	62	63	64	65	66	67	68	
		272796	272797	272793	272798	272794	272795	272485	272529	272450	272711	272750	
		170	155	160	155	155	170	177	284	150	150	154	
		S	0	0	0	0	0	0	NE	SW	0	0	
		2	0	0	0	0	0	0	5	5	0	0	
		Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	Pr	
		Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	Fl	
		100	100	100	100	100	100	80	80	30	10	5	
								60					
								20	10				
		80	75	30	30	30	30	30	40	80	80	90	
		53	73	30	47	60	23	22	53	31	17	19	
		50	50	50	100	100	50	100	100	20	20	10	
		10/22/2018	10/22/2018	10/22/2018	10/22/2018	10/22/2018	10/22/2018	10/14/2018	10/24/2018	9/22/2018	11/7/2018	11/8/2018	
		Tolmin-Tolminka	Tolmin-Tolminka	Tolmin-Tolminka	Tolmin-Tolminka	Tolmin-Tolminka	Tolmin-Tolminka	Dolenja Trebuša-Idrijca	Ježica-Sava	Tolmin-sv. Urh	Tolmin-sv. Urh	Tolmin-sv. Urh	
5116452	403031	9848/1						9949/1	9853/3	9848/1	9848/1	9848/1	
5115586	403055	9848/1						410548	462835	402155	402124	401921	
5116115	402950	9848/1						5106441	5106864	5115650	5115664	5115744	
5115697	402930	9848/1											
5115735	402883	9848/1											
5116331	403120	9848/1											
												Pr.	Fr.
.	.	.	.	.	.	.	.	2	.	.	.	.	1	1
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+	+	2	3	+	3	1	+	.	.	.	.	.	57	84
.	.	.	.	.	.	1	+	+	+	.			54	79
+	1	.	+	1	.	.	.	.	.	.			52	76
1	+	+	+	+	.	.	+	.	.	+			52	76
.	+	.	.	.	.	+	1	.	.	.			49	72
.	.	.	+	.	.	+	+	.	.	.			49	72
+	.	.	.	+	.	+	+	.	.	.			47	69
.	.	.	.	+	.	.	.	.	.	.			44	65
.	.	.	+	+	.	.	+	.	.	.			43	63
.	.	.	+	+	.	1	+	.	.	.			38	56
.	.	.	.	+	.	.	+	.	.	.			50	74
.	.	.	.	.	.	.	+	.	.	.			22	32
.	+	.	+	+	.	.	.	2	3	.			29	43
+	1	+	+	+	+	.	.	3	3	+			52	76

			Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
Am-N	FC	Ge	*Helianthus tuberosus*	E1	.	.	1	.	.	.	.	+	+	.	.	.	.
As-E	AV	He	*Artemisia verlotiorum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	MA	He	*Ranunculus repens*	E1	.	+	+	.	.	.	.	.	+	.	.	.	.
	EF		***Epilobion fleischeri***														
		He	*Scrophularia canina*	E1	.	.	r	+	+	+	.	.	.	.	.	+	.
As-E		Fa	*Buddleja davidii*	E1	.	.	1	.	.	.	.	.	.	.	.	.	.
		Te	*Erucastrum gallicum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Hieracium piloselloides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Equisetum ramosissimum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Stc		*Stipion calamagrostis*														
		He	*Calamintha einseleana*	E1	.	.	+	+	+	+	.	.	+	.	.	.	.
		Te	*Microrrhinum litorale*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
		He	*Equisetum variegatum*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		Ha	*Chamaenerion palustre*	E1	+	.	.	.	+	.	.	.	.	.	.	.	.
		He	*Peucedanum verticillare*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.
		He	*Achnatherum calamagrostis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Galeopsis angustifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	PeP		***Petasition paradoxi***														
		He	*Arabis alpina*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		Ha	*Gypsophila repens*	E1	.	.	.	+	.	.	.	.	.	+	.	.	.
		He	*Hieracium porrifolium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Aquilegia einseleana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Aurinia petraea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Campanula cespitosa*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Cerastium subtriflorum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Leontodon hispidus subsp. hyoseroides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	GA		***Galeopsietalia segetum***														
		He	*Epilobium collinum*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
	TR		*Thlaspietea rotundifolii*														
		He	*Hieracium bifidum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Af-S		Ha	*Senecio inaequidens*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	AT		***Asplenietea trichomanis***														
		He	*Cymbalaria muralis*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
		Te	*Sedum hispanicum*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
		He	*Moehringia muscosa*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Sedum album*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Hieracium glaucum*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		Ha	*Micromeria thymifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	MuA		***Mulgedio-Aconitetea***														
		He	*Senecio ovatus*	E1	.	+	+	.	.	.	.	.	.	.	.	.	.
		He	*Silene dioica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Salix appendiculata*	E1	+	1	.	.	.	.	.	.	.	.	.	.	.
	SP		***Salicetea purpureae***														
		Fa	*Populus nigra*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Populus nigra*	E2	.	.	.	.	.	.	+	.	.	.	.	.	.
		Fa	*Populus nigra*	E1	.	.	.	.	1	.	3	4	2	.	.	.	.
		Fa	*Salix purpurea*	E1	+	.	1	.	+	.	1	+	1	+	.	.	.
		He	*Humulus lupulus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Salix daphnoides*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Salix alba*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.
	BT		***Bidentetea***														
		Te	*Polygonum mite*	E1	.	+	+	+	.	+	+	1	3	.	.	+	+
		Te	*Rorippa palustris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	1
		Te	*Polygonum hydropiper*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	SM		***Papaveretea rhoeadis (Stellarietea mediae)***														
		He	*Plantago major*	E1	1	1	1	+	.	+	+	r	+	.	1	+	1
		He	*Taraxacum sect. Ruderalia*	E1	+	2	+	+	.	.	.	1	1	.	1	1	1
		Te	*Sonchus asper*	E1	.	.	.	.	+	.	.	+	.	.	1	+	+
		Te	*Poa annua*	E1	.	1	+	.	.	+	.	.	.	.	2	2	2
		Te	*Solanum nigrum subsp. nigrum*	E1	.	+	.	.	+	.	+	+	+	.	+	+	.
Am-C,S		Te	*Solanum lycopersicum*	E1	.	.	+	+	+	.	.	.	+	.	1	2	2
Am-N		Te	*Erigeron annuus subsp. annuus*	E1	.	.	.	+	1	.	.	.	+	+	.	+	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
.	.	.	.	.	.	+	+	2	2	.	15	22
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1	1	.	+	.	.	1	2	1	1	.	55	81
1	+	.	+	+	.	.	+	+	+	.	50	74
2	1	1	1	2	+	.	+	.	+	.	48	71
2	1	+	+	+	.	.	+	+	.	+	44	65
1	1	1	1	1	1	.	.	+	.	.	41	60
+	.	.	.	.	+	+	+	1	1	1	40	59

		Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
	Te	*Microrrhinum minus*	E1	.	+	+	1	+	+	.	.	.	+	.	+	.
Am-S	Te	*Galinsoga ciliata*	E1	+	+	+	.	.	.	.	+	+	.	1	1	+
	Te	*Polygonum persicaria*	E1	.	.	.	.	+	.	+	.	2	1	.	+	.
	Te	*Stellaria media*	E1	+	.	.	.	.	.	.	.	.	.	+	1	+
	He	*Cardamine hirsuta*	E1	.	+	.	.	.	+	.	.	+	.	1	1	+
	Te	*Oxalis fontana*	E1	.	.	+	.	+	.	.	.	.	.	.	.	.
	Te	*Rorippa sylvestris*	E1	.	.	.	.	.	.	.	.	+	.	.	.	.
AS-Ce	Te	*Veronica persica*	E1	+	.	.	.	.	+	.	.	.	.	1	1	+
	Te	*Polygonum aviculare*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+
	Te	*Capsella bursa-pastoris*	E1	.	.	.	.	.	.	.	.	.	.	+	.	+
AM-S	Te	*Galinsoga parviflora*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
	Te	*Senecio vulgaris*	E1	.	.	.	.	.	.	.	.	.	.	+	+	+
	He	*Chelidonium majus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N	Te	*Helianthus annuus*	E1	.	.	.	.	+	.	.	.	+	+	.	.	.
	Te	*Sonchus oleraceus*	E1	.	.	.	.	.	.	.	.	+	.	+	+	+
	Te	*Lamium purpureum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+
Med	Te	*Satureja hortensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
E-Af	Te	*Guizotia abyssinica*	E1	.	.	.	.	+	.	.	.	.	.	.	+	.
Med	Te	*Matricaria chamomilla*	E1	.	.	.	.	.	.	.	.	.	.	+	+	+
AS	Te	*Cucumis sativus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N	Te	*Cucurbita pepo*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Cerastium glomeratum*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
	te	*Euphorbia helioscopia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Fallopia convolvulus*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
	He	*Mentha arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Goj.	He	*Viola x wittrockiana*	E1	.	.	.	.	.	.	.	.	.	.	+	+	.
Med	Te	*Beta vulgaris subsp. vulgaris*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
Goj.	Te	*Lactuca sativa*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Goj.	Te	*Linum usitatissimum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-C,S	Te	*Tagetes erecta*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
Am-S	He	*Verbena bonariensis*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
Med.	Te	*Calendula officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Brassica napus subsp. napus*	E1	.	.	.	.	.	+	.	.	.	.	.	+	.
As-E	Te	*Callistephus chinensis*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
Am-C,S	Te	*Cleome spinosa*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.
As-W	Te	*Consolida ajacis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Myosotis arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Med	Te	*Papaver rhoeas*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
Aus-Nz	Te	*Tetragonia tetragonoides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Veronica arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	te	*Vicia hirsuta*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Eu-SE	He	*Antirrhinum majus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-S	Te	*Bidens bipinnata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Eu-W- med	Te	*Brassica oleracea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Brassica sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Cichorium sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	GE	*Convolvulus arvensis*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
Med-As-W	Te	*Avena sativa*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	te	*Euphorbia platyphyllos*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Galium aparine*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Goj.	Te	*Papaver somniferum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
As-SW	Te	*Secale cereale*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Med	Te	*Sinapis arvensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Sonchus asper subsp. glaucescens*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Te	*Veronica sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N	He	*Viola sororia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
SI		***Sisymbrietea***														
	He	*Diplotaxis tenuifolia*	E1	.	+	+	+	1	+	.	.	.	1	.	.	.
	Te	*Anagallis arvensis*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
	Te	*Lactuca serriola*	E1	.	+	.	.	+	.	.	.	.	.	.	.	.
Am-S	He	*Physalis peruviana*	E1	.	.	.	.	.	.	.	.	.	.	+	.	+
	Te	*Atriplex patula*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
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1	+	.	.	.	.	.	+	.	.	.	37	54
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2	+	+	+	1	.	.	.	.	.	.	31	46
+	+	1	1	2	+	.	+	.	.	.	29	43
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			Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
		He	*Cichorium intybus*	E1	.	.	+	.	+	.	.	.	.	.	.	.	+
		he	*Crepis taraxacifolia*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
Med-As		Te	*Euphorbia lathyris*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		Te	*Geranium purpureum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Lepidium virginicum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Solanum nigrum subsp. schultesii*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-C,S		Te	*Datura stramonium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
EU-S		Te	*Iberis umbellata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Potentilla norvegica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Sisymbrium officinale*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	DE		***Digitario sanguinalis-Eragrostietea minoris***														
		Te	*Setaria pumila*	E1	+	.	+	1	1	+	+	1	+	1	+	1	+
		Te	*Digitaria sanguinalis*	E1	.	+	.	+	+	.	+	.	.	.	.	+	+
Am-N		Te	*Conyza canadensis*	E1	+	.	+	.	.	.	.	+	.	.	+	+	+
Am-N		Te	*Ambrosia artemisiifolia*	E1	.	+	.	.	.	.	.	+	.	.	.	.	.
		Te	*Echinochloa crus-galli*	E1	.	.	.	.	.	.	.	+	+	.	.	.	.
		Te	*Chenopodium album*	E1	.	1	.	.	+	.	.	+	+	.	.	.	.
		Te	*Chenopodium polyspermum*	E1	.	.	+	.	.	.	.	.	+	+	.	.	.
Am-N,C		Te	*Amaranthus powellii*	E1	.	.	.	.	.	r	+	.	.	.	.	.	.
Am-N,C		Te	*Amaranthus cruentus*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		Te	*Digitaria ischaemum*	E1	.	.	.	.	.	.	.	r	.	.	.	.	.
As-E		Te	*Setaria faberi*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Acalypha virginica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Amaranthus blitum (A. lividus)*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
		Te	*Euphorbia peplus*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
Med		Te	*Eragrostis cilianensis*	E1	.	.	.	.	.	.	.	.	.	.	.	+	+
Am-N		Te	*Euphorbia marginata*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
Am-S		Te	*Conyza sumatrensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
As-S		He	*Abutilon theophrasti*	E1	.	r	.	.	.	.	.	.	.	.	.	.	.
As-S		Te	*Amaranthus caudatus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Te	*Amaranthus retroflexus*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
		te	*Setaria italica*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
Am-N		Te	*Euphorbia nutans*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	AV		***Artemisietea vulgaris***														
Am-C,S		Te	*Salvia hispanica*	E1	1	1	+	r	+	+	+	+	1	+	+	3	1
		He	*Artemisia vulgaris*	E1	+	1	1	+	2	+	.	.	+	1	.	.	+
		He	*Rumex obtusifolius*	E1	.	+	.	.	.	.	.	.	+	.	1	+	+
		He	*Ballota nigra subsp. meridionalis*	E1	.	.	+	.	.	+	.	.	+	.	.	.	.
		Te	*Silene latifolia subsp. alba*	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
		He	*Tanacetum vulgare*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
As-E		Te	*Fallopia japonica*	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
		He	*Arctium minus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Dipsacus fullonum*	E1	.	.	r	.	.	.	.	.	.	.	.	.	.
		He	*Picris hieracioides*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
Apen-S		Ha	*Cerastium tomentosum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		he	*Cirsium vulgare*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Linaria vulgaris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Med		He	*Melissa officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Mentha spicata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Reseda lutea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Artemisia absinthium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Mentha x villoso-nervata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Oenothera glazioviana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		G	*Phytolacca americana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Eu-se/As		He	*Tanacetum parthenium*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum densiflorum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	GU		***Galio-Urticetea***														
		He	*Urtica dioica*	E1	+	1	+	.	.	.	.	.	.	.	.	+	1
		Te	*Geranium robertianum*	E1	+	.	+	+	+	+	.	.	.	.	.	.	.
		Te	*Galeopsis pubescens*	E1	.	.	+	+	+	1	.	.	.	.	.	.	.
As		Te	*Impatiens glandulifera*	E1	.	+	.	.	+	.	.	.	.	1	.	.	.
Am.N		He	*Solidago gigantea*	E1	.	.	+	+	+	.	.	.	.	.	.	.	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
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			Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
AS-E		Te	*Impatiens parviflora*	E1	.	.	.	.	+	.	.	.	.	1	.	.	.
As-E		Te	*Commelina communis*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		Te	*Aethusa cynapium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Aegopodium podagraria*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		He	*Lamium maculatum*	E1	+	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Lapsana communis*	E1	.	+	.	.	.	.	.	.	.	.	+	.	.
		He	*Alliaria petiolata*	E1	.	.	+	.	.	+	.	.	.	.	.	.	.
		He	*Glechoma hederacea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
As		Te	*Impatiens balfourii*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		He	*Parietaria officinalis*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Anthriscus sylvestris*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
		Ha	*Chaerophyllum sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Geum urbanum*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.
Am-N		He	*Solidago canadensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Torilis japonica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	FP		***Filipendulo-Petasition***														
		He	*Symphytum officinale*	E1	.	.	.	.	.	.	.	+	+	.	.	.	.
		He	*Lythrum salicaria*	E1	.	+	+	.	.	.	.	+	.	.	.	.	.
		Ge	*Stachys palustris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	FC		***Convolvuletalia sepium***														
		He	*Saponaria officinalis*	E1	.	.	.	.	+	1	+	+	1	.	.	.	+
		He	*Epilobium parviflorum*	E1	.	+	+	.	.	.	.	.	.	.	.	.	.
		He	*Epilobium hirsutum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Calystegia sepium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Aster lanceolatus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		He	*Aster novi-belgii*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Galega officinalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	EA		***Epilobietea angustifolii***														
		He	*Eupatorium cannabinum*	E1	.	+	.	+	.	.	+	+	.	1	.	+	.
		He	*Verbascum thapsus*	E1	.	+	.	.	.	+	.	.	.	+	.	+	+
		Te	*Galeopsis speciosa*	E1	.	.	+	+	+	.	.	.	.	.	.	.	.
		He	*Atropa bella-donna*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+
		He	*Verbascum nigrum*	E1	.	.	.	.	.	.	.	.	.	.	+	+	+
		He	*Arctium nemorosum*	E1	.	.	.	.	+	.	.	.	.	+	.	.	.
		He	*Fragaria vesca*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
		He	*Stachys sylvatica*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum lanatum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	PM		***Phragmiti-Magnocaricetea***														
		Hi	*Veronica beccabunga*	E1	+	.	+	.	.	.	.	.	.	.	.	.	.
		Hi	*Nasturtium officinale*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Lycopus europaeus*	E1	.	.	+	.	.	.	.	r	.	.	.	.	.
		He	*Typhoides arundinacea*	E1	.	.	.	.	.	.	.	.	+	.	.	.	.
		He	*Galium palustre*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Hi	*Veronica anagallis-aquatica*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Carex elata*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	IN		***Isoëto-Nanojuncetea***														
		He	*Juncus articulatus*	E1	+	.	.	.	.	.	.	+	.	.	.	.	.
		He	*Mentha pulegium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Cyperus fuscus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ca		***Calthion, Molinion***														
	Mo	He	*Centaurea carniolica*	E1	.	.	+	.	+	.	.	.	.	+	.	+	.
		He	*Angelica sylvestris*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.
		Ge	*Scirpus sylvaticus*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.
		He	*Myosotis palustris (M. scorpioides)*	E1	.	.	.	.	.	.	.	.	.	.	.	.	+
	PP		***Potentillo-Polygonetalia***														
		He	*Barbarea vulgaris*	E1	+	.	+	.	.	+	.	.	+	+	.	.	+
		He	*Rumex crispus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Verbena officinalis*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
		He	*Carex hirta*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Juncus inflexus*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.
	AR		***Agropyretalia intermedio-repentis***														
		Ge	*Tussilago farfara*	E1	.	+	.	+	+	.	.	.	+	+	.	.	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
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		Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
	Ge	*Equisetum arvense*	E1	+	.	1	.	.	.	.	+	.	.	.	.	.
	He	*Agropyron repens*	E1	.	.	.	.	.	.	+	.	.	.	.	+	+
	He	*Poa compressa*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
MA		***Molinio-Arrhenatheretea***														
	He	*Galium mollugo*	E1	+	.	+	+	+	1	.	+	.	.	.	.	.
	he	*Plantago lanceolata*	E1	.	.	+	+	+	+	.	+	+	+	1	.	.
	He	*Leontodon hispidus*	E1	1	+	+	.	+	+	+	.	+	.	.	+	+
	Te	*Daucus carota*	E1	.	.	+	.	+	.	.	.	.	.	.	.	.
	He	*Trifolium pratense*	E1	+	.	+	.	+	.	.	+	.	.	.	.	.
	He	*Achillea millefolium*	E1	.	.	+	.	+	.	.	.	.	.	.	+	.
	He	*Leucanthemum vulgare*	E1	.	.	+	.	.	.	.	.	+	+	.	.	.
	He	*Pastinaca sativa*	E1	.	.	.	.	+	+	.	.	.	+	.	.	.
	he	*Deschampsia cespitosa*	E1	.	.	+	.	.	.	.	.	.	.	.	+	.
	He	*Dactylis glomerata s.str.*	E1	.	.	.	.	.	+	.	.	.	.	.	.	+
	Ha	*Prunella vulgaris*	E1	.	+	+	.	.	.	.	.	.	.	.	+	.
	He	*Trifolium repens*	E1	.	.	+	.	.	.	.	.	+	.	.	.	.
	He	*Ranunculus nemorosus*	E1	.	.	.	.	.	+	.	.	.	.	.	.	.
	He	*Pimpinella major*	E1	.	.	.	+	+	.	.	.	.	.	.	.	.
	He	*Rumex acetosa*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
	He	*Ranunculus acris*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
	He	*Vicia cracca*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Lotus corniculatus*	E1	.	.	.	.	.	.	+	.	.	.	.	.	.
	He	*Poa trivialis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Centaurea jacea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Cerastium holosteoides*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Lychnis flos-cuculi*	E1	.	.	.	.	.	.	.	.	.	.	+	.	.
	He	*Vicia sepium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Arrhenatherum elatius*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Bellis perennis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Leontodon autumnalis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Potentilla reptans*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
KC		***Koelerio-Corynephoretea***														
	Te	*Echium vulgare*	E1	+	+	.	+	+	+	.	.	.	+	.	.	.
	Te	*Arenaria serpyllifolia agg.*	E1	.	.	.	.	.	+	.	.	.	.	+	+	+
	He	*Cardaminopsis arenosa*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
	He	*Petrorhagia saxifraga*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Medicago minima*	E1	.	.	.	.	r	.	.	.	.	.	.	.	.
FB		***Festuco-Brometea***														
	He	*Medicago lupulina*	E1	.	+	+	.	+	+	+	+	.	.	.	.	.
	He	*Sanguisorba minor*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
	He	*Buphthalmum salicifolium*	E1	.	.	.	+	+	.	.	.	.	.	.	.	.
	He	*Pimpinella saxifraga*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
	He	*Brachypodium rupestre*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Campanula rotundifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Centaurea fritschii*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.
	He	*Euphorbia cyparissias*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.
	Te	*Euphrasia stricta*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Galium corrudifolium*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
	He	*Plantago media*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Salvia pratensis*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Scabiosa triandra*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Stachys recta*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
TG		***Trifolio-Geranietea***														
	He	*Hypericum perforatum (subsp. veronense)*	E1	.	.	+	.	+	.	.	.	.	+	.	.	.
	He	*Verbascum austriacum*	E1	.	.	.	.	.	+	.	.	.	+	.	.	.
	He	*Lathyrus sylvestris*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
	He	*Astragalus glycyphyllos*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Clinopodium vulgare*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Coronilla varia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Digitalis grandiflora*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Inula conyza*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Libanotis sibirica subsp. montana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
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			Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
		He	*Peucedanum venetum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Te	*Trifolium aureum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Verbascum lychnitis*	E1	.	.	.	.	.	.	.	.	.	+	.	.	.
	SC		***Sambuco-Salicion capreae***														
Am-N		Fa	*Robinia pseudoacacia*	E3a	.	.	.	.	.	.	.	.	.	.	.	.	.
Am-N		Fa	*Robinia pseudoacacia*	E2a	.	.	.	.	.	.	.	1	.	+	.	.	.
Am-N		Fa	*Robinia pseudoacacia*	E1	.	.	.	+	+	.	1	2	+	.	.	.	.
As-E		Fa	*Ailanthus glandulosa (A. altissima)*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Betula pendula*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Salix caprea*	E1	+	.	.	.	.	.	.	.	.	.	.	.	.
	RP		***Rhamno-Prunetea***														
		Fa	*Cornus sanguinea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		NFa	*Rubus fruticosus agg.*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Berberis vulgaris*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
Med-As w		Fa	*Ficus carica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
As-E		Fa-vzp.	*Lonicera japonica*	E2a	.	.	.	.	.	.	.	.	.	.	.	.	.
Aa-E		Nfa	*Lonicera nitida*	E2a	.	.	.	.	.	.	.	.	.	+	.	.	.
		Fa	*Platanus x hispanica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	TA		***Tilio-Acerion***														
		He	*Cardamine impatiens*	E1	+	.	.	.	.	.	.	.	+	.	.	.	.
		Fa	*Ulmus glabra*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		He	*Aruncus dioicus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Lunaria rediviva*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	AI		***Alnion incanae***														
		NFa	*Rubus caesius*	E1	.	.	+	+	+	.	+	+	.	.	.	.	.
		He	*Festuca gigantea*	E1	.	.	.	.	.	+	.	.	+	.	.	.	.
		Fa	*Frangula alnus*	E1	.	.	.	+	.	.	.	+	.	.	.	.	.
		Ha	*Chaerophyllum hirsutum*	E1	+	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Agropyron caninum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Alnus incana*	E1	.	.	.	.	r	.	.	.	.	.	.	.	.
Goj.		Fa-vzp	*Vitis vinifera*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.
Am-N		Fa	*Acer negundo*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Circaea intermedia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		te	*Impatiens noli-tangere*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	FS		***Fagetalia sylvaticae***														
		He	*Brachypodium sylvaticum*	E1	.	.	+	+	.	+	.	.	.	.	.	.	.
		He	*Salvia glutinosa*	E1	.	+	+	+	.	.	.	.	.	.	.	.	.
		He	*Mycelis muralis*	E1	.	.	+	.	.	+	.	.	.	.	.	.	+
		He	*Myosotis sylvatica agg.*	E1	.	.	.	.	.	.	.	.	.	.	.	+	.
		Fa	*Carpinus betulus*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.
		He	*Galium laevigatum*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Campanula trachelium*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Carex sylvatica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Heracleum sphondylium*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Ge	*Circaea lutetiana*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Laburnum alpinum*	E1	.	+	.	.	.	.	.	.	.	.	.	.	.
		He	*Ranunculus lanuginosus*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		Fa	*Sambucus nigra*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		He	*Viola reichenbachiana*	E1	.	.	+	.	.	.	.	.	.	.	.	.	.
		He	*Aposeris foetida*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	QP		***Quercetalia pubescenti-petraeae***														
		He	*Arabis turrita*	E1	.	.	.	.	+	.	.	.	.	.	.	.	.
		He	*Calamintha sylvatica*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Ostrya carpinifolia*	E2a	.	.	.	.	.	.	.	.	.	+	.	.	.
		Fa	*Ostrya carpinifolia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	QF		***Querco-Fagetea***														
		Fa-vz	*Clematis vitalba*	E1	.	.	.	+	+	.	.	+	.	+	.	.	+
		He	*Cerastium sylvaticum*	E1	+	.	+	.	.	+	.	.	.	.	.	+	+
		Me	*Moehringia trinervia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Ulmus minor*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa-vzp	*Hedera helix*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
		Fa	*Corylus avellana*	E1	.	.	.	+	.	.	.	.	.	.	.	.	.

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
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		Number of relevé (Zaporedna številka popisa)		45	46	47	48	49	50	51	52	53	54	55	56	57
	Fa	*Quercus robur*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
EP		***Erico-Pinetea***														
	He	*Carex ornithopoda*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Me	*Molinia arundinacea*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Aquilegia nigricans*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Calamagrostis varia*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ha	*Chamaecytisus hirsutus*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
O		**Other species (Druge vrste)**														
	He	*Cerastium sp.*	E1	.	.	.	.	.	.	.	.	.	.	.	.	.
	He	*Crepis sp.*	E1	.	.	.	.	.	.	.	+	.	.	.	.	.

Legend - Legenda

Pr. Presence (number of relevés in which the species is presented) - število popisov, v katerih se pojavlja vrsta
Fr. Frequency in % - frekvenca v %
Pr Gravel - Prod
Fl Luvisols - Obrečna tla
Te Therophytes - Terofiti
Ha Chamaephytes - Hamefiti
Ge - Geophytes - Geofiti
He Hemicryptophytes - Hemikriptofiti
Hi Hydrophytes - Hidrofiti
Fa Phanerophytes - Fanerofiti
Am American species - ameriška vrsta
Af - African species - afriška vrsta
As - Asian species - azijska vrsta
Med - Mediterranean species - sredozemska vrsta
Go. Cultivated species - gojena vrsta
Aus-Nz Australian and New Zealand species - avstralska in novozelandska vrsta

58	59	60	61	62	63	64	65	66	67	68	Pr.	Fr.
.	.	.	.	.	.	.	+	.	.	.	1	1
.	.	.	.	.	.	.	.	.	.	.	3	4
.	.	.	.	.	.	.	+	.	.	.	3	4
.	.	.	.	.	.	.	.	.	.	.	2	3
.	.	.	.	.	.	.	.	.	.	.	2	3
.	.	.	.	.	.	.	.	.	.	.	1	1
.	.	.	.	+	.	.	.	.	.	.	1	1
.	.	.	.	.	.	.	.	.	.	.	1	1

Table 2: Synoptic table of initial plant communities on riverine gravel terraces in Slovenia
Preglednica 2: Sintezna preglednica inicialnih prodiščnih združb v Sloveniji

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Sign for syntaxa (Oznaka združb)		PlSe	PlSe-Sa	PlSe-ne	ChPo-Ba	PlSe-To	ChPo-Id	ESc-Na	CsSp
Author (Avtor)		ID	ID	ID	ID	ID	ID	BČ	VP
Number of relevés (Število popisov)		27	11	8	8	9	9	12	10
Epilobion fleischeri									
Scrophularia canina	E1	41	100	50	.	33	.	100	40
Buddleja davidii	E1	11	45	13	.	.	.	.	.
Erucastrum gallicum	E1	7	55	.	.	.	.	67	.
Equisetum ramosissimum	E1	7	.	.	.	.	.	.	.
Hieracium piloselloides	E1	.	27	.	.	.	.	58	.
Chamaenerion palustre	E1	.	.	.	.	.	.	42	.
Aethionema saxatile	E1	.	.	.	.	.	.	8	.
Stipion calamagrostis									
Calamintha einseleana	E1	56	64	63	.	.	.	.	.
Microrrhinum litorale	E1	26	55	13	.	.	.	.	40
Chamaenerion palustre	E1	4	.	13	13	.	.	.	.
Achnatherum calamagrostis	E1	4	.	.	.	.	.	50	.
Galeopsis angustifolia	E1	4	.	.	.	.	.	.	.
Equisetum variegatum	E1	.	18	13	.	.	.	.	.
Peucedanum verticillare	E1	.	.	13	.	.	.	50	.
Petasition paradoxi									
Petasites paradoxus	E1	56	91	63	38	33	11	100	.
Arabis alpina	E1	7	18	13	.	33	.	.	.
Gypsophila repens	E1	7	18	25	.	.	.	25	.
Hieracium porrifolium	E1	7	.	.	.	.	.	25	.
Aquilegia einseleana	E1	.	9	.	.	.	.	17	.
Cerastium subtriflorum	E1	.	9	.	.	.	.	.	.
Leontodon hyoseroides	E1	.	9	.	.	.	.	.	.
Campanula cespitosa	E1	.	.	13	.	.	.	17	.
Aurinia petraea	E1	.	.	.	.	11	.	.	.
Carduus crassifolius	E1	.	.	.	.	.	.	17	.
Euphorbia kerneri	E1	.	.	.	.	.	.	8	.
Galeopsietalia segetum									
Epilobium collinum	E1	4	.	13	.	.	.	.	.
Thlaspietea rotundifolii									
Hieracium bifidum	E1	.	9	.	13	.	.	.	.
Senecio inaequidens	E1	.	9	.	.	11	.	.	.
Asplenietea trichomanis		.	.	.	.	.			
Cymbalaria muralis	E1	33	9	.	25	78	.	.	.
Moehringia muscosa	E1	4	9	.	.	11	.	.	.
Sedum album	E1	4	.	.	.	11	.	.	.
Sedum hispanicum	E1	.	18	.	.	22	.	.	.
Hieracium glaucum	E1	.	.	13	.	.	.	.	.
Micromeria thymifolia	E1	.	.	.	.	11	.	.	.
Kernera saxatilis	E1	.	.	.	.	.	.	8	.
Mulgedio-Aconitetea									
Petasites hybridus	E1	96	55	63	100	22	100	8	.
Senecio ovatus	E1	19	18	13	13	.	.	.	.
Silene dioica	E1	19	.	.	.	11	.	.	.
Salix appendiculata	E1	.	.	.	50	.	.	.	.
Salicetea purpureae									
Salix eleagnos	E3a	.	.	.	.	.	.	.	.
Salix eleagnos	E2a	.	.	13	.	.	.	.	.
Salix eleagnos	E1	89	91	88	75	89	33	83	20
Populus nigra	E2	4	.	13	.	.	.	.	.
Populus nigra	E1	41	18	50	.	22	22	.	.
Salix purpurea	E1	41	45	75	50	11	11	25	60
Humulus lupulus	E1	7	9	.	.	.	.	.	40
Salix daphnoides	E2a	4	.	.	.	.	.	.	.
Salix alba	E2a	.	.	.	.	.	.	.	40

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Salix fragilis	E2	.	.	.	.	.	.	.	20
Bidentetea									
Polygonum lapathifolium	E1	93	100	38	75	78	44	.	.
Polygonum mite	E1	85	100	75	75	67	78	.	50
Bidens frondosa	E1	52	55	38	.	44	22	.	.
Polygonum hydropiper	E1	4	.	.	.	.	.	.	.
Rorippa palustris	E1	.	18	.	.	11	.	.	.
Bidens tripartita	E1	.	.	.	.	.	.	.	30
Xanthium italicum	E1	.	.	.	.	.	.	.	20
Papaveretea rhoeadis (Stellarietea mediae)									
Plantago major	E1	93	73	75	100	89	11	42	.
Taraxacum sect. Ruderalia	E1	93	73	50	100	67	44	75	.
Sonchus asper	E1	93	82	25	50	78	11	8	.
Solanum nigrum subsp. nigrum	E1	85	36	50	38	78	11	.	.
Poa annua	E1	81	64	25	75	100	22	.	.
Polygonum persicaria	E1	78	36	50	13	22	22	33	90
Microrrhinum minus	E1	67	100	63	13	44	11	92	30
Oxalis fontana	E1	67	45	25	13	.	.	.	.
Solanum lycopersicum	E1	63	82	50	13	100	67	.	.
Erigeron annuus subsp. annuus	E1	59	73	50	50	33	33	58	40
Stellaria media	E1	56	36	.	50	89	56	.	.
Galinsoga ciliata	E1	52	64	38	88	56	44	.	.
Rorippa sylvestris	E1	44	27	13	50	.	33	.	.
Galinsoga parviflora	E1	44	9	13	.	11	33	.	.
Veronica persica	E1	33	9	13	25	67	.	.	.
Helianthus annuus	E1	33	.	38	.	.	.	.	.
Polygonum aviculare	E1	30	18	.	25	44	22	.	.
Cardamine hirsuta	E1	26	36	25	75	100	11	.	.
Capsella bursa-pastoris	E1	22	27	.	.	67	.	.	.
Senecio vulgaris	E1	22	18	.	13	67	.	17	.
Sonchus oleraceus	E1	22	9	13	.	33	22	.	.
Guizotia abyssinica	E1	15	0	13	.	11	.	.	.
Cucumis sativus	E1	15	9	.	.	.	.	.	.
Euphorbia helioscopia	E1	15	.	.	.	.	.	.	.
Satureja hortensis	E1	11	27	.	.	11	.	.	.
Cucurbita pepo	E1	11	18	.	.	.	11	.	.
Chelidonium majus	E1	7	45	.	25	33	11	.	.
Mentha arvensis	E1	7	18	.	.	.	11	.	20
Fallopia convolvulus	E1	7	9	13	.	.	11	17	.
Tagetes erecta	E1	7	.	13	.	.	11	.	.
Verbena bonariensis	E1	7	.	13	.	.	.	.	.
Beta vulgaris subsp. vulgaris	E1	7	.	.	.	11	.	.	.
Lactuca sativa	E1	7	.	.	.	11	.	.	.
Vicia hirsuta	E1	7	.	.	.	.	22	.	.
Lamium purpureum	E1	4	45	.	.	33	11	.	.
Calendula officinalis	E1	4	18	.	.	.	.	.	.
Cerastium glomeratum	E1	4	9	.	.	33	.	.	.
Cleome spinosa	E1	4	.	13	.	.	.	.	.
Papaver rhoeas	E1	4	.	13	.	.	.	.	.
Tetragonia tetragonoides	E1	4	.	.	13	.	.	.	.
Linum usitatissimum	E1	4	.	.	.	22	.	.	.
Veronica arvensis	E1	4	.	.	.	11	.	.	.
Antirrhinum majus	E1	4	.	.	.	.	.	.	.
Brassica oleracea	E1	4	.	.	.	.	.	.	.
Cichorium sp.	E1	4	.	.	.	.	.	.	.
Avena sativa	E1	4	.	.	.	.	11	.	.
Euphorbia platyphyllos	E1	4	.	.	.	.	.	.	.
Galium aparine	E1	4	.	.	.	.	.	.	.
Secale cereale	E1	4	.	.	.	.	.	.	.
Sonchus asper subsp. glaucescens	E1	4	.	.	.	.	.	.	.
Consolida ajacis	E1	.	18	.	.	.	.	.	.
Callistephus chinensis	E1	.	9	13	.	.	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Brassica sp.	E1	.	9	.	.	.	.	.	.
Papaver somniferum	E1	.	9	.	.	.	.	.	.
Sinapis arvensis	E1	.	9	.	.	.	.	.	.
Veronica sp.	E1	.	9	.	.	.	.	.	.
Matricaria chamomilla	E1	.	9	.	.	44	.	.	.
Brassica napus subsp. napus	E1	.	.	13	.	11	.	.	.
Convolvulus arvensis	E1	.	.	.	13	.	.	.	.
Viola x wittrockiana	E1	.	.	.	.	44	.	.	.
Myosotis arvensis	E1	.	.	.	.	22	.	.	.
Viola sororia	E1	.	.	.	.	11	.	.	.
Xanthium strumarium	E1	.	.	.	.	.	.	20	.
Veronica chamaedrys	E1	.	.	.	.	.	.	8	.
Sisymbrietea									
Diplotaxis tenuifolia	E1	70	64	63	25	33	.	67	.
Anagallis arvensis	E1	33	.	.	13	11	11	.	.
Atriplex patula	E1	30	9	.	.	.	.	.	.
Crepis taraxacifolia	E1	22	.	13	.	11	.	.	.
Cichorium intybus	E1	15	.	25	.	22	.	.	.
Geranium purpureum	E1	11	.	.	.	.	.	.	.
Lactuca serriola	E1	7	27	13	13	22	.	.	.
Euphorbia lathyris	E1	7	.	13	.	.	.	.	.
Iberis umbellata	E1	7	.	.	.	.	.	.	.
Physalis peruviana	E1	4	18	.	.	44	.	.	.
Solanum nigrum subsp. schultesii	E1	4	9	.	13	.	22	.	.
Lepidium virginicum	E1	4	.	.	.	22	.	.	.
Datura stramonium	E1	4	.	.	.	.	.	.	.
Potentilla norvegica	E1	4	.	.	.	.	.	.	.
Sisymbrium officinale	E1	.	9	.	.	.	.	.	.
Diplotaxis muralis	E1	.	.	.	.	.	.	17	.
Digitario sanguinalis-Eragrostietea minoris									
Setaria pumila	E1	93	55	100	75	78	56	.	.
Panicum barbipulvinatum (P. riparium)	E1	74	64	88	75	100	.	.	.
Ambrosia artemisiifolia	E1	52	18	13	25	11	11	.	.
Echinochloa crus-galli	E1	41	27	25	.	11	44	.	60
Digitaria sanguinalis	E1	33	36	38	25	44	11	.	.
Chenopodium album	E1	26	18	25	38	.	.	.	80
Conyza canadensis	E1	19	45	25	25	78	.	17	50
Chenopodium polyspermum	E1	19	27	38	.	22	11	.	70
Digitaria ischaemum	E1	19	.	13	.	.	.	.	.
Amaranthus powellii	E1	15	27	25	.	11	.	.	.
Setaria faberi	E1	15	9	.	.	11	.	.	.
Amaranthus cruentus L.	E1	11	27	13	.	.	22	.	.
Amaranthus blitum (A. lividus)	E1	7	.	.	.	11	11	.	.
Euphorbia marginata	E1	4	.	13	.	.	.	.	.
Conyza sumatrensis	E1	4	.	.	.	.	.	.	.
Euphorbia nutans	E1	4	.	.	.	.	.	.	.
Abutilon theophrasti	E1	.	.	.	13	.	.	.	.
Euphorbia peplus	E1	.	.	.	.	33	.	.	.
Eragrostis cilianensis	E1	.	.	.	.	22	.	.	.
Acalypha virginica	E1	.	.	.	.	11	.	.	.
Amaranthus caudatus	E1	.	.	.	.	11	.	.	.
Amaranthus retroflexus	E1	.	.	.	.	11	.	.	.
Setaria italica	E1	.	.	.	.	11	.	.	.
Setaria viridis	E1	.	.	.	.	.	22	8	.
Artemisietea vulgaris									
Salvia hispanica	E1	100	100	100	100	100	.	.	.
Artemisia vulgaris	E1	93	91	75	100	44	22	83	70
Melilotus albus	E1	89	91	100	88	11	56	92	20
Rumex obtusifolius	E1	52	82	13	63	78	44	.	.
Ballota nigra subsp. meridionalis	E1	52	27	38	13	.	.	.	.
Silene latifolia subsp. alba	E1	26	27	13	.	22	22	8	.
Tanacetum vulgare	E1	15	36	13	.	.	.	17	50

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Dipsacus fullonum	E1	11	.	13	.	.	.	.	.
Arctium minus	E1	7	27	.	.	11	.	.	.
Picris hieracioides	E1	7	.	13	.	.	.	8	.
Artemisia verlotiorum	E1	7	.	.	.	.	.	.	.
Linaria vulgaris	E1	7	.	.	.	.	.	.	.
Melissa officinalis	E1	7	.	.	.	.	.	.	.
Reseda lutea	E1	7	.	.	.	.	.	25	.
Fallopia japonica	E1	4	45	13	.	.	11	.	.
Mentha spicata	E1	4	9	.	.	.	.	.	.
Cirsium vulgare	E1	4	.	.	13	.	.	.	.
Oenothera glazioviana	E1	4	.	.	.	.	.	.	.
Phytolacca americana	E1	4	.	.	.	.	.	.	.
Verbascum densiflorum	E1	4	.	.	.	.	.	.	.
Mentha x villoso-nervata	E1	.	9	.	.	.	.	.	.
Tanacetum parthenium	E1	.	.	.	13	.	.	.	.
Cerastium tomentosum	E1	.	.	.	.	22	.	.	.
Artemisia absinthium	E1	.	.	.	.	11	.	.	.
Arctium tomentosum	E1	.	.	.	.	.	.	25	.
Melilotus officinalis	E1	.	.	.	.	.	.	8	20
Arctium lappa	E1	.	.	.	.	.	.	.	50
Asclepias syriaca	E1	.	.	.	.	.	.	.	20
Humulus scandens (H. japonicus)	E1	.	.	.	.	.	.	.	10
Galio-Urticetea									
Geranium robertianum	E1	70	100	50	38	56	22	92	.
Galeopsis pubescens	E1	70	64	50	13	22	.	75	70
Urtica dioica	E1	67	91	13	75	78	22	.	70
Impatiens glandulifera	E1	56	9	25	25	.	11	.	40
Commelina communis	E1	44	9	13	13	11	11	.	.
Impatiens parviflora	E1	33	45	25	.	.	11	58	.
Aegopodium podagraria	E1	33	9	13	.	.	11	.	40
Aethusa cynapium	E1	30	9	.	25	11	.	.	.
Solidago gigantea	E1	26	18	38	.	11	.	.	40
Lapsana communis	E1	19	.	.	38	33	.	.	.
Lamium maculatum	E1	15	36	.	38	.	.	.	20
Parietaria officinalis	E1	11	.	13	.	.	.	.	40
Alliaria petiolata	E1	7	36	25	.	.	.	.	.
Glechoma hederacea	E1	7	27	.	.	.	.	.	.
Impatiens balfourii	E1	7	9	13	13	.	.	.	.
Anthriscus sylvestris	E1	4	.	.	13	.	.	.	60
Chaerophyllum sp.	E1	4	.	.	.	.	.	.	.
Torilis japonica	E1	4	.	.	.	.	.	.	.
Geum urbanum	E1	.	.	13	.	.	.	.	.
Solidago canadensis	E1	.	.	.	.	.	11	.	.
Cruciata laevipes	E1	.	.	.	.	.	.	8	.
Epilobietea angustifolii									
Eupatorium cannabinum	E1	100	82	50	75	11	22	42	20
Verbascum thapsus	E1	52	36	25	13	67	.	.	.
Galeopsis speciosa	E1	33	36	38	.	.	11	92	40
Atropa bella-donna	E1	22	27	.	13	11	.	.	.
Verbascum nigrum	E1	4	9	.	.	67	.	.	.
Fragaria vesca	E1	4	.	.	.	22	.	.	.
Verbascum lanatum	E1	4	9	.	.	.	.	.	.
Stachys sylvatica	E1	.	9	.	25	.	22	.	.
Arctium nemorosum	E1	.	.	25	13	.	.	.	.
Filipendulo-Petasition									
Mentha longifolia	E1	93	91	63	100	11	67	42	.
Myosoton aquaticum	E1	89	100	50	63	67	44	33	60
Symphytum officinale	E1	4	27	25	0	11	44	.	.
Stachys palustris	E1	4	.	.	.	.	11	.	.
Lythrum salicaria	E1	.	.	25	13	.	11	.	30
Filipendulo-Convolvuletea									
Saponaria officinalis	E1	93	100	63	38	56	44	58	100

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Epilobium parviflorum	E1	48	100	13	25	11	.	.	.
Helianthus tuberosus	E1	22	18	38	.	.	67	17	40
Epilobium hirsutum	E1	19	9	.	.	.	.	.	.
Calystegia sepium	E1	7	.	.	13	.	.	.	80
Galega officinalis	E1	4	.	.	.	.	11	.	40
Aster lanceolatus	E1	.	9	.	.	.	.	.	.
Echinocystis lobata	E1	.	.	.	.	.	.	.	80
Silene baccifera (Cucubalus baccifer)	E1	.	.	.	.	.	.	.	60
Lysimachia vulgaris	E1	.	.	.	.	.	.	.	30
Rudbeckia laciniata	E1	.	.	.	.	.	.	.	20
Phragmiti-Magnocaricetea									
Veronica beccabunga	E1	7	36	13	50	11	.	.	.
Nasturtium officinale	E1	7	45	13	.	.	.	.	.
Typhoides arundinacea	E1	7	.	13	.	.	33	.	100
Galium palustre	E1	4	18	.	.	.	.	.	.
Lycopus europaeus	E1	.	45	25	.	.	.	.	70
Veronica anagallis-aquatica	E1	.	18	13	.	.	.	.	.
Carex elata	E1	.	9	.	.	.	.	.	.
Mentha aquatica	E1	.	.	.	.	.	11	.	20
Isoëto-Nanojuncetea									
Juncus articulatus	E1	7	9	13	13	.			
Mentha pulegium	E1	7	9	.	.	.			50
Cyperus fuscus	E1	.	18	.	.	.			
Calthion, Molinion									
Cirsium oleraceum	E1	33	55	25	50	.	22	.	.
Centaurea carniolica	E1	26	27	38	25	11	11	25	.
Angelica sylvestris	E1	15	18	13	38	.	11	17	20
Scirpus sylvaticus	E1	4	18	13	.	.	.	.	.
Myosotis palustris (M. scorpioides)	E1	.	.	.	.	11	.	.	.
Selinum carvifolia	E1	.	.	.	.	.	11	.	.
Gratiola officinalis	E1	.	.	.	.	.	.	.	40
Potentillo-Polygonetalia		.	.	.	.	.	.	.	.
Agrostis stolonifera	E1	85	100	38	100	22	22	17	60
Barbarea vulgaris	E1	63	100	50	63	22	22	75	.
Rumex crispus	E1	19	36	.	.	.	.	.	.
Verbena officinalis	E1	11	27	.	.	11	.	.	.
Juncus inflexus	E1	.	.	13	.	.	.	.	.
Agropyretalia intermedio-repentis									
Tussilago farfara	E1	74	27	50	38	.	11	25	.
Equisetum arvense	E1	56	45	25	63	.	67	8	40
Agropyron repens	E1	22	.	13	.	56	.	.	50
Poa compressa	E1	11	18	13	13	.	.	25	.
Chondrilla juncea	E1	.	.	.	.	.	.	.	40
Molinio-Arrhenatheretea									
Galium mollugo	E1	81	91	63	50	11	44	83	.
Plantago lanceolata	E1	74	45	88	38	56	22	42	.
Daucus carota	E1	74	45	25	50	22	33	50	.
Trifolium pratense	E1	44	45	38	25	33	11	8	.
Leontodon hispidus	E1	37	82	63	75	56	.	50	.
Pastinaca sativa	E1	37	18	38	25	.	11	.	.
Achillea millefolium	E1	30	45	25	.	33	.	25	.
Leucanthemum vulgare	E1	26	36	38	38	.	.	.	.
Deschampsia cespitosa	E1	19	27	13	13	44	33	58	.
Prunella vulgaris	E1	19	9	13	13	11	11	.	.
Ranunculus nemorosus	E1	19	18	13	.	.	.	.	.
Vicia cracca	E1	15	.	.	.	.	.	.	50
Ranunculus repens	E1	11	45	25	50	.	.	.	.
Dactylis glomerata s.str.	E1	11	27	13	25	33	22	17	.
Pimpinella major	E1	11	.	25	13	.	.	.	.
Ranunculus acris	E1	11	.	13	.	.	.	.	.
Trifolium repens	E1	7	.	25	38	11	11	8	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Centaurea jacea	E1	7	.	.	.	.	.	.	.
Cerastium holosteoides	E1	7	.	.	.	.	.	.	.
Rumex acetosa	E1	4	9	.	13	33	.	.	.
Lotus corniculatus	E1	4	.	13	.	11	.	8	.
Poa trivialis	E1	4	.	.	.	22	.	.	.
Leontodon autumnalis	E1	4	.	.	.	.	.	.	.
Vicia sepium	E1	.	.	.	13	11	.	.	.
Lychnis flos-cuculi	E1	.	.	.	.	22	.	.	.
Arrhenatherum elatius	E1	.	.	.	.	11	.	.	.
Bellis perennis	E1	.	.	.	.	11	.	.	.
Agrostis capillaris	E1	.	.	.	.	.	.	8	.
Lathyrus pratensis	E1	.	.	.	.	.	.	8	.
Leucanthemum ircutianum	E1	.	.	.	.	.	.	8	.
Koelerio-Corynephoretea									
Echium vulgare	E1	37	27	50	25	.	.	67	.
Arenaria serpyllifolia agg. (inc. A. leptoclados)	E1	7	27	13	.	78	.	25	.
Cardaminopsis arenosa	E1	7	55	13	.	11	.	.	.
Petrorhagia saxifraga	E1	.	18	.	.	11	.	.	.
Medicago minima	E1	.	.	13	.	.	.	.	.
Sedum sexangulare	E1	.	.	.	.	.	.	17	.
Festuco-Brometea									
Silene vulgaris	E1	78	91	50	25	56	11	83	.
Medicago lupulina	E1	52	45	63	50	11	.	50	.
Sanguisorba minor	E1	7	9	13	.	.	11	8	.
Buphthalmum salicifolium	E1	4	.	25	.	.	.	17	.
Euphrasia stricta	E1	4	.	.	.	.	.	17	.
Salvia pratensis	E1	4	.	.	.	.	.	17	.
Brachypodium rupestre (inc. B. pinnatum)	E1	4	.	.	.	.	.	.	20
Campanula rotundifolia	E1	4	.	.	.	.	.	.	.
Scabiosa triandra	E1	4	.	.	.	.	.	.	.
Pimpinella saxifraga	E1	.	9	13	.	.	.	.	.
Plantago media	E1	.	9	.	.	.	.	.	.
Euphorbia cyparissias	E1	.	.	13	.	.	.	83	20
Centaurea scabiosa subsp. fritschii	E1	.	.	13	.	.	.	.	.
Galium corrudifolium	E1	.	.	13	.	.	.	.	.
Stachys recta	E1	.	.	13	.	.	.	8	.
Asperula cynanchica	E1	.	.	.	.	.	.	17	.
Thymus praecox	E1	.	.	.	.	.	.	17	.
Satureja montana	E1	.	.	.	.	.	.	17	.
Koeleria pyramidata	E1	.	.	.	.	.	.	8	.
Genista tinctoria	E1	.	.	.	.	.	.	8	.
Hipocrepis comosa	E1	.	.	.	.	.	.	8	.
Arabis hirsuta	E1	.	.	.	.	.	.	8	.
Centaurea stoebe (C. rhenana)	E1	.	.	.	.	.	.	.	40
Trifolio-Geranietea									
Verbascum austriacum	E1	19	9	25	.	.	.	.	.
Hypericum perforatum (inc. subsp. veronense)	E1	15	9	38	13	11	.	50	.
Lathyrus sylvestris	E1	11	.	13	.	11	22	.	.
Astragalus glycyphyllos	E1	7	.	.	.	.	.	.	.
Clinopodium vulgare	E1	4	9	.	.	.	.	.	.
Digitalis grandiflora	E1	4	.	.	.	.	.	.	.
Inula conyza	E1	4	.	.	.	.	.	.	.
Peucedanum venetum	E1	4	.	.	.	.	.	.	.
Libanotis sibirica subsp. montana	E1	.	9	.	.	.	.	.	.
Trifolium aureum	E1	.	9	.	.	.	.	.	.
Verbascum lychnitis	E1	.	.	13	.	.	.	.	.
Sambuco-Salicion capreae					.				
Robinia pseudoacacia	E2a	.	.	25	.	.	.	.	.
Robinia pseudoacacia	E1	67	36	63	.	.	33	.	.
Betula pendula	E1	4	.	.	.	.	.	.	.
Ailanthus glandulosa (A. altissima)	E1	.	27	.	.	.	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Salix caprea	E1	.	.	.	13	.	.	.	.
Rhamno-Prunetea									
Cornus sanguinea	E1	7	9	.	.	.	11	25	.
Rubus fruticosus agg.	E2a	4	.	.	.	.	.	.	.
Berberis vulgaris	E1	4	.	.	.	.	.	.	.
Ficus carica	E1	4	.	.	.	.	.	.	.
Lonicera nitida	E2a	.	.	13	.	.	.	.	.
Euonymus europaea	E1	.	.	.	.	.	11	.	.
Tilio-Acerion									
Cardamine impatiens	E1	19	18	13	63	22	11	.	.
Ulmus glabra	E1	37	36	13	.	.	22	.	.
Lunaria rediviva	E1	4	.	.	.	.	11	.	.
Aruncus dioicus	E1	.	9	.	.	.	11	.	.
Anthriscus nitida	E1	.	.	.	.	.	11	.	.
Acer pseudoplatanus	E1	.	.	.	.	.	.	8	.
Alnion incanae									
Solanum dulcamara	E1	81	91	75	63	11	33	58	80
Rubus caesius	E1	37	36	63	.	.	33	25	80
Festuca gigantea	E1	30	9	25	38	.	33	.	.
Alnus incana	E1	11	.	13	.	.	.	8	.
Frangula alnus	E1	4	27	25	.	.	.	50	.
Chaerophyllum hirsutum	E1	4	.	13	38	.	22	17	.
Vitis vinifera	E1	4	.	13	13	.	.	.	.
Impatiens noli-tangere	E1	4	.	.	.	.	11	.	.
Agropyron caninum	E1	.	36	.	.	.	11	100	.
Acer negundo	E1	.	9	.	.	.	.	.	.
Circaea intermedia	E1	.	9	.	.	.	.	.	.
Alnus glutinosa	E2	.	.	.	.	.	.	.	20
Fagetalia sylvaticae									
Scrophularia nodosa	E1	85	100	38	63	33	11	25	.
Brachypodium sylvaticum	E1	67	91	38	38	11	33	.	.
Salvia glutinosa	E1	59	64	25	25	.	22	50	.
Mycelis muralis	E1	37	73	25	25	22	.	.	.
Myosotis sylvatica agg.	E1	11	27	.	.	33	.	.	.
Carpinus betulus	E1	11	.	13	.	.	.	.	.
Galium laevigatum	E1	11	9	.	.	.	.	33	.
Heracleum sphondylium	E1	7	.	.	.	.	11	.	.
Carex sylvatica	E1	4	9	.	.	.	.	.	.
Campanula trachelium	E1	4	.	13	.	.	11	.	.
Circaea lutetiana	E1	4	.	.	.	.	.	.	.
Aposeris foetida	E1	.	9	.	.	.	.	.	.
Ranunculus lanuginosus	E1	.	.	13	.	.	11	17	.
Viola reichenbachiana	E1	.	.	13	.	.	.	.	.
Laburnum alpinum	E1	.	.	.	13	.	.	.	.
Knautia drymeia	E1	.	.	.	.	.	11	42	.
Lamium orvala	E1	.	.	.	.	.	11	.	.
Geranium nodosum	E1	.	.	.	.	.	11	.	.
Allium ursinum	E1	.	.	.	.	.	11	.	.
Galeobdolon flavidum	E1	.	.	.	.	.	11	.	.
Quercetalia pubescenti-petraeae									
Arabis turrita	E1	15	.	13	.	22	.	.	.
Calamintha sylvatica	E1	4	.	.	.	.	.	.	.
Ostrya carpinifolia	E2a	.	.	13	.	.	.	.	.
Ostrya carpinifolia	E1	.	9	.	.	.	.	8	.
Fraxinus ornus	E1	.	.	.	.	.	.	8	.
Querco-Fagetea									
Clematis vitalba	E1	81	45	50	25	22	11	83	20
Cerastium sylvaticum	E1	37	82	25	50	78	.	33	.
Hedera helix	E1	7	.	.	.	.	.	.	.
Moehringia trinervia	E1	4	18	.	13	22	.	.	.
Ulmus minor	E1	4	.	.	.	33	.	.	.
Corylus avellana	E1	.	.	13	.	.	.	.	.

Successive number (Zaporedna številka)		1	2	3	4	5	6	7	8
Ranunculus cassubicus	E1	.	.	.	.	.	11	.	.
Anemone nemorosa	E1	.	.	.	.	.	11	.	.
Hieracium murorum	E1	.	.	.	.	.	.	25	.
Cruciata glabra	E1	.	.	.	.	.	.	8	.
Erico-Pinetea, Vaccinio-Piceetea									
Molinia arundinacea	E1	4	9	.	.	.	.	25	.
Calamagrostis varia	E1	4	9	.	.	.	.	42	.
Carex ornithopoda	E1	.	18	.	13	.	.	.	.
Aquilegia nigricans	E1	.	18	.	.	.	.	.	.
Chamaecytisus hirsutus	E1	.	9	.	.	.	.	.	.
Solidago virgaurea	E1	.	.	.	.	.	.	8	.
Other species (Druge vrste)									
Crepis sp.	E1	.	.	13	.	.	.	.	.
Cerastium sp.	E1	.	.	.	.	11	.	.	.
Mosses (Mahovi)									
Brachythecium rutabulum	E0	.	.	.	.	.	11	.	.
Mnium undulatum	E0	.	.	.	.	.	.	.	20
Eurrhynchium sp.	E0	.	.	.	.	.	.	.	20

Legend - Legenda

ID Igor Dakskobler, BČ Boško Čušin, VP Viktor Petkovšek

1 PlSe P*olygono lapathifoliae-Salicetum eleagni*, this article, relevés 1–27 in Table 1

2 PlSe–Sa *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 28–38 in Table 1 (relevés from the Soča Valley between Volarje and Žaga and from the Sava Bohinjka Valley)

3 PlSe-ne *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 47–54 in Table 1 (atypical relevés from the valleys of the Soča, Bača, Nadiža and Sava Bohinjka)

4 ChPo-Ba *Chaerophyllo-Petasitetum officinalis*, this article, relevés 39–46 in Table 1 (the upper part of the Bača Valley from the hamlet Humar to Podbrdo).

5 PLSe-To *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 55–63, initial plant community on gravel terraces of the Tolminka River near Tolmin

6 ChPo-Id *Chaerophyllo-Petasitetum officinalis*, the Idrijca Valley, Dakskobler (2010, Table 1)

7 ESc-Na *Epilobio-Scrophularietum caninae*, the Nadiža Valley, Čušin (2001, Table 1)

8 CsSp *Calystegio-Salicetum purpureae*, central and southeastern Slovenia, Petkovšek (1966)

Table 3: Sociological groups of initial plant communities on riverine gravel terraces in western Slovenia (relative frequencies)
Preglednica 3: Skupine diagnostičnih vrst v prodiščnih združbah v zahodni Sloveniji (relativne frekvence)

Successive number (Zaporedna številka)	1	2	3	4	5	6	7	8
Sign for syntaxa (Oznaka združb)	PlSe	PlSe-Sa	PlSe-ne	ChPo-Ba	PlSe-To	ChPo-Id	ESc-Na	CsSp
Author (Avtor)	ID	ID	ID	ID	ID	ID	BČ	VP
Number of relevé (Število popisov)	27	11	8	8	9	9	12	10
Epilobion fleischeri	1.02	3.27	1.24	0	0.72	0	7.36	1.41
Stipion calamagrostis	1.42	1.96	2.23	0.29	0	0	2.68	1.41
Petasition paradoxi	1.19	2.22	2.23	0.88	1.67	0.42	5.59	0
Galeopsietalia segetum	0.06	0	0.25	0	0	0	0	0
Thlaspietea rotundifolii	0	0.26	0	0.29	0.24	0	0	0
Asplenietea trichomanis	0.62	0.52	0.25	0.58	**2.86**	0	0.21	0
Mulgedio-Aconitetea	2.04	1.05	1.49	**3.80**	0.72	3.81	0.21	0
Salicetea purpureae	2.84	2.35	**4.71**	2.92	2.63	2.51	2.89	**6.34**
Bidentetea	3.58	3.92	2.98	3.51	**4.30**	**5.48**	0	3.52
Papaveretea rhoeadis (Stellarietea mediae)	**20.7**	**17.12**	**13.9**	**19.59**	**31.3**	**21.01**	**9.36**	**6.34**
Sisymbrietea	3.41	1.96	2.48	1.46	3.58	1.26	2.25	0
Digitario sanguinalis-Eragrostietea minoris	**6.64**	**5.10**	**8.19**	**6.14**	**10.26**	**7.16**	*0.67*	**9.15**
Artemisietea vulgaris	**7.72**	**7.84**	**7.69**	**9.06**	**6.44**	**5.90**	7.12	**8.45**
Galio-Urticetea	**7.78**	**6.67**	**5.71**	**6.73**	**4.77**	3.77	**6.23**	**13.38**
Epilobietea angustifolii	3.35	3.01	2.73	3.22	3.82	2.09	3.58	2.11
Filipendulo-Petasition	2.90	3.14	3.23	**4.09**	1.91	**6.74**	2.01	3.17
Filipendulo-Convolvuletea	2.95	3.40	2.23	1.75	1.43	**4.64**	2.01	**15.85**
Phragmiti-Magnocaricetea	0.40	2.48	1.49	1.17	0.24	1.67	0	**6.69**
Isoëto-Nanojuncetea	0.23	0.52	0.25	0.29	0	0	0	1.76
Calthion, Molinion	1.19	1.70	1.74	2.63	0.48	2.09	1.12	2.11
Potentillo-Polygonetalia	2.73	3.79	1.98	3.80	1.19	1.67	2.46	2.11
Agropyretalia intermedio-repentis	2.50	1.31	1.98	2.63	1.19	2.97	1.55	**4.58**
Molinio-Arrhenatheretea	**8.52**	**7.84**	**10.42**	**11.11**	**9.31**	**7.54**	**9.98**	1.76
Koelerio-Corynephoretea	0.80	1.83	1.74	0.58	2.15	0	**2.92**	0
Festuco-Brometea	2.44	2.35	**4.22**	1.75	1.43	0.84	**9.79**	2.82
Trifolio-Geranietea	1.02	0.65	1.74	0.29	0.48	0.84	1.34	0
Sambuco-Salicion capreae	1.08	0.91	1.74	0.29	0	1.26	0	0
Rhamno-Prunetea	0.28	0.13	0.25	0	0	0.84	0.67	0
Alnion incane, Tilio-Acerion	3.58	**4.05**	**4.96**	**4.97**	0.72	**7.96**	**7.12**	**6.34**
Fagetalia sylvaticae	**4.60**	**5.49**	3.47	3.80	2.15	**5.86**	**4.68**	0
Quercetalia pubescenti-petraeae, Querco-Fagetea	2.33	2.22	2.23	2.05	**3.82**	1.26	**4.41**	0.70
Erico-Pinetea	0.11	0.91	0	0.29	0	0	1.79	0
Other species (Druge vrste)	0	0	0.2	0	0.2	0.42	0	0
Total (Skupaj)	100	100	100	100	100	100	100	100

Legend - Legenda

ID Igor Dakskobler, BČ Boško Čušin, VP Viktor Petkovšek
1 PlSe *Polygono lapathifoliae-Salicetum eleagni*, this article, relevés 1–27 in Table 1
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8 CsSp *Calystegio-Salicetum purpureae*, central and southeastern Slovenia, Petkovšek (1966)

Table 4: Life forms spectra of initial plant communities on riverine gravel terraces in Slovenia
Preglednica 4: Spekter življenjskih oblik v inicialnih prodiščnih združbah v Sloveniji

Successive number (Zaporedna številka)	1	2	3	4	5	6	7	8
Sign for syntaxa (Oznaka združb)	PlSe	PlSe-Sa	PlSe-ne	ChPo-Ba	PlSe-To	ChPo-Id	ESc-Na	CsSp
Author (Avtor)	ID	ID	ID	ID	ID	ID	BČ	VP
Number of relevé (Število popisov)	27	11	8	8	9	9	12	10
Phanerophytes (Fanerofiti)	6.64	5.75	9.68	5.56	3.82	5.89	**7.97**	6.34
Nanophanerophytes (Nanofanerofiti)	0.62	0.52	1.49	0	0	1.26	0.67	2.82
Gephytes (Geofiti)	6.42	5.23	5.71	7.60	1.91	**11.47**	4.90	**7.04**
Chamaephytes (Hamefiti)	3.24	3.27	3.97	5.26	1.91	5.08	**7.14**	2.82
Hemicryptophytes (Hemikriptofiti)	**43.67**	49.80	47.39	**50**	**44.15**	39.14	**57.68**	**53.17**
Hydrophytes (Hidrofiti)	0.23	1.44	0.74	1.17	0.24	0	0	0
Therophytes (Terofiti)	**39.18**	33.98	31.01	30.41	**47.97**	37.16	**21.64**	**27.82**
Total (Skupaj)	100	100	100	100	100	100	100	100

Legend - see Table 3 / **Legenda** - glej preglednico 3

PRVA FITOCENOLOŠKA RAZISKOVANJA V KAMNIŠKI BISTRICI
(Ob 70. obletnici oddelka za gozdarstvo in obnovljive vire Biotehniške fakultete univerze v Ljubljani)

FIRST PHYTOCENOLOGICAL RESEARCH IN KAMNIŠKA BISTRICA
(At the occasion of the 70th anniversary of the establishment of Department for Forestry and Renewable Forest Resources at Biotechnical Faculty, University of Ljubljana)

Mitja ZUPANČIČ[1] & Andrej ROZMAN[2]

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IZVLEČEK

Prva fitocenološka raziskovanja v Kamniški Bistrici

Cvekov elaborat *Opis gozdnih združb doline Kamniške Bistrice, s posebnim ozirom na gozdnogojitveno problematiko* oziroma njegov vegetacijski del, ki je bil predložen za njegovo habilitacijo za univerzitetnega učitelja, je verjetno prvi elaborat, ki podaja gozdnogojitvene smernice na podlagi gozdnih fitocenoz. Morda je bil sočasno ali malo pozneje izdelan podoben elaborat Tregubova za območje Leskove doline na Snežniku. V vegetacijskem delu elaborata za Kamniško Bistrico je Cvek opisal 21 sintaksonov gozdnih fitocenoz. V petdesetih letih prejšnjega stoletja je bilo območje Kamniške Bistrice fakultetno posestvo Fakultete za agronomijo in gozdarstvo. Izdelani sta bili dve vegetacijski karti v merilu 1 : 10.000.

Ključne besede: fitocenologija, Kamniška Bistrica, Slovenija

ABSTRACT

First phytocenological research in Kamniška Bistrica

Cvek's study *A description of the forest associations of the Kamniška Bistrica valley, with particular regard to silvicultural questions,* or its vegetational part, which was proposed for his habilitation as a university teacher, is probably the first study to provide silvicultural guidelines on the basis of forest phytocoenoses. Perhaps a similar study by Tregubov for the area of the Leskova valley on Snežnik was made simultaneously, or a little later. In the vegetational part of the study for Kamniška Bistrica, Cvek described 21 syntaxa of forest phytocoenoses. In the 1950s, the area of Kamniška Bistrica was a faculty estate of the Faculty of Agronomy and Forestry. Two vegetation maps in a scale of 1 : 10.000 were produced.

Key words: phytocoenology, Kamniška Bistrica, Slovenia

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1. UVOD

Po drugi svetovni vojni so se razširila fitocenološka raziskovanja, zlasti na področju gozdarstva. Zasluga za tovrstna raziskovanja gre predvsem trem pionirjem, tisti čas vodilnim fitocenologom dr. V. Tregubovu, gozdarju, ter prof. G. Tomažiču in dr. M. Wraberju, biologoma. Vsi trije so že med svetovnima vojnama opravljali fitocenološke raziskave. Tregubov je v Bosni preučeval gozdno vegetacijo, Tomažič gozdno-grmiščno in negozdno vegetacijo Slovenije ter Wraber hrastove gozdove južne Francije. Po drugi svetovni vojni so združili svoje znanje in se dogovorili za vegetacijska (fitocenološka) raziskovanja za potrebe gospodarstva, zlasti gozdarstva. Na inštitutski raziskovalni ravni sta bila najbolj dejavna Tregubov in Wraber, na visokošolskem raziskovalnem področju pa Tomažič, ki je ob ustanovitvi gozdarskega oddelka (zdaj mineva 70 let od njegove ustanovitve), začel predavati fitocenologijo za gozdarje.

Tregubov in Wraber sta se osredotočila na fitocenološke raziskave alpskih in predalpskih bukovih gozdov Slovenije, Tregubov še na dinarske gozdove, Wraber pa na gozdove Pohorja in soseščine. Tomažič je dal idejo o fitocenološkem raziskovanju Kamniške Bistrice, kjer je to bilo tedaj eno od treh fakultetnih posestev, (drugi sta bili Velika Nedelja in Panovec). Botanik Tomažič je bil predavatelj fitocenologije za gozdarje v sklopu gozdnogojitvene katedre, ki ji je načeloval gozdar prof. S. Sotošek, njegov asistent na katedri pa je bil S. Cvek, univ. dipl. inž. gozd., že uveljavljeni gojitelj gozdov in fitocenolog. Tomažič kot idejni vodja projekta je operativno izvedbo fitocenoloških raziskav zaupal Cveku. Raziskave so se verjetno začele v letu 1950 ali morda leto prej, končale pa so se leta 1955 z izdelavo elaborata. Naslov elaborata je bil *Opis gozdnih združb doline Kamniške Bistrice, s posebnim ozirom na gozdnogojitveno problematiko*.

Prva preučevanja v Kamniški Bistrici sta opravila Tomažič in Cvek, v nadaljevanju pa Cvek sam, ker je Tomažič po letu 1952 zaradi bolezni nekaj časa opustil predavanja na gozdarski in filozofski fakulteti ter terenska raziskovanja. Tomažič si je med tedanjimi študenti za spremljevalca in pozneje sodelavca izbral Ž. Koširja (pozneje univ. dipl. inž in dr. gozdarstva, vodja Biroja za gozdarsko načrtovanje, uslužbenec v državni upravi in uspešen fitocenolog, inovator na področju vrednotenja gozdnih rastišč). Pozneje je Košir pod vodstvom Cveka samostojno preučeval tamkajšnjo gozdno vegetacijo. Cvek pa si je za spremljevalca med študenti izbral D. Juga (pozneje univ. dipl. gozd. inž. na Gozdnem gospodarstvu Celje). Jug je zbolel in Cvek je za drugega spremljevalca izbral študenta D. Robiča, pozneje magistra gozdarstva in univerzitetnega predavatelja fitocenologije za gozdarje.

Izdelava rokopisnega elaborata z vegetacijsko karto Kamniške Bistrice je bila končana leta 1955. To je bil eden izmed prvih gozdnogojitvenih elaboratov na podlagi gozdnih vegetacijskih združb, ki je nastajal verjetno sočasno z elaboratom Tregubova za Leskovo dolino na snežniškem pogorju za Gozdno gospodarstvo Postojna. Pozneje, vse do leta 1991, so bil izdelani mnogi elaborati za različna gozdna gospodarstva Slovenije. Tregubov s sodelavci je leta 1957 na podlagi prej omenjenega elaborata za Leskovo dolino izdelal monografijo *Prebiralni gozdovi Snežnika*. Fitocenološke ali vegetacijske raziskave v Leskovi dolini so se začele leta 1948 in rokopisna vegetacijska karta je bila izdelana v letih 1951–52. Raziskovalna dela v Kamniški Bistrici so se verjetno začela leta 1949 z ustanovitvijo gozdarskega oddelka tedanje Fakultete za agronomijo in gozdarstvo ali kakšno leto pozneje (1950–1951). Verjetno je to edini gozdnogojitveni elaborat na podlagi gozdnih združb z vegetacijsko karto, izdelan na tedanji fakulteti. Poznejši elaborati so nastajali na Gozdarskem inštitutu Slovenije oz. Inštitutu za gozdno in lesno gospodarstvo Slovenije (IGLGS), Biološkem inštitutu Jovana Hadžija ZRC SAZU oz. Inštitutu za biologijo SAZU in Biroju za gozdarska načrtovanja in melioracijo.

Elaborat za Leskovo dolino je bil znanstveno predstavljen v ediciji Strokovna in znanstvena dela 4 IGLGS pri založbi Kmečka knjiga Ljubljana. Menimo, da bi bilo prav, da tudi elaborat *Opis gozdnih združb doline Kamniške Bistrice, s posebnim ozirom na gozdnogojitveno problematiko* znanstveno predstavimo. V zapuščini prof. Dušana Robiča, ki jo je njegova vdova Danica Robič s posredovanjem prof. Andreja Bončine prepustila v hrambo Katedri za gojenje gozdov in izrecno naslednikom pokojnega moža pri predmetu fitocenologija, ga je spomladi leta 2017 našel soavtor te razprave, doc. Andrej Rozman. Za njegovo predstavitev smo povsem po naključju izbrali čas, ko praznujemo sedemdesetletnico Oddelka za gozdarstvo in obnovljive vire (Oddelek za gozdarstvo). Predstavljen bo le botanično-fitocenološki del elaborata, ki ga imamo na voljo v rokopisni obliki. Celotnega elaborata nismo uspeli dobiti – kljub prizadevanju bibliotekark knjižnic na Oddelku za gozdarstvo in obnovljive vire, Oddelku za agronomijo ter Gozdarskega inštituta. Elaborata preprosto ni, verjetno je bil pri izposoji izgubljen. Majhna možnost za najdbo je v knjižnici agronomskega oddelka, ko bo knjižni fond v celoti prenesen v računalniško obliko. Če bo elaborat najden, bomo dopolnili članek ali napisali dopolnilo v prihodnji številki te revije.

Namen pričujočega članka je analiza tedanjega poznavanja gozdnih združb, njihove floristične sestave ter njihovih rastiščnih in ekoloških razmer v primerjavi z vedenjem o njih v današnjem času. Zato zadostuje botanično-fitocenološki del elaborata od strani 54 do 81 s kartama, ki je glavni in osnovni del elaborata. Ta del elaborata je asistent Cvek verjetno predal za ponovno habilitacijo v naziv višji asistent. Vsebina ekološkega dela elaborata je na visoki strokovni ravni.

Rastline so poimenovane po tedanji splošni uporabi latinskih rastlinskih imen v gozdarstvu. Podobno velja tudi za latinska imena sintaksonov. Sodobna imena združb sledijo Šilcu & Čarniju (2012). V posebnem poglavju so latinska imena, ki jih je zapisal Cvek prevedena v imena po Mali flori Slovenije (Martinčič et al. 2007).

Na kratko naj navedemo nekaj biografskih podatkov o Stanku Cveku. Rodil se je v Borovljah (Ferlach) 20. 12. 1915, umrl v Ljubljani 11. 12. 1959. Diplomiral je leta 1940 na Oddelku za gozdarstvo, Kmetijsko-gozdarske fakultete v Zagrebu. Po diplomi je bil najprej zaposlen v gozdarski operativi in pozneje v raziskovalnih organizacijah gozdarske stroke na Hrvaškem in v Sloveniji. Leta 1950 je bil imenovan za višjega asistenta na gozdarskem oddelku Fakultete za agronomijo in gozdarstvo. Med prvimi je v gozdnogospodarsko načrtovanje uvajal fitocenološke izsledke. (Robič 1988: 86–87, Anonymus 1957: 194–195).

2. ANALIZA GOZDNIH ZDRUŽB V PRETEKLOSTI IN SEDANJOSTI

Držali se bomo vrstnega reda opisa gozdnih združb po fitocenološko-gozdnogojitvenem delu elaborata avtorja Stanka Cveka (1955) *Opis gozdnih združb doline Kamniške Bistrice, s posebnim ozirom na gozdnogojitveno problematiko*; tako začnemo z asociacijo:

2.1. Cariceto remotae-Fraxinetum (Carici remotae-Fraxinetum excelsioris W. Koch 1925)

Avtor Cvek je objavil tri fitocenološke popise te vlagoljubne, ob gorskih potokih razvite gozdne združbe, in sicer:

tipično obliko **Carici remotae-Fraxinetum** z naslednjim fitocenološkim popisom:

»Drevesni sloj:
Fraxinus excelsior 2.2.
Alnus incana 3.3
Acer pseudoplatanus 2.2.
Carpinus betulus +
Picea excelsa +
Acer campestre +

Grmovni sloj:
Corylus avellana 1.2.
Acer pseudoplatanus +
Salix glabra +
Daphne mezereum +
Solanum dulcamara +

Zeliščni sloj:
Petasites hybridus 3.3.
Deschampsia caespitosa 3.3
Lysimachia nummularia 2.2
Mentha aquatica 2.2.
Crepis paludosa 1.1.
Stellaria glochidiosperma 1.1.
Caltha palustris 2.2.
Herophylum cicutaria 3.3.
Juncus glaucum +.2
Brachypodium silvaticum +
Fragaria vesca +
Tussilago farfara 1.1
Euphorbia amygdaloides +
Galium vernum +
Carex silvatica +
Galeopsis speciosa +
Stachys silvatica 1.1
Poa nemoralis +
Nephrodium dryopteris +
Aspidium spinolosum +
Carex remota +
Impatiens noli-tangere +
Ranunculus lanuginosus +
Salvia glutinosa 1.1.
Hypericum acuntangulum +
Prunella sp. +
Moehringia trinervia +
Pulmunaria officinalis +
Aspidium filix-mas +.3
Athyrium filix-femina +
Cardamine trifolia +
Aposeris foetida +
Ranunculus reptans +
Scrophularia nodosa +
Plantago major +
Equisetum palustris +
Mentha longifolia +
Oxalis acetosella +
Galium palustre +
Asarum europaeum +
Cirsium palustre +
Senecio fuchsii
Cerastium silvaticum +
Geranium robertianum +
Orchis maculata +

Mahovi:
Mnium undulatum 1.1
Mnium cuspidatum +2
Thuidium tamariscinum +
Trichocolea tomentella +
Ctenidium molluscum +
Fegatella conica 1.3

Asociacija porašča oligocenski glinasti peščenjak, delno pokrit z apnenim gruščem. Asociacija je površinsko majhna, toda pomembna zaradi dobrega uspevanja velikega jesena (Fraxinus excelsior).«

2.1.1. Drugi popis **Carici remotae-Fraxinetum alnetosum** opisuje subasociacijo s sivo jelšo **(Alnus incana)**. *»Raste na močvirnih rastiščih in je pomembna zaradi bujnega uspevanja sive jelše.*"

Drevesni sloj:
Alnus incana 3.3
Fraxinus excelsior +
Acer pseudoplantanus +
Sambucus nigra +

Grmovni sloj:
Alnus incana 1.1
Sambucus nigra 1.1
Fraxinus excelsior +
Picea excelsa
Daphne mezereum +
Fagus silvatica +
Clematis vitalba +

Zeliščni sloj:
Impatiens noli-tangere 3.3
Circaea lutetiana 2.2
Stachys silvatica 2.2.
Salvia glutinosa 3.3
Lysimachia nummularia 1.1.
Urtica urens 2.2.
Ranunculus lanuginosus 1.1.
Carex remota +1
Pulmunaria officinalis 1.1.
Petasites hybridus 1.1.
Stellaria glochidiosperma +
Arctium spec. 1.1
Aegopodium podagraria +
Deschampsia flexusa +.1
Deschampsia caespitosa +.1
Brachypodium silvaticum +
Senecio fuchsii +
Physalis alcecengi +
Solanum dulcamara +
Tussilago farfara +
Asperula odorata +
Arum maculatum +
Ranunculus reptans +
Scrophularia nodosa +
Aspidium filix-mas +
Cardamine trifolia +
Asarum europaeum +
Clematis alpina +
Angelica silvetris +«

Tretji popis predstavlja subasociacijo z belo jelko (**Abies alba**).

2.1.2. **Carici remotae-Fraxinetum abietetosum**, »*ki naseljuje pobočja nad potočnim jarkom. Rastišče je bolj sušno in zato izostaja izrazitejša vlagoljubna flora, v drevesni plasti pa je obilno primešana bela jelka.*

Drevesni sloj:
Abies alba 3.3
Fraxinus excelsior +
Fagus silvatica (+)

Grmovni sloj:
Fraxinus excelsior 2.2
Carpinus betulus 2.2
Acer pseudoplatanus 1.1.
Corylus avellana +
Sorbus aria +
Lonicera xylosteum +
Ostrya carpinifolia +
Daphne mezereum +
Rubus fructicosa +

Zeliščni sloj:
Petasites albus 2.2
Salvia glutinosa 2.2.
Clematis vitalba 1.1
Mercurialis perennis 1.1
Athyrium filix-femina +.1
Senecio fuchsii +
Fragaria vesca +
Oxalis acetosella +
Asarum europaeum +
Asperula odorata +
Lactuca muralis +
Hacquetia epipactis +
Carex digitata +
Calamagrostis varia +
Eupatorium canabinum +
Solidago virgaurea +
Euphorbia amygdaloides
Viola spec. +
Aposeris foetida +
Hieracium murorum +
Polygonatum multiflorum +
Prenathes purpurea +
Cardamine trifolia +
Lilium martagon +
Sanicula europaea +
Carex pendula +
Cyclamen europaeum +
Lamium orvala +
Gentiana asclepiadea +
Hypericum hirsutum +
Asplenium trichomanes +
Pulmunaria officinalis +
Campanula trachelium +
Angelica silvestris +
Galium silvaticum +
Cardamine bulbifera +
Nephrodium filix-mas +
Symphytum tuberosum +
Brachypodium sivlaticum +
Cirsium montanum +

Mahovi:
Neckera complanata
Ctenidium molluscum«

V poznejši literaturi, ki zadeva območje Kamniške Bistrice ta asociacija ni bila zabeležena. Verjetno zaradi izredno majnih površin (Vegetacijska karta Slovenije, Ljubljana – 2, 1982–86) ali pa je bila spregledana (Marinček 1995). Po Cvekovih popisih sodeč je na tem območju nesporno zastopana. V Cvekovih fitocenoloških popisih so zastopane tri značilnice asociacije od štirih, ki jih v literaturi navaja Oberdorfer (1957), te so: **Carex remota, C. pendula in Circaea lutetiana**.

2.2. Querceto-Carpinetum (Querco-Carpinetum Ht. (1938) 1949) je naslednja gozdna združba, ki jo opisuje Cvek. »*Nahaja se na nižinski valoviti planoti z oligocenskimi glinenci, ki so delno prekriti z apnencem. Izredno bujno uspevata veliki jesen (Fraxinus excelsior) in beli javor (Acer pseudoplatanus), ki sta v tej združbi dominantna*«. Cvek je zabeležil naslednji fitocenološki popis:

»*Nadstojni drevesni sloj:*
Fraxinus excelsior 2.2.
Acer pseudoplatanus 1.1.
Tilia cordata +
Fagus silvatica +
Prunus avium +
Quercus sessiliflora (+)

Podstojni drevesni sloj (viš. do 6 m):
Carpinus betulus 3.3.
Fraxinus excelsior 1.1.
Acer campestre +

Gmovni sloj:
Carpinus betulus 1.1.
Fraxinus excelsior 1.1.
Corylus avellana 1.1.
Lonicera xylosteum +
Viburnum opulus +
Euonymus europaea +
Picea excelsa +
Sorbus aucuparia +
Acer platanoides +
Daphne mezereum +
Acer campestre +
Rosa canina +
Rubus idaeus +
Clematis vitalba +
Acer pseudoplatanus +
Viburnum lantana +
Crataegus oxyacantha +
Salix caprea +
Rhamnus cathartica +
Sorbus aria +
Berberis vulgaris +
Fagus silvatica +
Rosa arvensis +
Crataegus monogyna +
Rhamnus carniolica +
Ribes alpinum +
Cornus sanguinea +
Fraxinus onus +

Zeliščni sloj:
Crocus vernus 2.2.
Aegopodium podagraria 2.2
Stellaria holostea 1.2.
Aposeris foetida 2.2.
Anemone hepatica 1.1.
Lamium luteum 1.1.
Brachypodium silvaticum 1.1.
Hacquetia epipactis 1.1.
Milium effusum 1.1.
Adoxa moschatellina 1.1.
Salvia glutinosa 1.1.
Galium vernum 1.1.
Campanula bracheteciu m +
Viola silvestris +
Athyrium filix-femina +
Deschampsia caespitosa +
Luzula pilosa +
Helleborus macranthus +
Aremonia agrimonioides +
Ranunculus lanuginosus +
Fragaria elatior +
Aspidium filix-mas +
Cyclamen europaeum +
Veronica urticifolia +
Polystichum lobatum +
Majanthemum bifolium +

Asarum europaeum +
Euphorbia amygdaloides +
Mercurialis perennis +
Geum urbanum +
Melica nutans +
Sanicula europaea +
Moehringia trinervia +
Phyteuma spicatum +
Symphytum tuberosum +
Carex silvatica 1.2
Polygonatum multiflorum +
Glechoma hederacea +
Cardamine flexuosa +
Festuca gigantea +
Anemone nemorosa +
Oxalis acetosella +
Polypodium vulgare +
Euphorbia carniolica +
Senecio fuchsii +
Gentiana asclepiadea +
Saturea vulgaris +
Primula acaulis +
Hedera helix +

Mahovi:
Mnium undulatum +.3
Ctenidium molluscum +.2
Eurhynchicum striatum +.3«

Pozneje jo je Tomažič s sodelavci invalidno (nepravilno) preimenoval v **Fraxino-Carpinetum** zaradi večinskega pojavljanja vitalnega velikega jesena in belega gabra ter številne karpinetalne flore v družbi s fagetalno floro. Marinček (1995) je po Kodeksu neveljavno objavljeno Tomažičevo asociacijo, preimenoval v sintaskonom **Hacquetio-Fraxinetum** var. geogr. **Dentaria pentaphyllos dentarietosum trifoliae Marinček 1991** var. **Carpinus betulus Marinček 1995** in ga predstavil s 15 fitocenološkimi popisi. Menimo, da gre za sekundarno združbo na potencialno hrastovo-belogabrovih rastiščih, na kar da misliti opozorilo Cveka (1995) o močnem izkoriščanju tega gozda tudi z golosečnjami.

2.3. Acereto-Fraxinetum (Aceri-Fraxinetum W. Koch 1926) »*se v Kamniški Bistrici pojavlja na dveh gruščnatih rastiščih, in sicer v ozkih pasovih ob jarkih ali na gruščnatih skalovitih vršajih*« (Cvek piše stožcih), *ki so jih odložili plazovi*.« Cvek (1955) je zabeležil naslednji fitocenološki popis:

»*Drevesni sloj:*
Fraxinus excelsior 2.2
Acer pseudoplatanus 2.2.
Fagus silvatica

Grmovni sloj:
Fraxinus excelsior +
Acer pseudoplatanus +
Fagus silvatica +
Picea excelsa +
Daphne mezereum 1.1
Rhamnus fallax +

Zeliščni sloj:
Lunaria rediviva 2.2
Lamium orvala 2.2.
Circaea lutetiana 1.1
Scolopendrium vulgare 1.1
Mercurialis perennis 1.1
Adoxa moschatellina +
Aspidium filix-mas +
Asperula odorata +
Galeopsis speciosa +
Actaea spicata +
Salvia glutinosa +
Saxifraga rotundifolia +
Angelica silvestris +
Gentiana asclepiadea +
Lactuca muralis +
Asplenium trichomanes +
Clematis vitalba +
Impatiens noli-tangere +
Urtica dioica +
Thalictrum aquilegifolium +
Melandrium rubrum +
Oxalis acetosella +
Geranium robertianum +
Senecio fuchsii
Aposeris foetida +
Polystichum lobatum +
Polygonatum officinale +
Veratrum album +
Phytheuma spicatum +
Stellaria glochidiosperma +
Crepis paludosa +

Mahovi:
Ctenidium molluscum +.1
Minium spec. +.1«

Cvek pravi, »*da kljub neugodnosti terena lepo uspevata jesen in beli javor, ki gradita glavno maso sestoja. Združba ima varovalni pomen*.« V rokopisni vegetacijski karti v merilu 1 : 50.000, list Ljubljana – 2, je asociacija zabeležena kot **Aceri-Fraxinetum** (1982–86), enako tudi na Karti naravne potencialne vegetacije v merilu 1 : 1,000.000 (1986). P. Košir & Marinček (1999) sta združbo po kodeksu korektno opisala kot **Lamio orvalae-Aceretum pseudoplatani P. Košir & Marinček 1999.**

2.4. Rhodothamneto-Rhodoretum (Rhodothamno-Rhododendretum (Aichinger 1933) Br.–Bl. 1939 = Rhodothamno - Pinetum mugo (Aichinger 1933) Zupančič & Žagar in Zupančič 2015 je v elaboratu zabeležen v dveh subasocijah, in sicer:

2.4.1. **Rhodothamno-Rhododendretum mughetosum = Rhodothamno - Pinetum mugo**

Cvek pravilno ugotavlja, »*da se ta alpska grmiščna združba ruševja nahaja v višjih nadmorskih višinah, kjer ne morejo več uspevati drevesa zaradi neugodnih klimatskih razmer. Njeno floristično sestavo nam kaže fitocenološki popis posnet, v nadmorski višini 1600 m*:

Grmovni sloj:
Pinus mughus 3.3
Rhodothamnus chamaecistus 2.2
Rhododendron hirsutum 1.2
Vaccinum myrtillus 1.2
Salix glabra +
Vaccinum vitis-idaea +
Sorbus aucuparia +
Sorbus chamaemespilus +
Salix caprea +
Juniperus nana +
Alnus viridis +

Zeliščni sloj:
Erica carnea 2.3
Lycopodium annotinum 1.1.
Luzula silvatica 1.1.
Hieracium murorum +
Campanula scheuchzeri +
Tofieldia calyculata +
Cardamina enneaphylos +
Dryas octopetala +.1
Aposeris foetida +
Veronica lutea +
Astrantia minor +
Alchemila alpina +
Melampyrum silvaticum +
Selaginella selaginoides +
Pinguicula alpina +
Valeriana saxatilis +
Veratrum album +
Stachys jacquinii +
Polystichum lonchitis +
Lycopodium selago +
Geraninum robertianum +
Prenanthes purpurea +
Majanthemum bifolium +
Oxalis acetosella

Atragena alpina +
Homogyne alpina +
Homogyne silvestris +
Valeriana tripteris +
Thalictrum aquilegifolium +
Pedicularis verticilaris +
Aster amellus +
Phyteuma halleri +
Malica nutans +

Nekoliko nižje, kjer so ekološke razmere ugodnejše, zlasti klimatske, se pojavlja subasociacija:

2.4.2. **Rhodothamno-Rhododendretum laricetosum = Rhodothamno-Pinetum laricetosum**, *je alpsko grmišče s posameznimi macesni. Fitocenološki popis je bil popisan v nadmorski višini 1550 m.*

Drevesni sloj:
Larix europaea 1.1. *(Picea excelsa)*

Grmovni sloj:
Pinus mughus 4.4.
Vaccinium myritillus 4.4.
Rhododendron hirsutum 1.1.
Rhodothamnus chamaecistus +.1
Alnus viridis +
Sorbus chamaemepilus +
Juniperus nana +
Sorbus aucuparia +
Rosa spec. +
Vaccinium vitis-idaea +
Salix caprea +
Rubus saxatilis +

Zeliščni sloj:
Erica carnea 1.2.
Luzula nemorosa 1.1.
Lycopodium annotinum 1.1
Cardamine enneaphyllos +
Prenanthes purpurea +
Veratrum album +
Majanthemum bifolium +
Melampyrum silvaticum +
Astrantia minor
Hieracium murorum +
Polystichum lonchitis +
Homogyne alpina +
Luzula silvatica +
Phyteuma halleri +
Aposeris foetida +
Aconitum napellus +
Valeriana tripteris +
Veronica lutea +
Polygonatum verticillatum +
Gentiana pannonica +

Mahovi
Hylocomium triquetrum 2.2 *Pleurozium schreberi +.1«*

V karti potencialno naravne vegetacije (1986) in rokopisnih vegetacijskih kartah (M = 1 : 50.000) je združba označena kot **Rhodothamno-Rhododendretum**. Novejša literatura (Zupančič, Žagar & Culiberg 2006, Zupančič 2013) loči več oblik oziroma asociacij ruševja. V zvezi z območjem Kamniške Bistrice gre za **Rhodothamno-Pinetum mugo Zupančič & Žagar (1980, 2013) 2015**. Ruševje (**Pinus mugo**) je po Kodeksu nosilna vrsta združbe in ne kodominantna za subasociacijo. Zagotovo pa so v Cvekovemu sintaksonu **Rhodothamno-Rhododendretum laricetosum** zaobjeti tudi macesnovi sestoji iz asociacije **Rhodothamno-Laricetum deciduae Willner & Zukrigl 1999**. Nekaj sestojev te asociacije, iz gozdnega rezervata Kalce in Repovega kota, so objavili Dakskobler, Seliškar in Rozman (2018).

2.5. Sestoj Picea-Carex alba (comm.)

Cvek ga opisuje »*kot sekundarno tvorbo, nastalo po poseku primarne bukove združbe s pomočjo sadnje smreke (Picea abies). Pozneje ali celo sočasno se je tudi spontano zasemenila smreka, ker so ji ustrezale ekološke razmere, predvsem svetloba in mikroklima. Odprtost rastišča je povzročila nižje temperature od okolice, ki so dnevno in letno izraziteje nihale, kar je ustrezalo smreki, nikakor pa bukvi*«. Po popisu sodeč gre za rastišče alpskega bukovega gozda **Anemono trifoliae-Fagetum**, ki že po naravi vsebuje manjši delež smreke in piceetalne flore. Po številu so piceetalne in fagatalne vrste enakovredne, vendar prevladujejo bazifilne vrste. V popisu sta tudi zastopani diagnostično pomembni vrsti za asociacijo **Anemono trifoliae-Fagetum**, to sta **Anemone trifolia** in **Polygala chamaebuxus.** Fitocenološki popis ne kaže na smrekovo združbo, temveč na varianto alpskega bukovega gozda s smreko – **Anemono trifoliae-Fagetum Tregubov 1962 var. Picea abies**.

»*Drevesni sloj:*
Picea excelsa 3.3
Fagus silvatica 1.1.
Acer pseudoplatanus +.1
Ostrya carpinifolia +.1

Grmovni sloj:
Fagus silvatica 1.1.
Picea excelsa 2.2.
Acer pseudoplatanus +
Sorbus aria +
Sorbus aucuparia +
Lonicera alpigena +
Lonicera xylosteum +
Corylus avellana +
Rhamnus carniolica +
Salix glabra +
Ostrya carpinifolia +.1
Fraxinus ornus +.2
Clematis alpina +
Rosa pendulina +
Abies alba +
Daphne mezereum +

Zeliščni sloj:
Carex alba 3.3.
Calamagrostis varia 2.2
Vaccinium myrtillus 1.1
Melampyrum silvaticum 1.1
Gentiana asclepiadea 1.1
Homogyne silvestris +
Mercurialis perennis +
Asarum europaeum 1.1
Lamium luteum +
Fragaria vesca 1.1
Anemone trifolia 1.1
Cardamine trifolia 1.1
Carex digitata 1.1
Aspidium filix-mas +
Salvia glutinosa +
Clematis alpina +
Athyrium filix-femina +
Cynachum vincetoxicum +
Petasites hybridus +
Solidago virgaurea +
Euphrasia rustecoriana +
Rubus saxatilis +
Digitalis ambigua +
Galium mollugo +
Deschampsia caespitosa +
Buphthalmum salicifolium +
Scrophularia nodosa +
Oxalis acetosella +
Eupatorium cannabinum +
Majanthemum bifolium +
Nephrodium dryopteris +
Melica nutans +
Viola silvestris +
Polygala chamaebuxus +
Calamintha clinopodium +
Potentilla erecta +
Luzula pilosa +

Mahovi:
Ctenidium molluscum 2.4 *Dicranum scoparium +.2*

Hylocomium triquetrum 4.3 *Pleurozium schreberi 2.2.*
Neckera complanata 2.4 *Atrichum +.2«*

2.6. Asociacija *Abieto-Calamagrostidetum* *»je fragmentarno razvita na skalovitem edafsko slabem rastišču«*. Vprašljivo je, ali gre morda za asociacijo **Calamagrostio-Abietetum Ht. (1950) 1962**, ki je bila opisana na dinarskem območju Hrvaške ter v fragmentih sega na snežniško in trnovsko pogorje. Po fitocenološkem popisu sodeč sta od ilirskih vrst zabeleženi le **Cardamine trifolia** in **Rhamnus fallax**. Začasno bi jo uvrstili v Horvatovo združbo.

»Drevesni sloj:
Abies alba 3.3. *Tilia platyphyllos +*
Picea excelsa 1.1. *Sorbus aucuparia +*
Acer pseudoplatanus + *Sorbus aria +*

Grmovni sloj:
Abies alba 1.1. *Rhamnus carniolica +*
Sambucus racemosa 1.1. *Daphne mezereum +*
Picea excelsa + *Fagus silvatica +*

Zeliščni sloj:
Adenostyles glabra 1.1. *Polypodium vulgare +*
Calamagrostis varia 1.2 *Senecio fuchsii +*
Nephrodium drypopteris 1.1 *Lactuca muralis +*
Aspidium filix-mas 1.1 *Lamium luteum +*
Athyrium filix-femina + *Hiearacium murorum +*
Galium silvaticum + *Actaea spicata +*
Salvia glutinosa + *Hypericum hirsutum +*
Carex alba + *Paris quadrifolia +*
Carex digitata *Fragaria vesca +*
Polystichum lobatum + *Pulmunaria officinalis +*
Cardamine trifolia + *Moehringia muscosa+*
Epilobium montanum + *Veronica urticifolia +*
Mercurialis perennis + *Sorbus aria +*
Cyclamen europaeum + *Picea excelsa +*
Oxalis acetosella + *Abies alba +*
Rubus spec. + *Acer pseudoplatanus +*
Asplenium viride + *Ostrya carpinifolia*
Asplenium trichomanes +

Mahovi:
Cladonia pyxydata 1.3 *Ctenidium molluscum +.3*
Polytrichum atennuatum +.3 *Hylocomium triqetrum + .1*
Dicranum scoparium + *Neckera complanata +«*

2.7. Sestoj Larix-Ostrya združba (comm.)

»porašča debel gruščlapornatega apnenca na bolj ali manj strmih pobočjih. Floristično je združba obubožana zaradi velike pokrovnosti spomladanske rese (Erica carnea).

Drevesni sloj:
a) nadstojni:
Larix europaea 1.1 *Picea excelsa (+)*
Pinus silvestris 1.1
b) podstojni:
Ostrya carpinifolia 3.3 *Abies alba +*
Picea excelsa 1.1 *Laburnum alpinum +*
Fraxinus ornus + *Sorbus aria +*

Grmovnega sloja ni!

Zeliščni sloj:
Erica carnea 5.5 *Carex alba +*
Calamagrostis varia 3.3 *Asplenium ruta-muraria +*
Polygala chamaebuxus 1.1 *Moehringia muscosa +*
Cynanchum vincetoxicum + *Viola spec. +*

Lišaj:
Cladonia pyxydata +«

Po preučevanjih Dakskoblerja (2006) bi združbo macesna in črnega gabra uvrstili v asociacijo oziroma subasociacijo **Rhodothmano-Laricetum ostryetosum Dakskobler 2006**. Sestoji te subasociacije zagotovo uspevajo v dolini Kamniške Bistrice, čeprav so popise naravnega sestoja macesna in črnega gabra v skalovju ob lovski stezi med Žagano pečjo in gozdnim rezervatom Kalce Dakskobler, Seliškar in Rozman (2018) uvrstili v sintakson **Rhodthamno-Laricetum anemonetosum trifoliae** var. **typica**, ki ga z velikim zastiranjem označuje vrsta Sesleria caerulea.

2.8. V združbi ***Cardamineto-Fagetum* M. Wraber 1969**

sta glede na Cvekove štiri fitocenološke popise, zaobseženi dve bukovi asociaciji, in sicer **Ostryo-Fagetum M. Wraber ex Trinajstić 1972** in **Ranunculo platanfolii-Fagetum Marinček et al. 1993**.

Vse do šestdesetih let prejšnjega stoletja je bilo poznavanje bukovih gozdov na široki podlagi makroasociacij. Cvek je sledil temu mnenju. Tedaj je bila splošno znana zelo široko razumljena bukova asociacija **Cardamino-Fagetum** oziroma **Dentario-Fagetum Wraber 1969**, in sicer od submontanskega do altimontanskega višinskega pasu. Delitev bukovih gozdov na podrobnejše asociacije po ekoloških (klimatskih, edafskih) razmerah in fitogeografsko-floističnem principu sta začela uvajati Tregubov in Ž. Košir. Cvek je v svojih fitocenoloških popisih predvsem zajel popisne ploskve, ki so bile zastopane z vrstami iz rodov **Cardamine** in **Dentaria**, sicer stalnic bukovih gozdov, zlasti v območju ilirske florne province.

2.8.1. Prvi in četrti popis na nadmorskih višinah 960 m in 1200 m uvrščamo v sedanjo asociacijo **Ranunculo platanifolii-Fagetum Marinček et al. 1993,** kaže pa tudi določeno podobnost z asociacijo **Homogyno sylvestris-Fagetum Marinček et al. 1993**.

1. popis:

»Drevesni sloj:
Fagus silvatica 4.4. — *Fraxinus excelsior +*
Abies alba + — *Acer pseudoplatanus +*
Picea excelsa + — *Larix europaea +*

Grmovni sloj:
Daphne mezereum+ — *Laburnum alpinum*

Zeliščni sloj:
Cardamine trifolia + — *Aposeris foetida +*
Cardamine enneaphyllos + — *Veronica urticifolia +*
Cardamine pentaphyllos + — *Homogyne silvestris +*
Mercurialis perennis + — *Anemone hepatica +*
Cyclamen europaeum + — *Paris quadrifolia +*
Majanthemum bifolium + — *Helleborus niger +*
Lactuca muralis + — *Asplenium viride +*
Lamium luteum + — *Carex alba +*
Adenostyles glabra + — *Polygonatum verticillatum +*
Senecio fuchsii + — *Lycopodium selago +*
Prenanthes purpurea + — *Nephrodium dryopteris +*
Galium silvaticum + — *Melampyrum silvaticum +*
Neottia nidus-avis + — *Valeriana tripteris +*
Thesium alpinum + — *Buphthalmum salicifolium +*

Mahovi:
Ctenidium molluscum +.2

4. popis:

Drevesni sloj:
Fagus silvatica 4.4 — *Larix europaea 1.1*

Grmovni sloj manjka.

Zeliščni sloj:
Helleborus niger 1.1 — *Lamium luteum +*
Cardamine enneaphyllos + — *Polygonatum verticillatum +*
Cardamine bulbifera + — *Euphorbia amygdaloides +*
Oxalis acetosella + — *Phyteuma orbiculare +*
Luzula nemorosa + — *Mercurialis perennis +*
Carex digitata + — *Anemone nemorosa +*
Veronica urticifolia + — *Anemone hepatica +*
Hieracium murorum + — *Malampyrum silvaticum +*
Cyclamen europaeum + — *Vaccinium myrtillus +*
Prenanthes purpurea + — *Corallorhiza trifida +*
Lycopodium selago + — *Epipactis sp. +*
Aposeris foetida + — *Neottia nidus-avis +*
Asplenium viride + — *Lactuca muralis +*

Lišaj:
Fegatella conica +«

V fitocenoloških popisih so prisotne altimontansko-subalpinske vrste, od katerih so nekatere diagnostične za asociacijo npr. **Adenostyles glabra** in **Polygonatum verticillatum** ter kisloljubne vrste, npr. **Corallorhiza trifida**, **Huperzia selago**, **Larix decidua**, **Melampyrum sylvaticum**, **Veronica urticifolia** in **Valeriana tripteris**.

2.8.2. Drugi popis kaže na toploljubno bukovo združbo:

»Drevesni sloj:
Fagus silvatica 3.3. — *Acer pseudoplatanus +*
Ostrya carpinifolia 1.1 — *Acer platanoides +*
Abies alba + — *Fraxinus excelsior +*
Picea excelsa + — *Larix europaea +*

Grmovni sloj:
Abies alba + — *Daphne mezereum +*
Picea excelsa + — *Lonicera alpigena +*
Fagus silvatica +

Zeliščni sloj:
Cardamine bulbifera + — *Mercurialis perennis +*
Cardamine enneaphyllos + — *Salvia glutinosa +*
Cardamine trifolia + — *Aspidium filix-mas +*
Anemone nemorosa + — *Neottia nidus-avis +*
Anemone hepatica + — *Majanthemum bifolium +*
Veronica urticifolia + — *Gentiana asclepiadea +*
Lamium luteum + — *Valeriana tripteris +*
Senecio fuchsii — *Homogyne silvestris +*
Galium silvaticum + — *Oxalis acetosella +*
Carex alba + — *Monotropa hypopitis*

Mah:
Ctenidium molluscum +.2«

Popis je zabeležen na nadmorski višini 800 m. Značilna je prisotnost dveh toploljubnih drevesnih vrst: črnega gabra (**Ostrya carpinifolia**) in ostrolistnega javora (**Acer platanoides**), kar da misliti na zmerno toploljubni bukov-črnogabrov gozd, **Ostryo-Fagetum M. Wraber ex Trinajstić 1972**, ki potrebuje namočenost z več kot 1000 mm padavin. To potrjuje tudi tretji popis pred desetletji posekanega bukovega gozda, ki ga je Cvek opravil na nadmorski višini 840 m:

»Drevesni sloj:
Ø

Grmovni sloj:
Ostrya carpinifolia 3.3 — *Sambucus nigra +*
Fagus silvatica 1.1. — *Sambucus racemosa +*
Fraxinus excelsior + — *Daphne mezereum +*
Picea excelsa (pogozdena)+ — *Laburnum alpinum +*
Acer pseudoplatanus + — *Solanum dulcamara +*

Zeliščni sloj:
Mercurialis perennis 1.1. — *Melampyrum silvaticum +*
Lamium luteum 1.1. — *Galeopsis speciosa +*

Salvia glutinosa +
Epipactis latifolia +
Senecio fuchsii +
Nephrodium filix-mas +
Oxalis acetosella +
Cyclamen europaeum +
Viola silvatica +
Cardamine trifolia +
Epilobium montanum +
Polystichum lobatum +
Galium silvaticum +
Gentiana asclepiadea +
Majanthemum bifolium +
Angelica silvestris +
Veronica urticifolia +
Corallorhiza trifida +
Vaccinium myrtillus +

Popis kaže zaraščanje dvajsetletne poseke, kjer dominira črni gaber (Ostrya carpinifolia).«

Glede na to, da so bazični bukovi gozdovi floristično bogati, nas presenečajo Cvekovi fitocenološki popisi z majhnim številom rastlinskih vrst. Razlogov je lahko več: sicer v katerem letnem času je bil fitocenološki popis opravljen, ali kot že omenjeno, da je Cvek spremljal izključno le sestoje, bogate z vrstami rodov **Cardamine** in **Dentaria**. Primerno bi bilo, da bi Cvek popisoval tudi pomladanski aspekt združb, kjer se obilno pojavlja pomladanska flora. Manjka tudi poznopoletni in jesenski aspekt združb.

Zaradi širokega razpona asociacije, ki je segala od kolinskega do altimontanskega oziroma subalpinskega pasu, se v njej skrivajo še druge bazične bukove asociacije, ki tedaj niso bile znane. Tu predvsem mislimo na bukovi asociaciji montanskega pasu **Lamio orvalae- Fagetum** (Ht. 1938) Borhidi 1963 in **Arunco-Fagetum** Ž. Košir ex Ht. et al. 1974.

2.9. Za združbo **Fagetum caricetosum albae (nom. nud.)**

piše Cvek, da je »*posebna vrsta bukovega gozda s prisotnostjo toploljubnih vrst Ostrya carpinifolia, Euonymus verrucosa, Carex alba in Peucedanum austriacum*«. Pojasnjuje, da se je ta »*tip bukovega gozda razvil iz nekdanje združbe, ki je spadala v zvezo Orneto-Ostryon. S kopičenjem humusa in s tem v zvezi tudi tal, so nastale možnosti uspevanja bukve*«.

Cvek nam s pričujočim popisom predstavlja tedanje stanje fitocenoze:

»Drevesni sloj:
Fagus silvatica 4.4
Ostrya carpinifolia +
Fraxinus excelsior +?

Grmovni sloj:
Fagus silvatica +
Picea excelsa +
Rhamnus frangula + ?
Lonicera xylosteum +
Euonymus verrucosa +
Lonicera alpigena +
Euonymus alpigena +

Zeliščni sloj:
Carex alba 3.3
Mercurialis perennis 2.2
Cardamine trifolia 1.1
Helleborus niger 1.1
Cardamine bulbifera +
Anemone hepatica +
Cardamine pentaphyllos +
Cynanchum vincetoxicum +
Peucedanum austriacum +
Polygonatum officinale +
Hacquetia epipactis +
Cyclamen europaeum +
Actaea spicata +
Aconitum spec. +
Digitalis ambigua +
Gentiana asclepiadea +
Salvia glutinosa +
Primula acaulis +
Nephrodium filix-mas +
Clematis vitalba +
Neottia nidus-avis +
Aposeris foetida +
Euphorbia amygdaloides +
Galium silvaticum +
Scrophularia nodosa +
Lamium luteum +«

Popis kaže na toploljubnost združbe. Poleg zgoraj naštetih štirih vrst je še prisotnih enajst toploljubnih vrst: **Clematis vitalba**, **Cynachum vincetoxicum** (=**Vincetoxicum hirundinaria**), **Digitalis ambigua** (=**D. grandiflora**), **Euonymus alpigena** (=**E. latifolia?**), **Lonicera xylosteum**, **Primula acaulis** in **Rhamnus frangula**. Posebnega pomena je prisotnost jugovzhodnoevropsko-ilirske flore: **Aposeris foetida**, **Cardamine trifolia**, **Cyclamen purpurascens**, **Hacquetia epipactis** in **Helleborus niger**. Gre za spodnjemontanski-montanski ilirski bukov gozd **Hacquetio-Fagetum Ž. Košir ex Ht. et al. 1974.** Verjetno je bil gozd deležen pretiranega antropogenega vpliva (pretirane sečnje, paša ipd.), zaradi česar se je razbohotil beli šaš (**Carex alba**) in je nastala subasociacija **Hacquetio-Fagetum caricetosum albae**. Žal Cvek ne navaja nadmorske višine popisa.

2.10. Pri vegetacijskiem kartiranju (najverjetneje v letih 1953–54) je Cvek opisal združbo **Tilieto--Aceretum**,

ki pa je ni objavil v pričujočem elaboratu (1955). Pač pa je Košir v svoji diplomski nalogi leta 1953 objavil isto fitocenozo pod imenom **Ostryo-Tilietum**, ki jo je pozneje preimenoval (ali so jo preimenovali) v **Tilio cordatae-Aceretum platanoidis ostryetosum carpinifoliae Ž. Košir 1954**. Primerjava Cvekovega fitocenološkega popisa s fitocenološko tabelo Koširja kaže, da gre za isto združbo. Popis je naslednji:

»Drevesni sloj:
a) nadstojni:
Tilia cordata 1.1
Ostrya carpinifolia 1.1
Fagus silvatica +
Acer platanoides +
b) podstojni:
Acer platanoides 1.1.
Fagus silvatica 1.1
Tilia cordata +
Carpinus betulus +
Acer pseudoplatanus +
Picea excelsa +
Grmovni sloj:
Laburnum alpinum +
Acer platanoides +

Rhamnus fallax +
Daphne mezereum +
Rosa pendulina +
Lonicera alpigena +
Sambucus nigra +
Fagus silvatica +
Solanum dulcamara +
Atragene alpina +

Zeliščni sloj:
Mercurialis perennis 1.1
Asarum europaeum 1.1
Galium silvaticum 1.1
Carex alba 1.3
Cirsium erisithales +
Hacquetia epipactis +
Cyclamen europaeum +
Platanthera bifolia +
Gentiana asclepiadea +
Lactuca muralis +
Actaea spicata +
Pulmunaria officinalis +
Prenanthes purpurea +
Asplenium viride +
Nephrodium dryopteris +.2
Anemone hepatica +
Solidago vigraurea +
Polygonatum officinalis +
Lamium luteum +
Salvia glutinosa +
Rubus saxatilis +
Athyrium filix-femina +
Carex digitala +
Paris quadrifolia +
Aconitum napellus
Veronica urticifolia +
Asplenium trihomanes +
Calamagrostis varia +.3

Mahovi:
Neckera complanata 1.3
Botrichia spec. +
Ctenidium molluscum 1.3
Fissidens taxifolius +.2«

Domnevamo, da se Cvek ni strinjal s Koširjem glede poimenovanja združbe, ki jo je Košir objavil dve leti prej (1953) kot Cvek v elaboratu za habilitacijo (1955), v kateri je bil pričujoči popis. Košir je v diplomi objavil fitocenološko tabelo z 20 popisi. Vsekakor je moral biti Cvek kot vodja terenskih raziskav in vegetacijskga kartiranja in končno avtor vegetacijske karte Kamniške Bistrice seznanjen s Koširjevimi raziskavami. Zanimivo je, da Košir (1953) Cveka v svoji diplomski nalogi sploh ne omenja, enako tudi Cvek ne Koširja, vsaj ne v nam znanem delu njegove habilitacijske naloge. Pozneje je tudi Koširjevo tolmačenje značilnih in razlikovalnih vrst asociacije doživelo spremembe (Zupančič & Žagar 2013).

2.11. Združbo **Ostryeto-Fagetum M. Wraber ex Trinajstić 1972**

je Cvek raziskoval najbolj poglobljeno in jo v elaboratu predstavil z enajstimi fitocenološkimi popisi. Ugotavlja »*posebnost rastišča in podnebja, ki omogočata sobivanje bukve, ki je drevo gostega sklopa in sonca ter črnega gabra, ki je drevo svetlobe in toplih rastišč*«. Nadalje ugotavlja, da v tej združbi »*močno prevladujejo rastline iz zveze Fagion, primešane pa so rastline iz zveze Orneto-Ostryon*«.

Leto dni prej, 1954, je Wraber poročal o asociaciji **Ostryeto-Fagetum** na mednarodnem biološkem kongresu v Parizu (Wraber 1960), ki jo je pozneje (1962) prikjučil kot subasociacijo v okviru asociacije **Dentario-Fagetum** ostryetosum in nato zopet (1960, 1964) kot asociacijo **Ostryo-Fagetum M. Wraber (1954) 1960**. Cvek je raziskoval vegetacijo Kamniške Bistrice verjetno že leta 1953, zagotovo pa od leta 1954, ko se je vrnil s specializacije pri Horvatu v Zagrebu (1952). Sklepamo, da sta Wraber in Cvek sočasno zaznala novo asociacijo **Ostryo-Fagetum**. Ker je prvo analitsko tabelo te asociacije objavil šele Trinajstić (1972), njeno avtorstvo pa pripisal Wraberju, je po pravilih Kodeksa avtorski citat **Ostryo-Fagetum Wraber ex Trinajstić 1972**. Najbrž je prvo analitsko fitocenološko tabelo te asociacije dejansko izdelal Cvek, čeprav le v habilitacijski nalogi, bi morda imel celo pravico do avtorstva. Zanimiva je Cvekova ugotovitev: »*Z ozirom na posebne rastiščne razmere in na sedanjo drevesno vegetacijo, je ta združba za sedanje čase in dogledno bodočnost, lahko rečemo, trajnega značaja*«.

Fitocenološko tabelo objavljamo v sintezni obliki in dodajamo detajl iz izvirnika (Sl. 1).

VRSTA	s. n.[3]
Drevesni sloj:	
Fagus silvatica	V
Ostrya carpinifolia	V
Fraxinus ornus	IV
Acer pseudoplatanus	III
Sorbus aria	III
Picea excelsa	III
Acer platanoides	III
Ulmus scabra	I
Grmovni sloj:	
Daphne mezereum	IV
Fagus silvatica	IV
Lonicera alpigena	III
Picea excelsa	III
Fraxinus ornus	II
Acer pseudoplatanus	II
Lonicera xylosteum	II
Abies alba	II
Rosa spec.	I
Rhamnus fallax	I
Evonymus verrucosa	I
Corylus avellana	I
Ulmus scabra	I
Carpinus betulus	I
Zeliščni sloj:	
Mercurialis perennis	V
Cyclamen purpurascens	V
Galium silvaticum	V
Calamagrostis varia	V
Lamium luteum	V
Carex alba	V
Fraxinus ornus	V
Anemone hepatica	V
Gentiana asclepiadea	V
Asarum europaeum	V

Cirsium erisithales	V
Prenanthes purpurea	V
Salvia glutinosa	IV
Veronica urticifolia	IV
Polygonatum multiflorum	IV
Acer pseudoplatanus	IV
Senecio fuchsii	IV
Carex digitata	IV
Ostrya carpinifolia	IV
Nephrodium robertianum	IV
Cardamine bulbifera	III
Cynanchum vincetoxicum	III
Primula acaulis	III
Viola spec.	III
Lactuca muralis	III
Solidago virgaurea	III
Lamium orvala	III
Asplenium viride	III
Actaea spicata	III
Nephrodium filix-mas	III
Polystichum lobatum	III
Campanula trachelium	III
Asplenium trichomanes	III
Lilium martagon	III
Neottia nidus-avis	III
Aposeris foetida	III
Cardamine pentaphyllos	III
Homogyne silvestris	III
Hacquetia epipactis	III
Stachys jacquinii	II
Laburnum alpinum	II
Picea excelsa	II
Clematis vitalba	II
Peucedanum austriacum	II
Cardamine trifolia	II
Euphorbia amygdaloides	II
Oxalis acetosella	II
Paris quadrifolia	II
Majanthemum bifolium	II
Cardamine enneaphyllos	II

2.12. Cvek ugotavlja, *»da so **smrekovi gozdovi v Kamniški Bistrici** na redkih mestih in na manjših površinah«.*

Deli jih v tri skupine (grupe): na »zgornji meji gozdne vegetacije, v nižjih predelih na velikih skalnatih podorih, na kisli podlagi ali na kisli podlagi, presuti z apnencem. Geološka podlaga je večinoma apnenec. Sestojni sklopi so redki od 0,2 do 0,6, kar je večinoma značilno za naravne smrekove gozdove, zlasti v subalpski ali altimontanski stopnji.« Fitocenološki popis je zabeležil le za:

2.12.1. **Tip Larix-Picea (nom. nud.)** na nadmorski višini 1450 m s sklopom 0,6:

[3] stopnja navzočnosti

»Drevesni sloj:
Picea excelsa 3.3 *Larix europaea +*

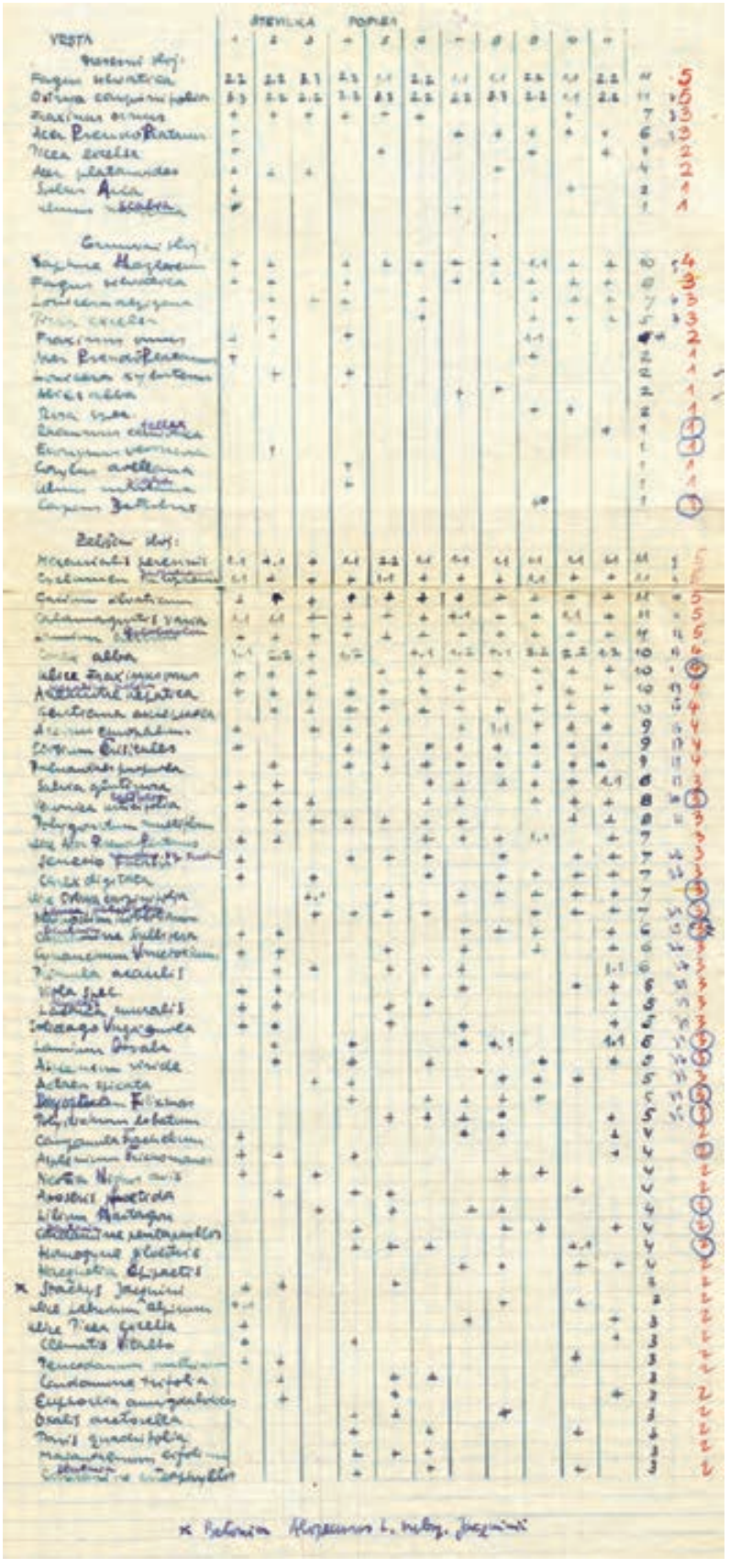
Grmovni sloj:
Picea excelsa + *Salix caprea +*
Daphne mezereum +

Zeliščni sloj:
Calamagrostis varia 2.3 *Mercurialis perennis +*
Luzula nemorosa 1.1 *Senecio abrotanifolius +*
Anemone hepatica 1.1 *Hypericum sp. +*
Corallorhiza trifida 1.1 *Valeriana tripteris +*
Melampyrum silvaticum + *Parnassia palustris +*
Luzula silvatica + *Primula spec. +*
Anemone nemorosa + *Fragaria vesca +*
Hieracium murorum + *Nephrodium dryopteris*
Buphthalmum salicefolium + *Astrantia minor*
Atragene alpina + *Asplenium viride +*
Veratrum album + *Helleborus niger +*
Lamium luteum + *Euphorbia amygdaloides*
Cardamine enneaphyllos + *Stachys jacquinii*
Aposeris foetida + *Thalictrum aquilegifolium +*
Veronica lutea + *Nephrodium phegopteris*
Ranunculus aconitifolius +? *Asplenium ruta-muraria +*
Campanula persicifolia +? *Oxalis acetosella +*
Cardamine trifolia +

Mahovi:
Dicranum scoparium +.1 *Peltigera canina. +*
Hypnum splendens +.1 *Hylocomium triquetrum +.1*
Eurhynchium striatum +.1 *Plagiochila asplenioides +*
Isothecium myurum *Ctenidium molluscum«*

Opomba: vrsta **Ranunculus aconitifolius** je zagotovo **R. platanifolius, Campanula persicifolia** pa je malo verjetna na nadmorski višini 1350, morda **C. witasekiana ?** (Dakskobler, ustno).

To je smrekov gozd na zgornji meji gozdne vegetacije redkega sestoja sklopa in floristično zelo obubožan. V popisu je osem subalpinskih vrst: **Clematis alpina** (**Atragene alpina**), **Larix decidua, Luzula sylvatica, Melampyrum sylvaticum, Ranunculus aconitifolius, Senecio abrotanifolius**. Sem lahko uvrščamo še naskalni vrsti **Asplenium viride** in **A. ruta-muraria**. Kisloljubnost popisanega rastišča nakazuje naslednjih devetnajst piceetalnih vrst: zgoraj naštete subalpinske vrste brez vrst rodu **Asplenium sp.** ter **Aposeris foetida, Calamagrostis varia**. Ne izključujemo možnost, da je tudi prisotna vrsta **Calamagrostis arundinacea, Corallorhiza trifida, Dicranum scoparium, Hieracium murorum, Hylocomium splendens** (**Hypnum splendens**), **Luzula luzuloides** (**L. nemorosa**), **Oxalis acetosella, Paederota lutea** (**Veronica lutea**), **Phegopteris connectilis** (**Nephrodium phegopteris**), **Gymnocarpium dryopteris** (**Aspidium dryopteris**), **Rhytidiadelphus triquetrus** (**Hylocomium triquetrus**) in **Valeriana tripteris**. Zaradi apnenčastega skalovitega terena se



Sl. 1: Izvirna fitocenološka tabela združbe Ostryeto-Fagetum.
Fig. 1: The original phytocenological table of Ostryeto-Fagetum.

pojavlja osem bazifilnih vrst: **Betonica alepecurus** (**Stachys jaquinii**), **Buphthalmum salicifolium**, **Cardamine enneaphyllos**, **Euphorbia amygdaloides**, **Galeobdolon flavidum** (**Lamium luteum**), **Helleborus niger** in **Mercurialis perennis**. Glede na zgornjo razvrstitev flore v pričujočem popisu bi lahko to smrekovo združbo opredelili kot **Adenostylo-Piceetum M. Wraber ex Zukrigl 1973 corr. Zupančič 1993 var. geogr. Caramine trifolia Zupančič 1999** ali morda celo za **Prenantho-Piceetum Zupančič 1999**, ki je pogosta v Karavankah in na Pokljuki. Cvek ugotavlja, »*da ta smrekov gozd v Kamniški Bistrici nima velike gospodarske vrednosti, pač pa varstveno, ker zarašča strmine, ki so izpostavljene ujmam*.«

2.12.2. **Suhi Piceetum (nom nud.)** »*se pojavlja v dolini ali na zaravnicah v pobočjih, kjer so grohotna tla (kamnitost in skupine velikih apnenčastih skalnih blokov). Bloki in skale so zamahovljene, ki jih zarašča smreka, ki korenini v razpokah med skalovjem*.« K tekstu ni dodan fitocenološki popis, tako le sklepamo, da bi lahko šlo za združbo **Asplenio-Piceetum Kuoch 1954** ali za **Laburno alpini-Piceetum Zupančič 1999** ali za **Rhamno fallaci-Piceetum Zupančič 1999**. Cvek ugotavlja, da je to »*smrekov gozd na bazičnih tleh, ki nima značilnih rastlin smrekovega gozda v zeliščnem sloju*« (plasti). Iz tega lahko sklepamo, da ima fitocneoza le malo piceetalnih vrst, tako vaskularne flore kot mahov. Mahovi pa so verjetno mešanica kisloljubnih in bazičnih mahov.

2.12.3. **Vlažni Piceetum (nom. nud.)** je na »*kisli podlagi v nadmorski višini 1300 m in ima visokogorski karakter. Ostanek tega gozda je na Dolu in Brusniku*.« Cvek pojasni, »*da polnoveljavnega fitocenološkega popisa ni bilo mogoče napraviti. Očuvani so ostanki nekdanjega rastlinstva smrekovega gozda. To so npr.: Blechnum spicant, Huperzia selago (Lycopodium selago), Luzula luzulina, L. sylvatica, Lycopodium annotinum, Melampyrum sylvaticum, Moneses uniflora (Pyrola uniflora), Rhytidiadelphus loreus (Hylocomium loreum), Saxifraga cuneifolia, Vaccinum myrtrillus in še nekatere druge*«. Iz zgornjega nabora piceetalnih vrst ni mogoče točno ugotoviti smrekove združbe. Naštete vrste so splošno razširjene v smrekovih združbah. Če gre za vlažni Piceetum, je to lahko **Adenostylo glabrae-Piceetum M. Wraber ex Zukrigl 1973 em. Zupančič 1999**. Mogoča je tudi bolj vlažna smrekova združba **Rhytidiadelpho lorei-Piceetum (M. Wraber 1953) Zupančič 1999**. Bolj se nagibamo k prvi združbi **Adenostylo glabrae-Piceetum**, ki ima nekaj vlagoljubne flore, predvsem vrste **Adenostyles glabra**, **A. alleriae**, **Cicerbita alpina**, **Dryopteris expansa**, **Polystichum lonchitis**, **Thelypteris limbosperma** idr., ki pa jih Cvek ne omenja. Za drugo združbo **Rhytidiadelpho lorei-Piceetum** so značilne številne vrste mahov, zlasti piceetalni, ter pogosto prisotna brinolistni in brezklasi lisičjak. Tudi za to fitocenozo Cvek ni objavil fitocenološkega popisa.

2.13. Abieto-Blechnetum oziroma Blechno-Abietetum Ht. 1950

je bila splošno razumljena kot kisloljubna jelova združba, dokler ni o njej pisal Wraber leta 1958 in 1959 v znanstveni razpravi o kisloljubnih jelovih združbah **Bazzanio-Abietetum M. Wraber 1958** in **Galio rotundifolii-Abietetum M. Wraber 1959**. Cvekov popis v elaboratu kaže, da gre za asociacijo **Bazzanio-Abietetum M. Wraber 1958**:

»*Drevesni sloj:*	
Abies alba 4.4	*Fagus silvatica +*
Picea excelsa +	
Grmovni sloj:	
Carpinus betulus 1.1.	*Daphne mezereum +*
Fagus silvatica 1.1	*Ostrya carpinifolia +°*
Picea excelsa +	
Zeliščni sloj:	
Blechnum spicant +.1	*Solidago virgaurea +*
Lycopodium selago +.2	*Polystichum lobatum +*
Pirola uniflora +.1	*Aposeris foetida +*
Hieracium murorum 1.1	*Veronica officinalis +°*
Luzula pilosa 1.1	*Rubus saxatilis +*
Gentiana asclepiadea 1.1	*Ranunculus lanuginosus +*
Cardamine trifolia 2.2	*Herophylum hirsutum +*
Calamagrostis arundinacea 2.2	*Prenathes purpurea +*
Athyrium filix-femina 1.1	*Veronica urticifolia +°*
Aspidium filix-mas 1.1	*Salvia glutinosa +*
Sanicula europaea 1.1	*Tussilago farfara +*
Oxalis acetosella 1.1	*Majanthemum bifolium +*
Carex digitata 1.1	*Fragaria vesca +*
Ajuga reptans 1.1	*Hedera helix +°*
Viola silvestris +	*Euphorbia carniolica +*
Senecio fuchsii +	*Hypericum montanum +°*
Mahovi:	
Bazzania trilobata 1.3	*Catharinaea hausknechtii +.2*
Plagiochla asplenioides 2.3	*Hylocomium triquetrum 1.2*
Polytrichum attenuatum 1.3	*Mnium undulatum +.2*
Hylocomium loreum 1.2	*Cladonia pyxydata +.2*
Hookeria lucens 1.2	*Leucobryum glaucum +.2*«
Thuidium tamariscinum +.2	

O jelovi združbi v Kamniški Bistrici pravi Cvek, da je »*na svoji spodnji meji, ki že meji na Querco-Capinetum (Carpinetum s. lat.), kar kaže prisotnost belega gabra (Carpinus betulus) in gradna (Quercus petraea)*«. Asociacija **Bazzanio - Abietetum** ni vezana na višinski pas in se pojavlja od kolinskega do montanskega pasu kot edafsko pogojena združba na zelo vlažnih kislih

tleh. Zanimivo je Cvekovo razmišljanje o sukcesiji združbe po goloseku, ki naj bi šel »*preko zaraščanja s trepetliko in ivo ponovno v združbo jelke*.« Odločno pa nasprotuje »*sadnji smreke, ker že itak preveč kislo podlago smrekovi nasadi še bolj zakisajo in s tem degradirajo tla*«. V Sloveniji ni znano pojavljanje asociacije **Blechno-Abietetum**. Široko zajeta Horvatova asociacija **Blechno-Abietetum** verjetno vsebuje tudi asociacijo **Galio rotundifolii-Abietetum** na bolj suhih koluvialnih tleh.

2.14. Querceto-Ostryetum carpinifoliae (Horvat) Ostryeto-Fraxinetum (Tomažič)

Vse kaže, da je želel dati Cvek prednost pri poimenovanju te grmiščne združbe našemu fitocenologu Tomažiču. Horvat je validno (pravilno) opisal združbo **Querco-Ostryetum Ht. 1938** s črnim gabrom (**Ostrya carpinifolia**) in hrastom puhavcem (**Quercus pubescens**). V Cvekovem popisu ni hrasta puhavca. Tomažičevo poimenovanje združbe **Ostryo-Fraxinetum Tomažič 1940 (prov.)** je provizorično ime, ki pa jo je Aichinger že leta 1933 validno opisal kot **Fraxino orni-Ostryetum carpinifoliae Aichinger 1933.** Težko je verjeti, da Cvek ne bi bil seznanjen s to Aichingerjevo združbo. Cvekov fitocenološki popis nazorno kaže na to asociacijo popisano, na Mošeniku, 1000 m nad morjem:

»Drevesni sloj:

Ostrya carpinifolia 2.2	*Sorbus aria +*
Fraxinus ornus 2.2	

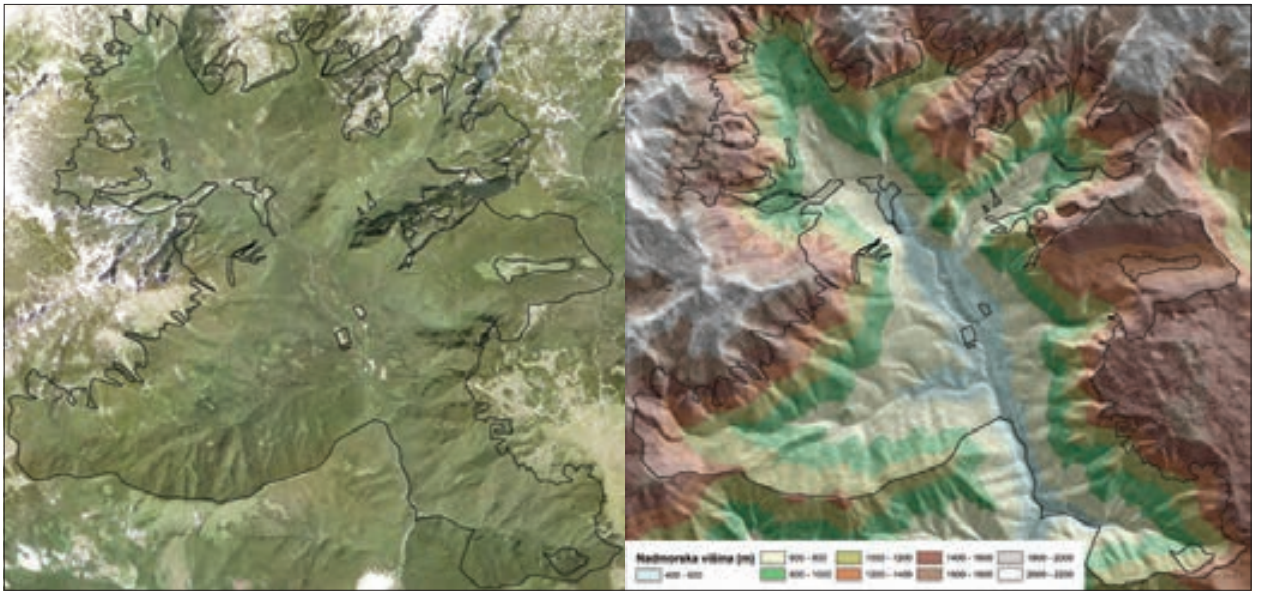
Grmovni sloj:

Fraxinus ornus 1.1	*Rhamnus cathartica +*
Sorbus aria +	

Zeliščni sloj:

Erica carnea 1.2	*Cynachum vincetoxicum +*
Calamagrostis varia 2.2	*Galium spec. +*
Carex alba 3.3	*Viola spec. +*
Buphthalmum salicifolium 1.1	*Campanula scheuchzeri +*
Origanum vulgare 1.1	*Asplenium ruta-muraria +*
Thymus serpyllum 1.1	*Teucrium montanum +*
Cyclamen europaeum +	*Fraxinus ornus +*
Stachys jacquinii +	*Ostrya carpinifolia +*
Peucedanum austriacum+	*Alium spec. +*
Salvia glutinosa +	*Hypericum spec. +«*

Zanimivo je Cvekovo razmišljanje o združbi: »*ki uspeva v skalnih strminah*« in je »*zelo osiromašena oblika združbe puhastega hrasta in črnega gabra. /.../ združba je že tako daleč na svoji zgornji meji, da se v njej nahajajo lahko še samo njeni najodpornejši floristični predstavniki. /.../ Puhastega hrasta sploh ni več opaziti*«. Da Cvek ni bil seznanjen z Aichingerjevo monografijo vegetacijskih združb Karavank, daje misliti o tedanji nedostopnosti tuje literature, ki je pri nas postala bolj dostopna šele ob koncu petdesetih oz. na začetku šestdesetih let prejšnjega stoletja, ko so bila sproščena devizna sredstva za nakup tuje znanstvene literature.



Sl. 2: Območje kartiranja gozdnih združb v dolini Kamniške Bistrice.
Fig. 2: The forest communities mapping area of in the Kamniška Bistrica Valley.

2.15. Quercetum na kisli podlagi »*se nahaja na majhni površini, kjer je zelo izsekana drevesna plast*«.

Zaradi površinske majhnosti in izsekanosti objekta Cvek ugotavlja, »*da je njena točnejša preučitev izključena*.« Nadaljuje pa z mislijo, da »*že površni pogled na to rastišče daje slutiti, da se nahajamo na terenu hrastovega gozda na kisli podlagi. Gradni, trepetlike, ive in breze v drevesnem sloju, ter obilica prisotnosti jesenskega vresja v zeliščnem sloju so jasni indikatorji tega gozdnega tipa*.« Glede na ta skop opis gradnovega gozda bi tvegali, da ga uvrstimo v asociacijo **Calluno-Quercetum (Marinček 1973) Marinček & Zupančič 1995**. To je sekundarni gozd na potencialno naravni združbi **Castaneo-Fagetum Marinček & Zupančič (1979) 1995**.

3. OPIS FITOCENOLOŠKE KARTE KAMNIŠKE BISTRICE

Poleg elaborata *Opis gozdnih združb doline Kamniške Bistrice,* je inž. Cvek izdelal tudi pripadajočo Fitocenološko karto za območje gozdne uprave Kamniška Bistrica (slika 2). Na karti subasociacija *Rhodothamno-Rhododendretum mugetosum*, ki je v elaboratu sicer opisana kot alpska grmiščna združba rušja nad gozdno mejo, ni prikazana, ampak so narisani le poligoni nižjeležečih gozdnih združb. Za potrebe analize fitocenološke karte smo rokopisno karto fotografirali (slika 3) in sliko geokodirali, nato pa s pomočjo GIS orodij digitalizirali v vektorski zapis (slika 6).

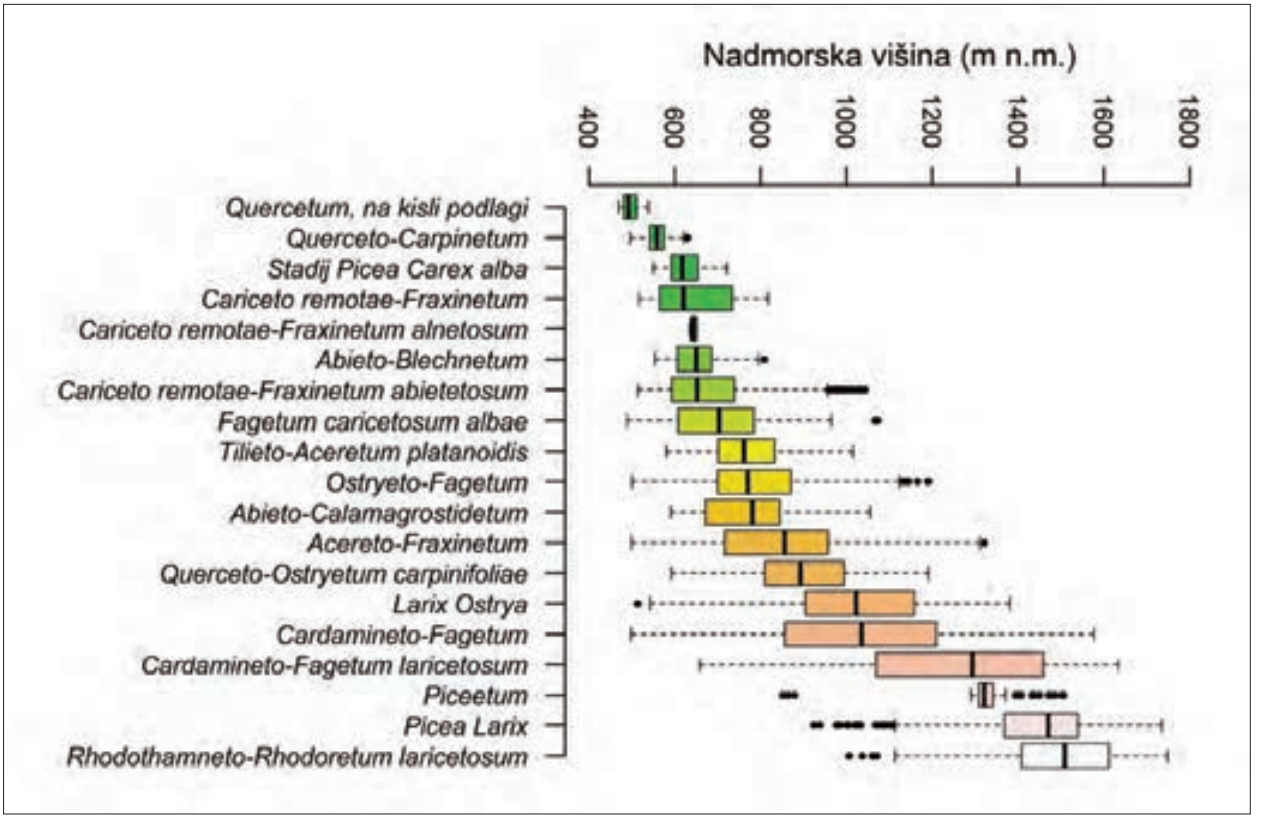
3.1. Površine kartiranih sintaksonov

Karta, narisana na kartografski podlagi v merilu 1:10.000, je izdelana precej natančno, saj je Cvek izločal poligone velikosti več kot od 0,1 ha, manj kot 20 % vseh poligonov je manjših od 1 ha. Največje površine pokrivajo bukova rastišča, kar je več kot 70 % vseh gozdnatih površin (preglednica 1). Daleč največ, nekaj manj kot 64 %, pokrivajo združbe asociacije *Cardamineto-Fagetum*, ki je bila v tistem času obravnavana na nivoju makroasociacije in po današnjih dognanjih zajema večje število asociacij od submon-

Preglednica 1: Površine gozdnih združb v dolini Kamniške Bistrice.
Table 1: Areas of forest communities in the Kamniška Bistrica valley.

Gozdna združba - Cvek	Veljavno ime sintaksona	Površina (ha)	Delež (%)
Cardamineto-Fagetum	*Ostryo-Fagetum* M. Wraber ex Trinajstić 1972 in *Ranunculo platanfolii-Fagetum* Marinček et al. 1993	2127.5	59.4
Cardamineto-Fagetum laricetosum	*Ranunculo platanfolii-Fagetum* Marinček et al. 1993	155.2	4.3
Ostryeto-Fagetum	*Ostryo-Fagetum* M. Wraber ex Trinajstić 1972	152.7	4.3
Stadij *Picea Carex alba* (comm.)	*Anemono trifoliae-Fagetum* Tregubov 1962 var. *Picea abies*	86.2	2.4
Fagetum caricetosum albae	*Hacquetio-Fagetum* Ž. Košir ex Ht. et al. 1974	30.6	0.9
Tip *Larix-Picea* (nom. nud.)	*Adenostylo-Piceetum* M. Wraber ex Zukrigl 1973 corr. Zupančič 1993 var. geogr. *Caramine trifolia* Zupančič 1999 / *Prenantho--Piceetum* Zupančič 1999	171.5	4.8
Piceetum	*Asplenio-Piceetum* Kuoch 1954 / *Laburno alpini-Piceetum* Zupančič 1999 / *Rhamno fallaci-Piceetum* Zupančič 1999 / *Adenstylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973 em. Zupančič 1999	32.4	0.9
Rhodothamneto-Rhodoretum laricetosum	*Rhodothamno-Laricetum deciduae* Willner et Zukrigl 1999	189.4	5.3
Sestoj *Larix Ostrya* združba (comm.)	*Rhodothmano-Laricetum deciduae* Willner et Zukrigl 1999 *ostryetosum* Dakskobler 2006	69.8	1.9
Querceto-Carpinetum	*Querco-Carpinetum* Ht. (1938) 1949	128.4	3.6
Querceto-Ostryetum carpinifoliae	*Fraxino orni-Ostryetum carpinifoliae* Aichinger 1933	101.8	2.8
Cariceto remotae-Fraxinetum	*Carici remotae-Fraxinetum excelsioris* W. Koch 1925	17.6	0.5
Cariceto remotae-Fraxinetum abietetosum	*Carici remotae-Fraxinetum excelsioris* W. Koch 1925 *abietetosum*	96.2	2.7
Cariceto remotae-Fraxinetum alnetosum	*Carici remotae-Fraxinetum excelsioris* W. Koch 1925 *alnetosum*	1.2	0.0
Acereto-Fraxinetum	*Lamio orvalae-Aceretum pseudoplatani* P. Košir & Marinček 1999	62.6	1.7
Tilieto-Aceretum platanoidis	*Tilio cordatae-Aceretum platanoidis ostryetosum carpinifoliae* Ž. Košir 1954	57.1	1.6
Abieto-Blechnetum	*Bazzanio-Abietetum* M. Wraber 1958	78.9	2.2
Abieto-Calamagrostidetum	*Calamagrostio-Abietetum* Ht. (1950) 1962	17.9	0.5
Quercetum, na kisli podlagi	*Calluno-Quercetum* (Marinček 1973) Marinček & Zupančič 1995 / *Castaneo-Fagetum* Marinček & Zupančič (1979) 1995	4.7	0.1

Sl. 3: Fitocenološka karta za območje gozdne uprave Kamniška Bistrica, izdelal Stanko Cvek okrog leta 1955.
Fig. 3: Phytocenological map of Kamniška Bistrica, made by Stanko Cvek around 1955.



Sl. 4: Nadmorska višina kartiranih gozdnih združb doline Kamniške Bistrice, sintaksoni so urejeni po naraščajoči mediani.
Fig. 4: Altitude of mapped forest communities of the Kamniška Bistrica Valley, syntaxa are arranged in a rising median. Syntaxa are arranged in ascending order of median.

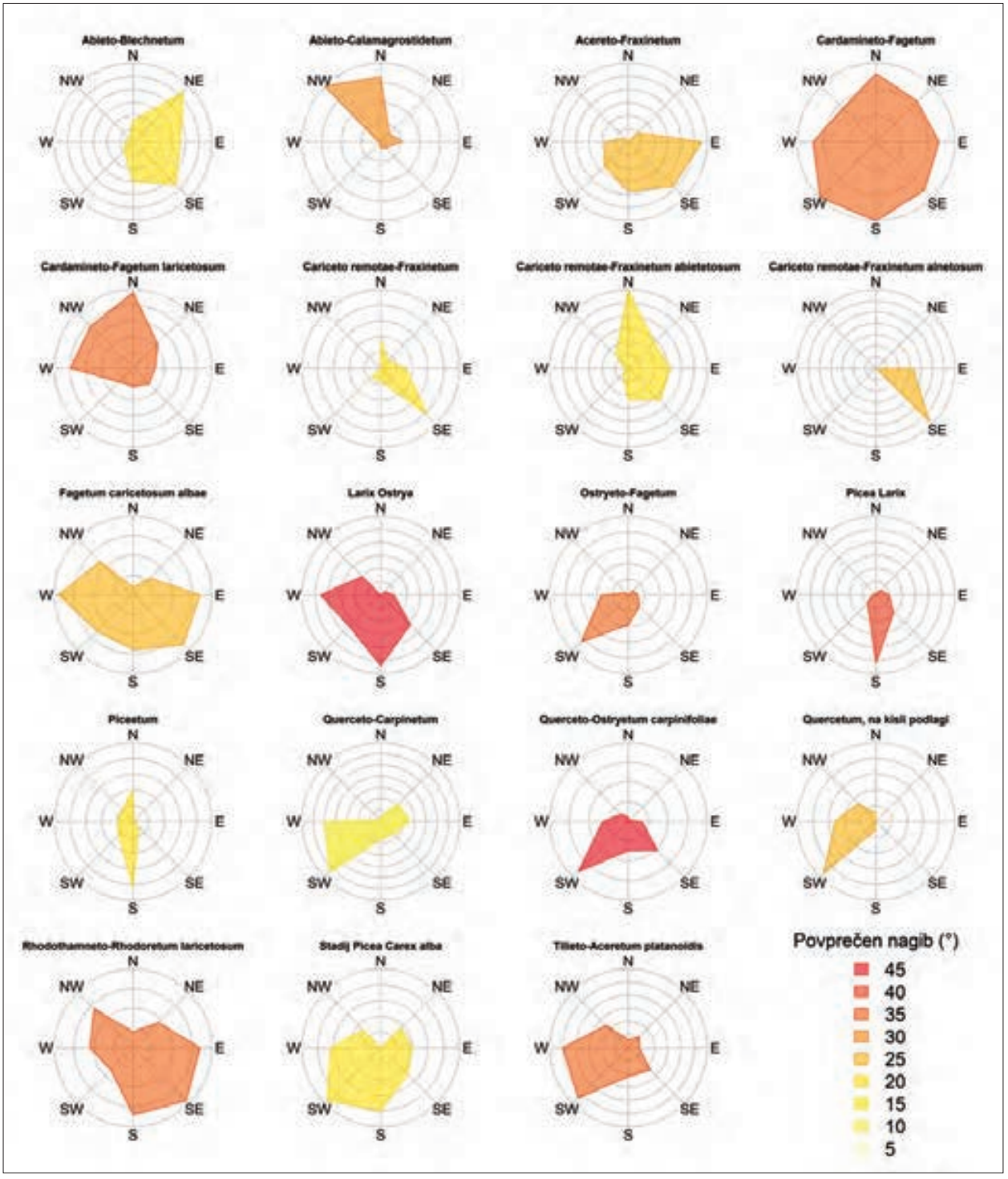
tanskega do subalpinskega pasu. Sem so po fitocenoloških popisih sodeč delno uvrščena tudi toploljubna bukovja asociacije *Ostryo-Fagetum*, ki je sicer na karti predstavljena tudi samostojno, zato skupne površine teh rastišč ne moremo oceniti. Vsekakor jih je več kot 4,3 %, kolikor jih je Cvek kartiral samostojno. Smrekovja pokrivajo nekaj manj kot 6 % območja, sem smo šteli tudi stadij z macesnom. Macesnovja pokrivajo 7,2 % površine, večinoma so to naravna rastišča macesna ob zgornji gozdni meji (*Rhodothamno-Rhododendretum laricetosum = Rhodothamno-Laricetum*), nekaj pa je tudi nižježečih rastišč subasociacije *ostryetosum*.

Med rastišča jelke lahko poleg rastišč asociacije *Abieto-Blechnetum* (=*Bazzanio-Abietetum*) in *Abieto-Calamagrostidetum* (=*Calamagrostio-Abietetum*) uvrstimo še sušnejša rastišča asociacije *Carici remotae-Fraxinetum*, ki jih je zaradi večjega deleža jelke Cvek kartiral kot subasociacijo *abietetosum* in skupaj pokrivajo 5,4 % (193 ha) površine. Uravnane ravninske dele v dnu doline večinoma poraščajo fitocenoze asociacije *Querceto-Carpinetum* (*Querco-Carpinetum*).

3.2. Ekološke razmere v sestojih kartiranih sintaksonov

Pri opisu ekoloških razmer smo si pomagali z digitalnim modelom reliefa (DMR). Po nadmorski višini (slika 4) je najbolj variabilna asociacija *Cardamineto-Fagetum*, kjer je kvartilni razmik (QR) 870 od 1230 m n.m., sega pa od 500 m n.m. do zgornje gozdne meje na višini 1630 m n.m. Višje se pojavljajo smrekovja (QR: 1330 - 1530 m n.m.) in macesnovja (QR: 1410 – 1610 m n.m.), do višine 1730 m oz. 1750 m n.m. Fitocenoze preostalih asociacij poraščajo pretežno rastišča pod 1000 m n.m., nižinska območja v dnu doline pokrivajo rastišča *Querceto-Carpinetum,* kjer gre večinoma za uravnave in blage nagibe (slika 5).

Glede na heterogenost združb, ki so vključene v sintakson *Cardamineto-Fagetum*, se ti sestoji pojavljajo v vseh nebesnih legah na znatnih nagibih, saj poraščajo velike površine pobočij doline Kamniške Bistrice (slika 5). Fitocenoze asociacije *Abieto-Calamagrostidetum* in subasociacije *Cariceto remotae-Fraxinetum abietetosum* se pogosteje pojavljajo v osojnih legah, večina

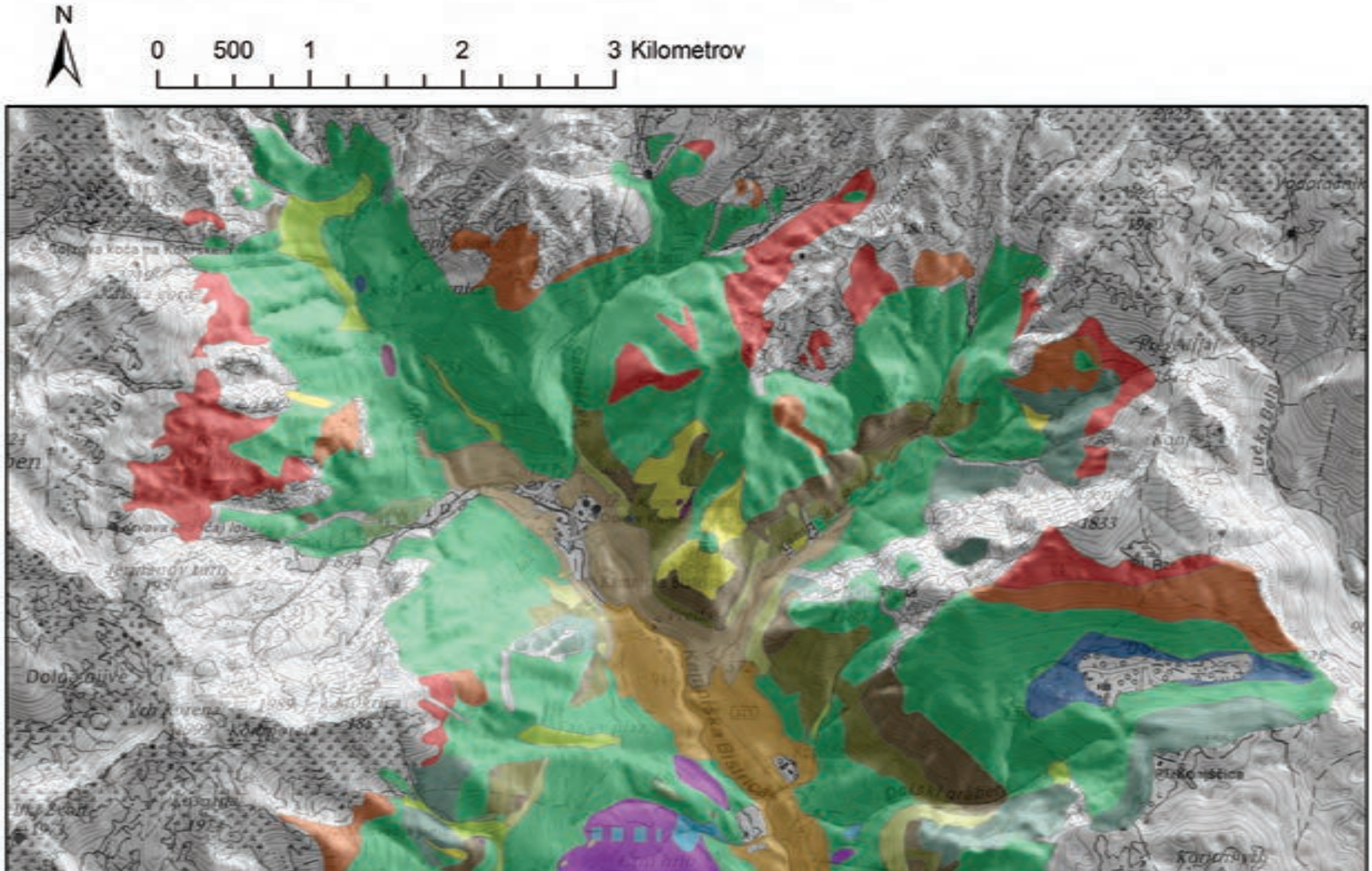


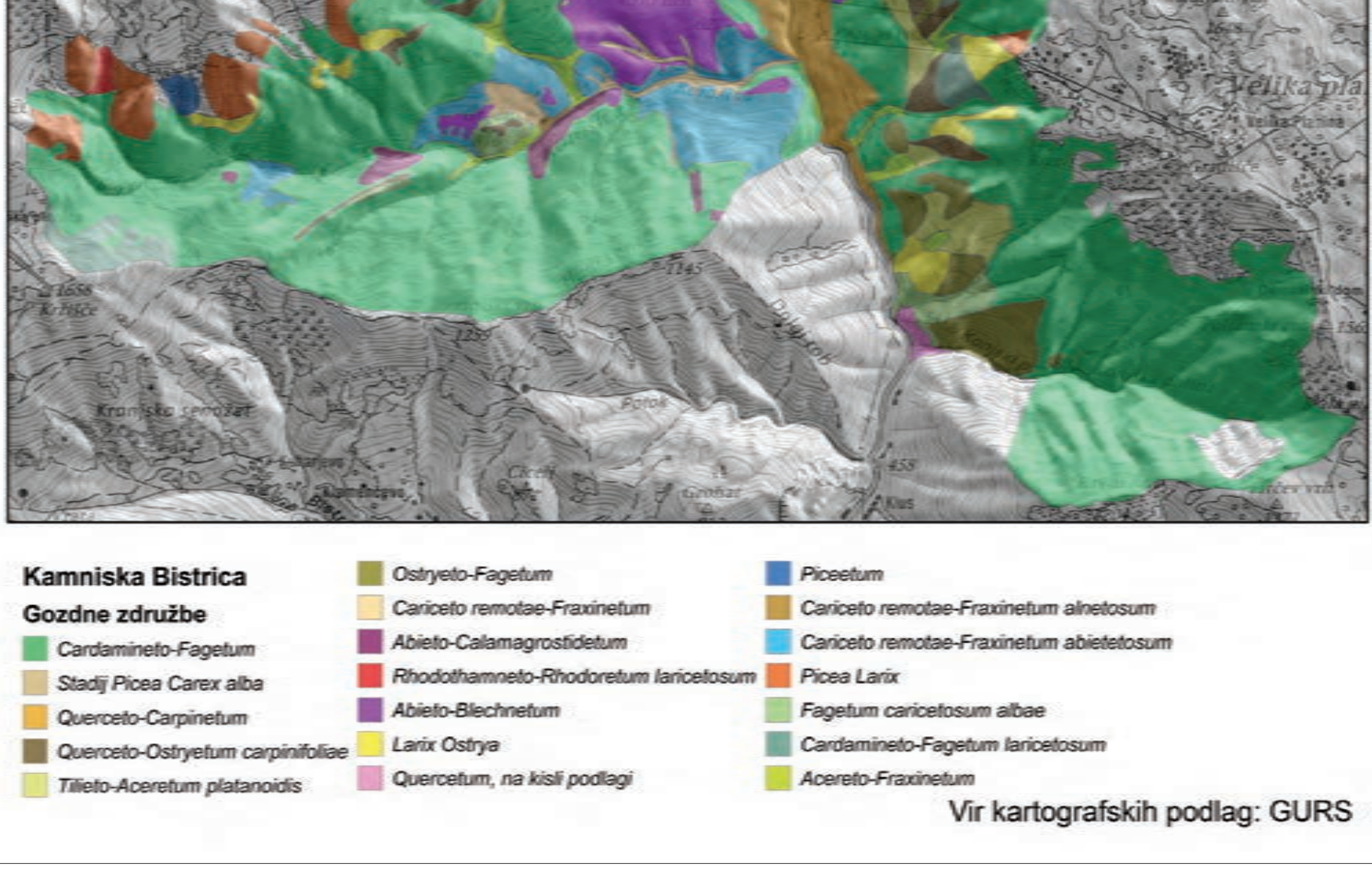
Sl. 5: Rože nebesnih leg s prikazom povprečne strmine po sintaksonih.
Fig. 5: Rose plots of exposition in combination with mean slope in each sintaxon.

Fitocenološka karta

Gozdna uprava Kamniška Bistrica

Leto izdelave: 1955 Izdelal: ing. Stanko Cvek





Sl. 6: Vektorska karta gozdnih združb Kamniške Bistrice, original narisal Stanko Cvek, 1955. Kartografska podlaga je zamenjana s topografsko karto 1:50.000, dodan je digitalni model reliefa (GURS).
Fig. 6: A vector map of Kamniška Bistrica forest communities, the original was made by Stanko Cvek, 1955. The original cartographic basis is replaced with a topographic map 1:50.000, digital elevation model is added (GURS).

ostalih združb pa porašča toplejše lege. Najstrmejše terene poraščajo združbe s črnim gabrom, macesnom ter lipovcem (*Larix-Ostrya, Picea-Larix, Querceto-Ostryetum, Ostryeto-Fagetum, Rhodothamno-Rhodoretum laricetosum, Tilieto-Aceretum*).

Poleg obravnavane fitocenološke karte Stanka Cveka, obstaja še druga karta območja Kamniške Bistrice, ki so jo v približno istem obdobju izdelali na takratni Agronomsko gozdarski fakulteti (slika 7), morda je avtor prav prof. Tomažič s sodelavci (a najbrž na podlagi karte S. Cveka), kateri so izdelali tudi elaborat. Glede na robustnejšo izdelavo na platnu gre sklepati, da so jo uporabljali za študijske namene. V primerjavi s karto, ki jo je izdelal Cvek, ima ta karta nekaj več vegetacijskih enot (25), v splošnem pa so meje poligonov enot precej podobne prvi.

4. SKLEPNE MISLI

Cvekov elaborat oziroma njegov fitocenološki del z vegetacijsko karto, ki je bil podlaga za njegovo habilitacijo na Gozdarskem oddelku Fakultete za agronomijo in gozdarstvo, je pionirsko delo. Za tisti čas, petdeseta leta prejšnjega stoletja, je bil uporabljen zelo sodoben pristop s korektnimi opisi tedaj znanih gozdnih združb in s presenetljivo dobrimi napotki za gojenje gozdov na podlagi fitocenoloških raziskav. Zdaj imamo pred seboj torzo tega elaborata, z vegetacijsko karto, ki je bila plod njegovega terenskega dela. Verjetno je bil med prvimi tako zasnovanimi elaborati. Tu imamo v mislih še elaborat Tregubova za Leskovo dolino na Snežniškem pogorju, izdelan verjetno v istem času. Če primerjamo obe raziskovani območji, kamniškobistriško in snežniško, ugotavimo, da je kamniškobistriško območje vegegtacijsko bolj raznovrstno in zapleteno, predvsem zaradi geoloških in mezoklimatskih razmer. Snežniško območje pa je geološko enotno in vegetacijsko manj pestro. Cvek je v ožjem območju Kamniške Bistrice opisal 21 sintaksonov, od tega sedemnajst osnovnih združb – asociacij oz. v rangu asociacij – in štiri subasociacije, pomembnejše za gospodarjenje. Opis združb je za tedanji čas zadovoljiv glede ideosistematike flore in na zavidljivi ravni glede sintaksonomike združb in ekoloških razmer (geoloških, talnih, klimatskih). Rezultate fitocenoloških raziskovanj ob koncu strne v ustrezne gozdnogojitvene ukrepe, ki so usklajeni z naravo in omogočajo ob koncu optimalen razvoj vegetacijske združbe. Poseben poudarek daje združbam varovalnega pomena, čeprav so večinoma površinsko majhne, vendar pomembne za stabilizacijo ekstremnega terena.

Zdaj, po skoraj sedemdesetih letih, je vedenje o gozdnih združbah bogatejše in glede na znanje so te ekološko in fitogeografsko ustrezneje preučene. Zato smo Cvekov prispevek dopolnili z današnjem vedenjem o sintaksonomskem uvrščanju združb in njihovih ekoloških razmer ter prikazali razvoj fitocenološke vede, kakor je potekal od petdestih let dvajsetega stoletja vse do zdaj. Znanstvena oz. strokovna vrednost elaborata je tudi po današnjih merilih zavidanja vredna. Cvekovo habilitacijsko delo za višjega asistenta je bilo za tisti čas izjemno, saj je imel malokdo v gozdarskem krogu tedanje fakultete boljša dela.

Žal smo imeli na voljo le vegetacijski del elaborata od strani 54 do 81, kar je sicer za naše primerjave zadostovalo. V literaturi smo zasledili, da je bil štiri leta pozneje izdelan elaborat Tomažič et al. 1959: Gozdna vegetacija Kamniške Bistrice za Gozdno gospodarstvo Ljubljana (Marinček 1995). Iz vsebine tega članka je razvidno, da sta bila poleg Tomažiča soavtorja še Cvek in Robič. Tudi ta elaborat je izgubljen. Poznal in uporabljal ga je Marinček še leta 1995 ali kakšno leto prej, ker ga navaja v literaturi za svoj članek.

Ohranjena fitocenološka karta s svojo natančnostjo nakazuje na opravljeno obsežno terensko delo pri izdelavi elaborata in karte. Gre za zelo zahteven teren, ki ga je bilo v tistem času ob kartiranju potrebno vsega prehoditi, saj pripomočkov, kot jih imamo na voljo danes (npr. letalski posnetki v visoki resoluciji, GIS orodja itd.), v tistem času ni bilo. Tudi s tega vidika je delo Stanka Cveka zelo dragoceno.

V Cvekovih popisih latinskih imen nismo posodabljali, pustili smo jih v izvirniku in v obliki kot je bilo v rabi tedaj.

5. PREGLED SINONIMIKE TAKSONOV

A. VASKULARNA FLORA

S. Cvek 1955	A. Martinčič et al. 2007
Alchemilla alpina	Alchemilla alpigena ?
Anemone hepatica	Hepatica nobilis
Asperula odorata	Galium odoratum
Aspidium dryopteris	Gymnocarpium dryopteris
Aspidium spinolosum	Thelypteris limbosperma
Aspidium filix-mas	Dryopteris filix-mas
Angelica silvestris	Angelica sylvestris
Astrantia minor	A. carniolica
Atragene alpina	Clematis alpina
Brachypodium silvaticum	Brachypodium sylvaticum
Calamintha clinopodium	Clinopodium vulgare
Campanula brachetecium	?
Campanula persicifolia?	Campanula witasekiana?
Carex silvatica	Carex sylvatica
Cerastium silvaticum	Cerastium sylvaticum
Cirsium montanum ?	Carduus personata?
Crocus vernus	Crocus naepolitanus
Cyclamen europaeum	Cyclamen purpurascens
Cynanchum vincetoxicum	Vincetoxicum hirundinaria
Digitalis ambigua	Digitalis garndiflora
Epipactis latifolia	Epipactis helleborine
Euonymum alpigena ?	Euonymus latifolia ?
Eupatorium canabinum	Eupatorium cannabinum
Euphrasia rustecoriana	Euphrasia rostkoviana
Equisetum palustris	Equisetum palustre
Fagus silvatica	Fagus sylvatica
Fragaria elatior	Fragaria moschata
Galium vernum	Cruciata glabra
Galium sylvaticum	Galium laevigatum
Helleborus macranthus	Helleborus niger
Herophylum cicutaria	Chaerophyllum hirsutum
Herophyllum hirsutum	Chaerophyllum hirsutum
Homogyne silvestris	Homogyne sylvestris
Hypericum acuntangulum	?
Juncus glaucum	Juncus inflexus
Juniperus nana	Juniperus alpina
Lactuca muralis	Mycelis muralis
Lamium luteum	Galeobdolon flavidum
Larix europaea	Larix decidua
Luzula nemorosa	Luzula luzuloides
Luzula silvatica	Luzula sylvatica
Lycopodium selago	Huperzia selago
Melampyrum silvaticum	Melampyrum sylvaticum
Melandrium rubrum	Silene dioica
Monotropa hypopitis	Monotropa hypopitys
Nephrodium dryopteris	Gymnocarpium dryopteris
Nephrodium filix-mas	Dryopteris filix-mas
Nephrodium phegopteris	Phegopteris connectilis
Nephrodium robertianum	Gymnocarpium robertianum
Orchis maculata	Dactylorhiza maculata s. lat. (D. fuchsii)
Pedicularis verticilaris	Pedicularis verticillata
Physalis alcecengi	Physalis alkekengi
Phyteuma halleri	Phyteuma ovatum
Pinus mughus	Pinus mugo
Polygonatum officinale	Polygonatum odoratum
Polystichum lobatum	Polystichum aculeatum

Primula acaulis	Primula vulgaris
Pirola uniflora	Moneses uniflora
Quercus sessiliflora	Quercus petraea
Ranunculus aconitifolius?	Ranunculus platanifolius
Rhamnus cathartica	Rhamnus catharticus
Rhamnus carniolica	Rhamnus fallax
Rhamnus frangula	Frangula alnus
Rubus fruticosa ?	Rubus fruticosus agg.
Satureja vulgaris	Clinopodium vulgare
Scolopendrium vulgare	Phyllitis scolopendrium
Stachys jacqunii	Betonica alopecurus
Stellaria glochidiosperma	Stellaria montana
Thymus serpyllum ?	Thymus serpyllum agg.
Ulmus scabra	Ulmus glabra
Veronica lutea	Paederota lutea
Viola silvestris	Viola reichenbachiana

B. MAHOVI IN LIŠAJI

S. Cvek 1955	H. Gams 1957
Catharinea hausknechtii	Atrichum hausknechtii
Eurhynchium striatum	Eurhynhium zetterstedtii
Fegatella conica	Conacephalum conicum
Hylocomium loreum	Rhytidiadelphus loreus
Hyloconium triquetrus	Rhytidiedelchus triquetrus
Hylolocomium triquetrum	Rhytidiadelphus triquetrus
Hypnum spendens	Hylocomium splendens
Polytrichum atenuatum	Polytrichum formosum
Polytrichum attenuatum	Polytrichum formosum

ZAHVALA

Zahvaljujeva se dr. Igorju Dakskoblerju za posredovanje pričujočega elaborata in njegove napotke. Elaborat je iz zapuščine mag. Dušana Robiča, katere skrbnik je doc. dr. Andrej Rozman. Danici Robič gre zahvala, da je strokovno zapuščino pokojnega moža dala na razpolago njegovim naslednikom pri predmetu fitocenologija. Gospe Ani Mariji Batič se iskreno zahvaljujeva za tehnično pomoč.

6. SUMMARY

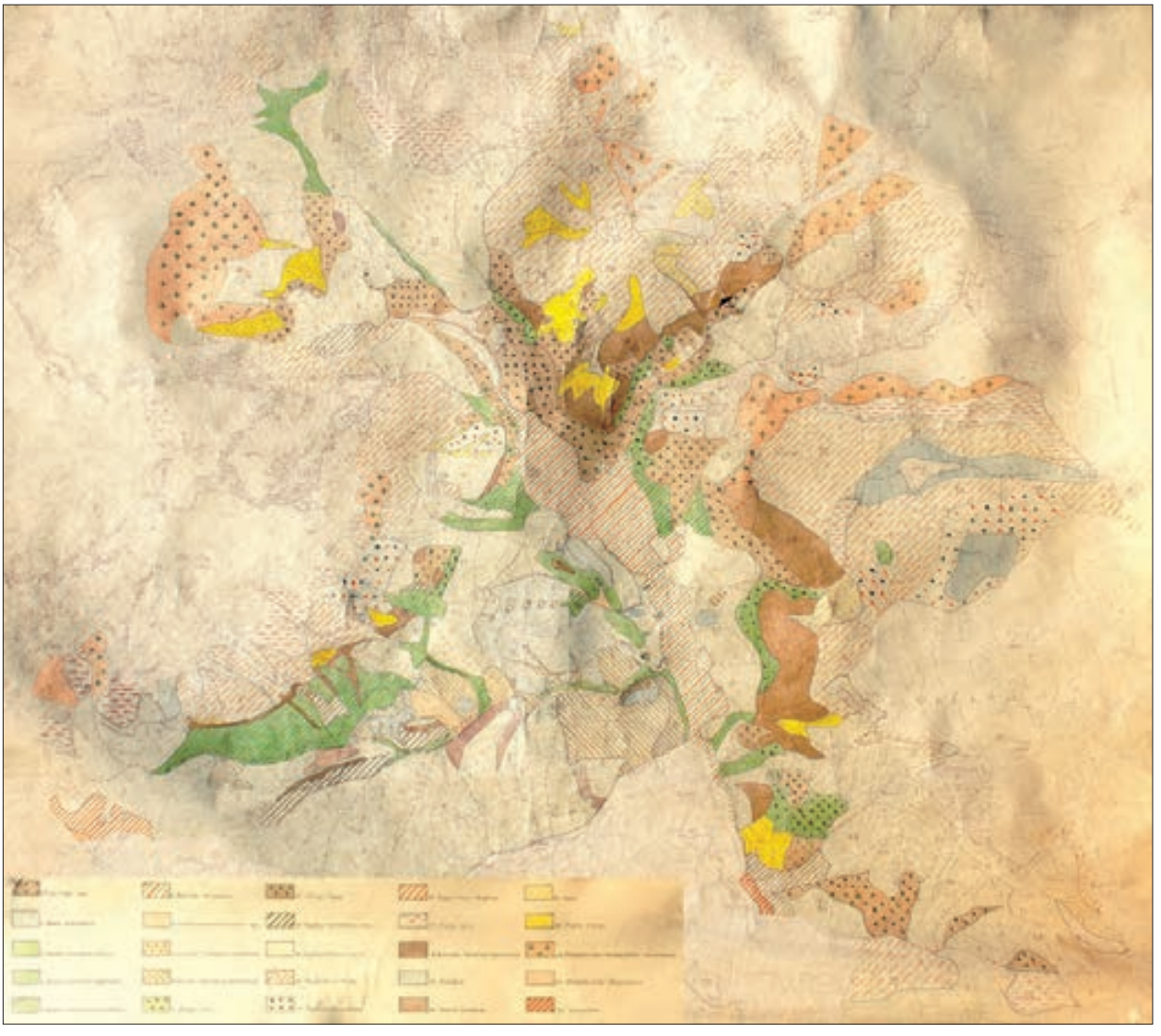
The study *A description of forest associations of the Kamniška Bistrica valley, with particular regard to silvicultural questions*, or its vegetational part (pages 54 to 81) was obtained by chance from the legacy of Prof. Dušan Robič. The study was accompanied by a vegetation map. Unfortunately, the whole study is not available, or has been lost. The authors of the study or researchers of the local forest vegetation were G. Tomažič and S. Cvek, who carried out the main part of the vegetation research and is the author of this part of the study. The fieldwork was assisted by then students of forestry, currently forestry engineers, Dr. Ž. Košir, D. Jug and D. Robič, M.A.

The study attracted our attention due to being the first approach to silviculture based on phytocoenological research, which was a novelty in the 1950s, or rather because it represented the start of a new silvicultural period in forestry, which flourished right up to the nineties. On the basis of this study, which took place at least from 1950 until 1955, a number of silvicultural studies were prepared on a vegetational basis. This study was probably the first of its kind, or was at least created simultaneously with a similar study for the Leskovo valley on the Snežnik massif led by Tregubov. In any case, the investigation of the Kamniška Bistrica area was more demanding than the Snežnik one in view of the local ecological conditions (geological, ground, climatic, vegetational).

Cvek (1955) described 21 syntaxa in the narrower region of Kamniška Bistrica, where there was then a

faculty estate of the Faculty of Agronomy and Forestry, of which 17 associations and 4 sub-associations are more important for forest management. In their inventories, or their research, which was reflected in the phytocoenological inventories, were included the forest associations of European ash (*Fraxinetum* s. lat.), European hornbeam (*Carpinetum* s. lat.), mountain pine (*Pinetum mugo* s. lat.), fir (*Abietetum* s. lat.), beech (*Fagetum* s. lat.), spruce (*Piceetum* s. lat.) and European hop-hornbeam (*Ostryetum* s. lat.). The description of the associations is at an enviable level of syntaxonomics of associations and ecological conditions (geological, ground, climatic) for the time. Cvek sums up the results of the phytocenological research at the end in suitable silvicultural measures, which are harmonized with nature and enable the optimal development of vegetation associations. Particular emphasis is placed on associations of protective significance, although they are mostly small in terms of surface area but important for stabilization of the extreme terrain.

We believe that it is a correct decision to present the present study scientifically, which was among the first, or even the first, to be based on modern science principles.



Sl. 7: Druga fitocenološka karta za območje Kamniške Bistrice v merilu 1:10.000, izdelali sodelavci na Agronomsko-gozdarski fakulteti v Ljubljani okrog leta 1955.
Fig. 7: Another phytocoenological map for the area of Kamniška Bistrica made in a scale 1:10.000, created by colleagues at the Agronomsko-gozdarska fakulteta in Ljubljana, around 1955.

Today, after almost seventy years, knowledge of forest associations is richer and, in view of such knowledge, these are more suitably studied ecologically and phytogeographically. We have therefore supplemented Cvek's study with contemporary knowledge of the syntaxonomical classification of associations and their ecological conditions, and demonstrated the development of phytocoenological science, as it has taken place from the nineteen fifties until today. The scientific or professional value of the study is also evaluated according to today's criteria of awareness.

Unfortunately, we only had the vegetational part of the study, from pages 54 to 81, but this was sufficient for our comparison. In the literature we found that a study by Tomažič et al. was elaborated four years later, in 1959: *Forest vegetation of Kamniška Bistrica for Ljubljana Forest Management Area* (Marinček 1995). From the contents of the article it is evident that, in addition to Tomažič, Cvek and Robič were co-authors. This study too is lost. Marinček was familiar with and used it in 1995, or perhaps a year earlier, because he cites it in the literature for his article.

The preserved phytocoenological map with its precision indicates the extensive field work performed in the elaborate study and the map preparation. It is a very demanding terrain in Kamniška Bistrica area, which at that time had to be made on foot during the mapping, because the devices we have available today (for example, high-resolution aerial imagery, GIS tools, etc.) were not available at that time. Therefore, also from this point of view, Stanko Cvek's work is very valuable.

We did not update the Latin names in Cvek's inventories; we left them in the original and in the form that was then used in forest management. We have made a special chapter, though, on the synonyms of taxa, in which older and more recent designations are shown comparatively.

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Zupančič, M., V. Žagar & M. Culiberg, 2006: *Slovensko alpsko ruševje v primerjavi z evropskimi ruševji* (*Rhodothamno-Rhododendretum hirsuti var. geogr. Paederota lutea*) = *Slovene Pinus mugo scrub in comparison with European Pinus mugo scrub* (*Rhodothamno-Rhododendretum hirsuti var. geogr. Paederota lutea*). Slovenska akademija znanosti in umetnosti, razred za naravoslovne vede, Dela 40. Ljubljana. 112 pp. + dve fitocenološki tabeli.

Zupančič, M. 2013: *New considerations on southeast-Alpine and Dinaric-central Balkan dwarf pine*. Hrvatska misao 17 (1) / 13 (61) nova serija sv. 46: 156-172.

Zupančič, M., V. Žagar 2013: *New association of small-leaved lime in eastern Slovenia* (*Viburno opuli-Tilietum cordatae ass. nova*). Folia biologica et geologica 54 (2): 262-289.

Svet za varovanje okolja pri Slovenski akademiji znanosti in umetnosti

POZIV SVETA ZA VAROVANJE OKOLJA SAZU K VAROVANJU OGROŽENE ČRNE ČLOVEŠKE RIBICE V BELI KRAJINI

Na osnovi strokovnih mnenj akad. Borisa Sketa, prof. dr. Borisa Buloga, doc. dr. Lilijane Bizjak Mali in prof. dr. Roka Kostanjška je Svet za varovanje okolja SAZU sprejel naslednja stališča:

1. V Beli krajini je v povirnem delu porečja Dobličice edini znan habitat črne človeške ribice na svetu, podvrste *Proteus anguinus parkelj*, ki je edinstvena rasa (podvrsta) zaščitene vrste. Petnajstletni monitoring spremljanja njenega življenjskega prostora, ki ga je izvajala Biotehniška fakulteta Univerze v Ljubljani (raziskovalna skupina prof. Borisa Buloga), potrjujejo domnevo, da je endemična jamska dvoživka, zavarovana živalska vrsta »rdečega« seznama ogroženih vrst, v Beli krajini resno ogrožena zaradi nadaljevanja dolgoletnega onesnaževanja kraških podzemnih voda. Tako je redni okoljski monitoring na lokaliteti v Jelševniku pri Črnomlju (habitat črne človeške ribice) ugotovil izjemno povišanje nekaterih onesnažil, zlasti arzena in cinka v črni človeški ribici, še vedno pa so izjemno visoke koncentracije polikroriranih bifenilov (PCB) v telesih izvrženih poginulih belih človeških ribic iz izvira Krupe (Bulog, 2013, 2016).

2. Širše vodno-ekološko zaledje habitata črne človeške ribice v Beli krajini je zaradi kraškega sveta, vodno-ekološko izjemno občutljivo; zlasti zaradi trenda zniževanja pretočnih vrednosti kot posledice podzemnih sprememb se samočistilne zmogljivosti kraških izvirov še znižujejo. Kljub dolgoletnim prizadevanjem za čistejše vode se nadaljujejo kmetijske obremenitve (zlasti razpršeno in hkrati ploskovno obremenjevanje z gnojenjem) zelo občutljivih kraških vodnih virov, ki se kažejo v prekomernih in za črno človeško ribico zakonsko preseženih količinah dušika in v praksi na splošno pretirane uporabe gnojil v vodozbirnem območju habitata črne človeške ribice. To še posebej velja za prekomerno rabo brezplačnega digestata iz belokranjske bioplinarne Lokve in gnojevke iz prašičje farme na Lokvah pri Črnomlju.

Drugi vir onesnažil je posledica nedograjene kanalizacije in nezadostnega čiščenja komunalnih odpadnih vod gospodinjstev in drugih virov na vplivnem zaledju habitata črne človeške ribice. Zaradi širjenja vodovodnega omrežja v povirju potoka Jelševnika in Dobličice, ki je olajšal vodno oskrbo prebivalcev, pa so se količine pretežno neprečiščene odpadne vode še povečale, kar dodatno ogroža kakovost podzemnih voda, v katerih živi črna človeška ribica.

Oba vira onesnaževanja podtalnice se po pilotni študiji Biotehniške fakultete UL (prof. Rok Kostanjšek) kažeta v prisotnosti bakterij fekalnega izvora na koži črne človeške ribice, kar bi lahko bilo, v povezavi s povečano vsebnostjo nitratov in drugih organskih onesnažil v podtalnici, za črno človeško ribico usodnega pomena.

3. Najnovejša znanstvena dognanja potrjujejo predpostavko, da so za človeško ribico nitrati v vodi nevarni že v koncentraciji pod 10 mg/l vode (Bulog, 2013, 2016), veljavna zakonsko dovoljena splošna vrednost za nitrate v

podzemni vodi pa je 50 mg/l vode**.** To potrjuje tudi najnovejša študija dr. Borisa Kolarja (2017)[1], ki predlaga mejno vrednost nitratov za človeško ribico v podzemni vodi ob upoštevanju naravne koncentracije ozadja 9,2 mg NO_3/l. Ugotovljene dejanske vrednosti nitratov v podzemnih vodah, kjer v Beli krajini živi črna človeška ribica (v obdobju 2000–2009 tudi blizu 20 mg/l), pa že več let dosegajo ali presegajo vrednosti 10 mg/l vode in so se po obratovanju bioplinske elektrarne v Lokvah leta 2010 in 2011 po ugotovitvah Buloga (2013) izrazito povečale. To pomeni, da se ohranjajo ali celo slabšajo neprimerne in tvegane življenjske razmere za zavarovano živalsko vrsto, kar pa postavlja dodatna vprašanja v zvezi z dolgoročnim ohranjanjem ustrezne kakovosti bližnjega črpališča pitne vode na izviru Dobličice, kjer je bila leta 1986 prvič odkrita črna človeška ribica.

4. Glede na navedeno so izpolnjeni predpisani pogoji za določitev strožjih vrednosti praga za nitrate (manj kot 50 mg/l vode) v vodnem telesu, v skladu z določbami 8. člena Uredbe o stanju podzemnih voda (Ur. l. št. 25/2009 s spremembami). Po oceni naravovarstvene stroke je v belokranjskem habitatu črne človeške ribice torej lokalno znatno zmanjšana ekološka kakovost vodnega telesa. Zato so izpolnjeni pogoji za določitev nujnih ukrepov zavarovanja habitata in njegovega zaledja.

5. Predlagamo, da Ministrstvo za okolje in prostor Vlade RS v sodelovanju z Ministrstvom za kmetijstvo Vlade RS pripravi predlog začasnega zavarovanja belokranjskega habitata črne človeške ribice, potem pa naj se opredelijo ključni trajni ukrepi, ki bodo zagotovili pogoje njenega preživetja.

Po mnenju Sveta za varovanje okolja SAZU mora odločitev o zavarovanju življenjskega prostora človeške ribice v Beli krajini in določitvi vplivnega območja z režimi, usmeritvami in konkretnimi ukrepi temeljiti na prioritetah naravovarstvenega vrednotenja, zlasti ker je nujno ohraniti kvalifikacijske vrste in njihove habitate. Črna človeška ribica in njen življenjski prostor v Beli krajini sta edinstvena na svetu, zato morajo država, lokalna skupnost in lokalni prebivalci do njiju prevzeti posebno odgovornost, saj:

1. Črni močeril je zelo dragocen, ker je zelo informativen.
2. Zelo je ogrožen (zaradi majhnega areala razširjenosti).
3. Ne poznamo njegove občutljivosti.

Zato zahtevamo najstrožje ukrepe varovanja!

Svet za varovanje okolja SAZU, zato podpira pobudo Zavoda RS za varstvo narave, OE Novo mesto (julij 2010) in Društva Proteus, okoljskega gibanja Bela krajina (2016), in poziva vse odgovorne, naj čimprej sprejmejo predlagane in tudi druge nujne ukrepe za zavarovanje ogrožene človeške ribice in njenega habitata v Beli krajini.

akad. znanstveni svetnik, zasl. prof. dr. Andrej Kranjc
predsednik Sveta za varovanje okolja pri Slovenski akademije znanosti in umetnosti

Ljubljana, 9. april 2018

[1] Ocena tveganja, ki ga predstavlja nitrat za ekosisteme za podzemne vode in za človeško ribico na projektnem območju Life Kočevsko (NIJZ).

NAVODILA AVTORJEM

Folia biologica et geologica so znanstvena revija IV. razreda SAZU za naravoslovne vede. Objavljajo naravoslovne znanstvene razprave in pregledne članke, ki se nanašajo predvsem na raziskave v našem etničnem območju Slovenije, pa tudi raziskave na območju Evrope in širše, ki so pomembne, potrebne ali primerljive za naša preučevanja.

1. ZNANSTVENA RAZPRAVA

Znanstvena razprava zajema celovit opis izvirne raziskave, ki vključuje teoretični pregled tematike, podrobno predstavlja rezultate z razpravo in zaključki ali sklepi in pregled citiranih avtorjev. V izjemnih primerih so namesto literaturnega pregleda dovoljeni viri, če to zahteva vsebina razprave.

Razprava naj ima klasično razčlenitev (uvod, material in metode, rezultati, diskusija z zaključki, zahvale, literatura idr.).

Dolžina razprave, vključno s tabelami, grafikoni, tablami, slikami ipd., praviloma ne sme presegati 2 avtorskih pol oziroma 30 strani tipkopisa. Zaželene so razprave v obsegu ene avtorske pole oziroma do dvajset strani tipkopisa.

Razpravo ocenjujeta recenzenta, od katerih je eden praviloma član SAZU, drugi pa ustrezni tuji strokovnjak. Recenzente na predlog uredniškega odbora revije *Folia biologica et geologica* potrdi IV. razred SAZU.

Razprava gre v tisk, ko jo na predlog uredniškega odbora na seji sprejmeta IV. razred in predsedstvo SAZU.

2. PREGLEDNI ČLANEK

Pregledni članek objavljamo po posvetu uredniškega odbora z avtorjem. Na predlog uredniškega odbora ga sprejmeta IV. razred in predsedstvo SAZU. Članek naj praviloma obsega največ 3 avtorske pole (tj. do 50 tipkanih strani).

3. NOVOSTI

Revija objavlja krajše znanstveno zanimive in aktualne prispevke do 7000 znakov.

4. IZVIRNOST PRISPEVKA

Razprava oziroma članek, objavljen v reviji *Folia biologica et geologica*, ne sme biti predhodno objavljen v drugih revijah ali knjigah.

5. JEZIK

Razprava ali članek sta lahko pisana v slovenščini ali katerem od svetovnih jezikov. V slovenščini zlasti tedaj, če je tematika lokalnega značaja.

Prevod iz svetovnih jezikov in jezikovno lektoriranje oskrbi avtor prispevka, če ni v uredniškem odboru dogovorjeno drugače.

6. POVZETEK

Za razprave ali članke, pisane v slovenščini, mora biti povzetek v angleščini, za razprave ali članke v tujem jeziku ustrezen slovenski povzetek. Povzetek mora biti dovolj obširen, da je tematika jasno prikazana in razumljiva domačemu in tujemu bralcu. Dati mora informacijo o namenu, metodi, rezultatu in zaključkih. Okvirno naj povzetek zajema 10 do 20 % obsega razprave oziroma članka.

7. IZVLEČEK

Izvleček mora podati jedrnato informacijo o namenu in zaključkih razprave ali članka. Napisan mora biti v slovenskem in angleškem jeziku.

8. KLJUČNE BESEDE

Število ključnih besed naj ne presega 10 besed. Predstaviti morajo področje raziskave, podane v razpravi ali članku. Napisane morajo biti v slovenskem in angleškem jeziku.

9. NASLOV RAZPRAVE ALI ČLANKA

Naslov razprave ali članka naj bo kratek in razumljiv. Za naslovom sledi ime/imena avtorja/avtorjev (ime in priimek).

10. NASLOV AVTORJA/AVTORJEV

Pod ključnimi besedami spodaj je naslov avtorja/avtorjev, in sicer akademski naslov, ime, priimek, ustanova, mesto z oznako države in poštno številko, država, ali elektronski poštni naslov.

11. UVOD

Uvod se mora nanašati le na vsebino razprave ali članka.

12. ZAKLJUČKI ALI SKLEPI

Zaključki ali sklepi morajo vsebovati sintezo glavnih ugotovitev glede na zastavljena vprašanja in razrešujejo ali nakazujejo problem raziskave.

13. TABELE, TABLE, GRAFIKONI, SLIKE IPD.

Tabele, table, grafikoni, slike ipd. v razpravi ali članku naj bodo jasne, njihovo mesto mora biti nedvoumno označeno, njihovo število naj racionalno ustreza vsebini. Tabele, table, slike, ilustracije, grafikoni ipd. skupaj z naslovi naj bodo priloženi na posebnih listih. Če so slike v

digitalni obliki, morajo biti pripravljene u zapisu **.tiff** v barvni skali **CMYK** in resoluciji vsaj **300 DPI/inch.** Risane slike pa v zapisu **.eps.**

Pri fitocenoloških tabelah se tam, kjer ni zastopana rastlinska vrsta, natisne pika.

14. LITERATURA IN VIRI

Uporabljeno literaturo citiramo med besedilom. Citirane avtorje pišemo v kapitelkah. Enega avtorja pišemo » (Priimek leto)« ali »(Priimek leto: strani)« ali »Priimek leto« [npr. (Bukry 1974) ali (Oberdorfer 1979: 218) ali ... Poldini (1991) ...]. Če citiramo več del istega avtorja, objavljenih v istem letu, posamezno delo označimo po abecednem redu »Priimek leto mala črka« [npr. ...Horvatić (1963 a)... ali (Horvatić 1963 b)]. Avtorjem z enakim priimkom dodamo pred priimkom prvo črko imena (npr. R. Tuxen ali J. Tuxen). Več avtorjev istega dela citiramo po naslednjih načelih: delo do treh avtorjev »Priimek, Priimek & Priimek leto: strani« [npr. (Shearer, Papike & Simon 1984) ali Pearce & Cann (1973: 290-300)...]. Če so več kot trije avtorji, citiramo »Priimek prvega avtorja et al. leto: strani« ali »Priimek prvega avtorja s sodelavci leto« [npr. Noll et al. 1996: 590 ali ...Meusel s sodelavci (1965)].

Literaturo uredimo po abecednem redu. Imena avtorjev pišemo v kapitelkah:

– **Razprava ali članek:**

Dakskobler**,** L, 1997: *Geografske variante asociacije Seslerio autumnalis-Fagetum (Ht.) M. Wraber ex Borhidi 1963.* Razprave IV razreda SAZU (Ljubljana) 38 (8): 165–255.

Kajfež, L. & A. Hočevar, 1984: *Klima. Tlatvorni činitelji.* V D. Stepančič: *Komentar k listu Murska Sobota.* Osnovna pedološka karta SFRJ. Pedološka karta Slovenije 1:50.000 (Ljubljana): 7–9.

Le Loeuff, J., E. Buffeaut, M. Martin & H. Tong, 1993: *Decouverte d'Hadrosauridae (Dinosauria, Ornithischia) dans le Maastrichtien des Corbieres (Aude, France).* C. R. Acad. Sci. Paris, t. 316, Ser. II: 1023–1029.

– **Knjiga:**

GORTANI, L. & M. GORTANI, 1905: *Flora Friuliana.* Udine.

Če sta različna kraja založbe in tiskarne, se navaja kraj založbe.

– **Elaborat ali poročilo:**

PRUS, T., 1999: *Tla severne Istre.* Biotehniška fakulteta. Univerza v Ljubljani. Center za pedologijo in varstvo okolja. Oddelek za agronomijo. Ljubljana. (Elaborat, 10 str.).

– **Atlasi, karte, načrti ipd.:**

KLIMATOGRAFIJA Slovenije 1988: Prvi zvezek: *Temperatura zraka 1951–1980.* Hidrometeorološki zavod SR Slovenije. Ljubljana.

LETNO poročilo meteorološke službe za leto 1957. Hidrometeorološki zavod SR Slovenije. Ljubljana.

Za vire veljajo enaka pravila kot za literaturo.

15. LATINSKA IMENA TAKSONOV

Latinska imena rodov, vrst in infraspecifičnih taksonov se pišejo kurzivno. V fitocenoloških razpravah ali člankih se vsi sintaksoni pišejo kurzivno.

16. FORMAT IN OBLIKA RAZPRAVE ALI ČLANKA

Članek naj bo pisan v formatu RTF z medvrstičnim razmikom 1,5 na A4 (DIN) formatu. Uredniku je treba oddati izvirnik in kopijo ter zapis na disketi 3,5 ali na CD-ROM-u. Tabele in slike so posebej priložene tekstu. Slike so lahko priložene kot datoteke na CD-ROM-u, za podrobnosti se vpraša uredništvo.

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The treatise should not be longer than 30 pages, including tables, graphs, figures and others. Much desired are treatises of 20 pages.

The treatises are reviewed by two reviewers, one of them being member of SASA as a rule, the other one a foreign expert.

The reviewers are confirmed by the Classis IV SASA upon the proposal of the editorial board of *Folia biologica et geologica*.

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The periodical publishes short, scientificaly relevant and topical articles up to 7000 characters in lenght.

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The treatise or article may be written in one of world language and in Slovenian language especially when the subjects are of local character.

The author of the treatise or article provides the translation into slovenian language and corresponding editing, unless otherwise agreed by the editorial board.

6. SUMMARY

When the treatise or article is written in Slovenian, the summary should be in English. When they are in foreign language, the summary should be in Slovenian. It should be so extensive that the subjects are clear and understandable to domestic and foreign reader. It should give the information about the intention, method, result, and conclusions of the treatise or article. It should not be longer than 10 to 20% of the treatise or article itself.

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It should give concise information about the intention and conclusions of the treatise or article. It must be written in English and Slovenian.

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The number of key words should not exceed 10 words. They must present the topic of the research in the treatise or article and written in English and Slovenian.

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It should be short and understandable. It is followed by the name/names of the author/authors (name and surname).

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They should be clear, their place should be marked unambiguously, and the number of them must rationally respond to the purport itself. Tables, figures, illus-

trations, graphs, etc. should be added within separated sheets. In case that pictures in digital form, **TIFF** format and **CMYK** colour scale with **300 DPI/inch** resolution should be used. For drawn pictures, **EPS** format should be used.

In cases, when certan plant species are not represented, a dot should be always printed in phytocenologic tables.

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The literature used is to be cited within the text. The citation of the authors is to be marked in capitals. One writes the single author as follows: "(Surname year)" or "(Surname year: pages)" or "Surname year" [(Bukry 1974) or (Oberdorfer 1979: 218) or ... Poldini (1991)...]. The works of the same author are to be cited in alphabetical order: "Surname year small letter" **[...**Horvatić (1963 a)... or (Horvatić (1963 b)]. The first letter of the author's name is to be added when the surname of several authors is the same (R. Tuxen or J. Tuxen). When there are two or three authors, the citation is to be as follows: "Surname, Surname & Surname year: pages" [(Shearer, Papike & Simon 1984) or Pearce & Cann (1973: 290-300)...]. When there are more than three authors, the citation is to be as follows: "Surname of the first one et al. year: pages" or "Surname of the first one with collaborators year" [Noll et al. 1996: 590 or Meusel with collaborators (1965)].

The literature is to be cited in alphabetical order. The author's name is written in capitals as follows:

– **Treatise or article:**

Dakskobler, I**,** 1997: *Geografske variante asociacije Seslerio autumnalis-Fagetum (Ht.) M. Wraber ex Borhidi 1963.* Razprave IV. Razreda SAZU (Ljubljana) 38 (8): 165-255.

Kajfež, L**.** & A. Hočevar, 1984: *Klima. Tlatvorni činitelji.* V D**.** Stepančič: *Komentar k listu Murska Sobota.* Osnovna pedološka karta SFRJ. Pedološka karta Slovenije 1:50.000 (Ljubljana): 7–9.

Le Loeuff, J**.,** E. Buffeaut, M. Martin & H. Tong, 1993: *Déecouverte d'Hadrosauridae (Dinosauria, Ornithischia) dans le Maastrichtien des Corbieres (Aude, France).* C. R**.** Acad. Sci. Paris, t. 316, Ser. II: 1023-1029.

– **Book:**

GORTANI, L. & M**.** GORTANI, 1905: *Flora Friuliana.* Udine.

In case that the location of publishing and printing are different, the location of publishing is quoted.

– **Elaborate or report:**

PRUS, T**.,** 1999: *Tla severne Istre.* Biotehniška fakulteta. Univerza v Ljubljani. Center za pedologijo in varstvo okolja. Oddelek za agronomijo. Ljubljana. (Elaborat, 10 str.).

– **Atlases, maps, plans, etc.:**

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Latin names for order, series, and infraspecific taxa are to be written in italics. All syntaxa written in phytocoenological treatises or articles are to be in italics.

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