

# PHYTOSOCIOLOGICAL AND SYNTAXONOMIC FEATURES OF ASS. *CORNO-LIGUSTRETUM* HT. EX TRINAJSTIĆ ET ZI. PAVLETIĆ (*BERBERIDION*)

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## Izvlaček

Fitocenološke in sintaksonomske značilnosti asociacije *Corno-Ligustretum* Ht. Ex Trinajstić et Zi. Pavletić (*Berberidion*). V delu je predstavljena sintaksonomska analiza floristične sestave asociacije *Corno-Ligustretum* na ozemlju Hrvaške. Floristična sestava obsega 108 vrst, med katerimi je 24 značilnic ali razlikovalnic posameznih sintaksonov, ostale pa so spremljevalke. V okviru asociacije sta opisani dve subasociaciji – subasociacija *cornetosum sanguineae* (= *typicum*) in subasociacija *rubetosum ulmifolii*. Za razvoj združbe *Corno-Ligustretum* je pomembna ornitohorija.

## Abstract

In the work the syntaxonomic analysis of floristic composition of ass. *Corno-Ligustretum* from the territory of Croatia was done. In its floristic composition 108 species have been registered, of which 24 species are characteristic and differential for individual syntaxa, and the others are accompanying species. Within this association two subassociations can be differentiated – the subass. *cornetosum sanguineae* (= *typicum*) and. subass. *rubetosum ulmifolii*. For the genesis of ass. *Corno-Ligustretum* the most important is ornithochoria.

**Ključne besede:** *Corno-Ligustretum*, ornitohorija, Hrvaška

**Key words:** *Corno-Ligustretum*, ornithochoria, Croatia

## 1. INTRODUCTION

The vegetation of mesophilic hedges and underbrushes arose the interest of phytosociologists in Europe relatively late. Thus, as it is known, Braun-Blanquet (1950) describes the alliance *Berberidion*, R. Tüxen (1952) classifies it into a new order *Prunetalia spinosae*, while Rivas Goday and Borja Carbonell exclude all this from the class *Quercu-Fagetea* and include in a special class *Rhamno-Prunetea*. Within the said syntaxa several associations have been described, and similarly within the said order, too, several separate alliances have been described (cf. Oberdorfer 1957, Husova 1985, Oberdorfer & Th. Müller 1992, Wirth 1993). Finally, just recently Weber (1998) published a review "Outline of the vegetation of shrubs and hedges in the temperate and boreal zone of Europe".

In Croatia, the phytosociological research of mesophilic hedges and underbrushes drew attention first of I. Horvat who from the western Croatia (Horvat 1962) described a special association "*Corno-Ligustretum croaticum*", which however is documented by him with a list of the most important species it consists of only. Neither later I. Horvat (cf. Horvat & al. 1974) published any analytic presentation of the said association with adequate phytosociological relevés of with an analytic phytosociological table. For this reason, in relation to the valid syntaxonomical codex (cf. Barkmann & al. 1986), the "ass. *Corno-Ligustretum croaticum*" in the form such as published was described invalidly. In order to bring this easily noticeable and in the vegetation of Croatia very spread association nomenclaturally and substantially in conformity with the syntaxonomical codex, it was necessary to

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omit in its name the geographical indication "croaticum" and to publish at least one relevé of this association. These nomenclatural deficiencies were remedied by Trinajstić & Zi. Pavletić (1991), who published 3 relevés originating from the "Ornithological Reserve Krapje Đol" in Posavina.

During several years of the underbrush and hedge vegetation phytosociological researches in certain parts of Croatia, sufficient data have been gathered (relevés) to start a detailed syntaxonomic analysis of the ass. *Corno-Ligustretum* and to fill the gap in the knowledge of the vegetation of the alliance *Berberidion* in Croatia.

## 2. MATERIAL AND METHODS

In the approach to the phytosociological analysis of the stands such as underbrushes and hedges, it is usually very difficult to satisfy the so-called "classical" methodological hypothesis that a phytosociological relevé must be homogeneous, as recommended in the corresponding manuals (cf. e.g. Horvat 1949, Horvat & al. 1950).

The underbrushes usually develop in a progressive forest succession process and normally conquer the areas covered with various nonforest vegetation forms. They can occupy more or less large areas, but the distribution of individual woody and herbaceous elements is not homogeneous, instead the woody and herbaceous elements generally are distributed in a "mosaic-complex" manner. In such complex, it is possible on one side to distinguish larger or smaller areas of dense and impassable underbrushes separated between them by one of grassland vegetation forms (meadows, pasture land), which almost as a rule has all syntaxonomic features of a meadow or pasture land association.

To avoid making a list of a large number of meadow- or pasture land- even ruderal-elements, if any, the analysis of a regular (usually square) area has to be abandoned and, instead, it is necessary to analyze a closed underbrush area only, no matter how large or small it is. If some underbrush occupies very large and at the same time homogeneous areas, methodologically it is evident that in such case the phytosociological record can be square in shape.

The hedges are normally in the form of a relatively narrow but very long line along village roads and field paths or boundaries, so their area expressed in square meters does not present a more

or less equally long and approximately equally large, more or less square area, such as recommended in a "classical" methodological approach.

When hedge and underbrush floristic composition is analyzed by selecting the closed underbrush stand and dense hedges only, it could be seen that hedges and underbrushes are quite floristically homogeneous and made of a relatively small number of characteristic species. Most species which can be designated as "Companions" most frequently occur in some phytosociological records only, and they contribute to the general floristical diversity of underbrush and hedge associations.

## 3. RESULTS

Ass. *Corno-Ligustretum* Ht. ex Trinajstić et Zi. Pavletić, Acta Bot. Croat. 50: 52 (1991)

The association *Corno-Ligustretum* has been studied on several sites in Croatia and its floristic composition is given in Table 1, based on 16 relevés. The relevés originate from the following localities: the relevés 1 and 2 from the Jezero area on the island of Krk, the relevés 3-5 from the Ornithological Reserve Krapje Đol in Posavina (Trinajstić & Zi. Pavletić 1991), the relevé 6 from Završje near Lobor in Hrvatsko Zagorje, the relevé 7 from Križančija near village of Županec in Podravina, the relevé 8 from Kuršanec near Varaždin in Međimurje, the relevés 9 and 10 from the village of Trnovec near Varaždin in Međimurje, the relevé 11 from Turopolje, the relevé 12 from Šilo on the island of Krk, the relevés 13, 14 and 15 from Vrbničko polje on the island of Krk, and the relevé 16 from the surroundings of Zadar in Dalmatia.

### 3.1 Floristic Composition Analysis

On the basis of earlier researches and knowledges of the floristic composition and structure of the ass. *Corno-Ligustretum* as shown in Table 1, it can be seen that this association in its floristic composition has a large number of species. Within 16 phytosociological relevés a total of 108 species have been registered, but it is interesting to note that some relevés comprise a relatively small number of species. If the relevé 11 which comprises as many as 36 species is not taken into account, the number of species per relevé ranges between 8 and 22 species or on the average 14,4 species per relevé. With regard to the total floristic composition, 24

species are important for individual syntaxa, while the remaining 84 species belong to the group of companions.

As the only characteristic species of association *Cornus sanguinea* has been indicated, and in the locality of Krapje Đol the species *C. hungarica* has been registered, too (cf. Trinajstić 1990) but its share in relation to *C. sanguinea* has not been analyzed separately.

As the characteristic species of the alliance *Berberidion*, the order *Prunetalia spinosae* and the class *Rhamno-Prunetea* 13 species have been registered, among which 4 species only (*Ligustrum vulgare*, *Prunus spinosa*, *Euonymus europaea*, *Rosa canina* s.l.) are represented in more than 50% of records, while 3 species occur in a few records only.

The ass. *Corno-Ligustretum* can be differentiated into two subassociations a typical one – the subass. *cornetosum sanguineae* and the subass. *rubetosum ulmifolii*. The former subassociation is significant for the continental part and the latter for the coastal part of Croatia.

The subassociation *rubetosum ulmifolii* is known to exist on the island of Krk (Trinajstić 1965) and around of Zadar, and it can be expected on the flysch areas in Istria and Kvarner littoral (e.g. the Vinodol valley).

Of the accompanying species, only *Ulmus carpiniifolia* and *Galium mollugo* are represented in more than 50% of relevés, while as many as 51 species are represented in only one relevé, and 19 species in two relevés. From the aforementioned it can be concluded that ass. *Corno-Ligustretum* consists of a relatively small number of characteristic species, and that in its floristic composition in addition to these species there is also quite a large number of species which are not very important for the association organisation.

### 3.2 Ecological Features of Characteristic Species

The pioneer forms of plant cover, whether developed on the primary or secondary habitats, are susceptible to many ecological factors, but conquering of space depends primarily on the possibility and the way of diaspore dissemination. Within the diaspore dissemination ecology in general two main forms of dissemination are known, namely by means of the wind (anemochoria) and by means of animals (zoochoria). In zoochoria, two ways of diaspore carrying are generally known,

namely epi- and endozoochoria. In each of these two ways the diaspores – seeds and fruits in the first place must be adapted by their morphology.

The underbrushes and hedges of moderate regions of Europe develop in the vegetation succession process, primarily as progression stages. The nonforest areas, once arable land cultivation, pasture land grazing or meadows mowing have ceased, are sowed with characteristic underbrush or hedge elements primarily by birds – ornithochoria as one of the forms of endozoochoria. The underbrushes and hedges vegetation elements have been adapted to such seed dissemination by their soft fruits serving as food for birds, and with regard to their structure and morphology these fruits can be berries, drupes, drupe berries and various group an collective fruits such as dogrose berry, blackberry, hawthorn berry and the like. Specialization to ornithochoria has gone so far that certain genera have become fully adapted to it. Such are *Berberis*, *Crataegus*, *Rosa*, *Rubus*, *Ligustrum*, *Prunus*, *Sambucus*, *Viburnum*, *Euonymus*, *Lonicera*, *Rhamnus* etc.

In our particular case of ass. *Corno-Ligustretum*, out of 24 for individual syntaxa characteristic and differential species, 20 are propagated by ornithochoria while two species (*Paliurus spina-christi*, *Clematis vitalba*) is propagated by anemochoria, one (*Corylus avellana*) by small mammals (rodents), and one (*Lamium bifidum*) by autochoria. If all floristic composition is taken into consideration, then as an important factor epizoochoria can be added, too. A practically identical situation is with the related associations *Ligustro-Prunetum* and *Rhamno-Coryletum*.

## 4. DISCUSSION

As far as the characteristic species of individual syntaxa are concerned, the underbrush and hedge vegetation consist of woody elements only. They are partly the real bushes, such as *Cornus sanguinea*, *Ligustrum vulgare*, *Rosa* sp. div., the small bush-like trees such as *Sambucus nigra*, *Crataegus monogyna*, *C. laevigata*, or the turf-like bushes with long downward curved branches, such as the species of the genus *Rubus*. To a lesser extent they are climbing plants such as *Clematis vitalba* and *Lonicera caprifolium*.

Within the forest vegetation all characteristic species of the underbrush and hedge vegetation individual syntaxa occur as a separate synusia, creating jointly with the forest species juvenile forms a laver of bushes, and therefore until recently in

Table 1 (Tabela 1): Ass. *Corno-Ligustretum* Ht. ex Trinajstić et Zi. Pavletić

Nr. of relevé	1	2	3	4	5*	6	7	8	9	10	11	12	13	14	15	16**	Sum.
Subass.	<i>cornetosum sanguinae</i>											<i>rubetosum ulmifolii</i>					
Size of relevé m <sup>2</sup> x 10	10	4	10	10	5	2	10	1	1	5	10	3	/	10	5	5	
Char. Ass.:																	
<i>Cornus sanguinea</i>	5	3	3	1	2	3	3	1	.	1	1	3	3	3	2	1	15
<i>Cornus hungarica</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Diff. Subass.:																	
<i>Rubus ulmifolius</i>	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	+	5
<i>Crataegus transalpina</i>	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2	3
<i>Asparagus acutifolius</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	2
<i>Lamium bifidum</i>	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	2
<i>Ruscus aculeatus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
<i>Lonicera implexa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
<i>Paliurus spina-christi</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1
<i>Juniperus oxycedrus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
Char. All., Order, Class:																	
<i>Ligustrum vulgare</i>	+	1	.	+	1	+	+	1	1	2	3	3	1	2	2	2	15
<i>Prunus spinosa</i>	+	1	1	.	1	1	1	2	4	2	2	.	+	.	+	1	13
<i>Euonymus europaea</i>	.	.	1	+	1	+	2	.	1	1	1	.	+	+	.	+	11
<i>Rosa canina</i> s. l.	+	+	.	+	2	.	+	.	1	.	2	.	.	.	1	1	9
<i>Crataegus monogyna</i>	.	.	.	.	2	2	+	.	+	2	3	.	.	.	.	.	6
<i>Rhamnus cathartica</i>	+	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	4
<i>Berberis vulgaris</i>	.	.	.	.	.	+	.	.	1	1	2	.	.	.	.	.	4
<i>Rubus fruticosus</i> col.	.	.	.	.	.	+	+	1	.	.	+	.	.	.	.	.	4
<i>Viburnum opulus</i>	.	.	.	+	.	.	.	3	.	+	.	.	.	.	.	.	3
<i>Clematis vitalba</i>	.	.	.	.	.	1	.	.	.	.	.	+	+	.	.	.	3
<i>Sambucus nigra</i>	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	3
<i>Rubus discolor</i>	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Crataegus laevigata</i>	.	.	.	+	.	.	.	.	.	3	.	.	.	.	.	.	2
<i>Corylus avellana</i>	.	.	.	.	.	3	.	.	.	+	.	.	.	.	.	.	2
Companions:																	
<i>Ulmus carpinifolia</i>	.	+	.	1	1	.	+	+	.	.	1	+	2	1	+	.	10
<i>Galium mollugo</i>	+	.	.	.	.	.	+	2	2	1	2	.	.	+	.	+	8
<i>Cruciata glabra</i>	.	+	.	.	.	.	.	.	.	.	1	+	+	+	.	.	5
<i>Acer campestre</i>	.	+	.	.	.	2	.	.	.	1	.	.	.	+	.	.	4
<i>Vicia cracca</i>	.	+	.	.	.	.	.	+	.	.	.	+	.	+	.	.	4
<i>Euphorbia cyparissias</i>	.	.	.	.	.	.	2	+	1	.	.	.	.	.	.	.	3
<i>Hedera helix</i>	.	.	.	.	.	1	.	.	.	.	+	.	.	.	.	1	3
<i>Rubus caesius</i>	.	.	+	.	1	.	.	+	.	.	.	.	.	.	.	.	3
<i>Clinopodium vulgare</i>	.	.	.	.	.	.	+	1	+	.	.	.	.	.	.	.	3
<i>Amorpha fruticosa</i>	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	3
<i>Calystegia sepium</i>	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	3
<i>Oenanthe fistulosa</i>	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	3

Holosyntypus \*/Ass.; \*\*/Subass.

-: cover value not estimated

terms of the syntaxonomy such associations were added to the class *Quercus-Fagetea*.

By forest vegetation elimination to obtain grasslands (meadows, pasture lands) and arable lands, the said elements first settled on the edges and boundaries of such agricultural lands forming

hedges, and after grazing and mowing have been abandoned they conquered larger areas in the form of more or less dense underbrushes.

Among the so far studied central European underbrushes, as can be seen from a very extensive tabular presentation published by Oberdorfer & Th.

Müller (1992), the closest to the ass. *Corno-Ligustretum* are two associations only, namely the ass. *Ligustro-Prunetum* and *Rhamno-Cornetum sanguineae*. Some interrelations of the said associations are shown in Table 2.

## 5. CONCLUSIONS

The ass. *Corno-Ligustretum* has been studied in Croatia in localities Jezero, Šilo and Vrbničko polje on the island of Krk, the Ornithological Reserve Krapje Dol in Posavina, Završje near Lohor in Hrvatsko zagorje, Križančija near the village Županec in Podravina, Kuršanec and Trnovec near Varaždin in Međimurje, Turopolje, and in surroundings of Zadar in Dalmacija. In its floristic composition 108 species have been registered, of which 24 species are characteristic and differential for individual syntaxa, and the other are accompanying species.

Within ass. *Corno-Ligustretum* two subassociations can be differentiated – the subass. *cornetosum sanguineae* (= *typicum*) and subass. *rubetosum ulmifolii*. For the genesis of ass. *Corno-Ligustretum* the most important is ornithochoria. In case of ass. *Corno-Ligustretum*, out of 24 for individual syntaxa characteristic and differential species, 20 are propagated by ornithochoria.

## 6. POVZETEK

**Fitocenološke in sintaksonomske značilnosti asociacije *Corno-Ligustretum* Ht. ex Trinajstić et Zi. Pavletić (*Berberidion*)**

S fitocenološkimi raziskovanji mezofilnih grmiščnih združb se je na Hrvaškem prvi ukvarjal I. Horvat (1962), ki je na področju zahodne Hrvaške opisal asociacijo "*Corno-Ligustretum croaticum*". Na žalost je navedel le najpomembnejše karakteristične vrste, tako da asociacija ni bila opisana v skladu z veljavnim nomenklaturnim kodeksom (Barkmann & al. 1986). Napako sta popravila Trinajstić & Zi. Pavletić (1991).

Asociacija *Corno-Ligustretum* je bila preučena na več lokalitetah Hrvaške (otok Krk, Hrvatsko Zagorje, Međimurje, Podravina, Posavina, Dalmacija), vendar je njen floristični inventar predstavljen na osnovi 16 fitocenoloških popisov. Skupaj je zabeleženih 108 vrst, med katerimi je 24 značilnic in razlikovalnic za posamezne sintaksone, 84 pa je spremljevalk. Število vrst v posameznem popisu se giblje med 8 in 36. Če izvzamemo popis 11, v

katerem je 36 vrst, se v posameznem popisu pojavlja od 8 do 22 vrst, povprečno pa 14,4 vrste.

Edina karakteristična vrsta asociacije je vrsta *Cornus sanguinea*, ki se ji na lokaliteti Krapje Dol pridružuje tudi vrsta *Cornus hungarica*. Vendar njen delež glede na vrsto *Cornus sanguinea* med raziskavimi ni bil posebej analiziran.

Med karakteristične vrste zveze *Berberidion*, reda *Prunetalia* in razreda *Rhamno-Prunetea* uvrščamo 12 vrst, med katerimi se samo 4 vrste (*Ligustrum vulgare*, *Prunus spinosa*, *Euonymus europaea*, *Rosa canina* s.l.) pojavljajo v več kot 50 % popisov, medtem ko se samo v posameznih popisih pojavljajo 3 vrste.

Asociacijo *Corno-Ligustretum* lahko razdelimo v dve subasociaciji *cornetosum sanguineae* in *rubetosum ulmifolii*. Prva subasociacija se pojavlja v celinskem delu, druga pa v primorskem delu Hrvaške.

Subasociacija *rubetosum ulmifolii* je bila doslej ugotovljena na otoku Krku (Trinajstić 1965) in v okolici Zadra, lahko pa predvidevamo, da se pojavlja tudi v flišnem delu Istre in nekaterih predelih Kvarnerskega primorja (npr. Vinodolska kotlina).

Za razvoj in razširjanje asociacije *Corno-Ligustretum* je pomembna ornitohorija. Od skupaj 24 značilnic in razlikovalnic za posamezne sintaksone se jih 20 razširja z ornitohorijo.

Od dosedaj preučenihi grmiščnih združb v srednji Evropi, kakor lahko razberemo iz izčrpnega gradiva, ki sta ga objavila Oberdorfer & Th. Müller (1992), je združba najbolj sorodna asociacijama *Ligustro-Prunetum* in *Rhamno-Cornetum sanguineae*. Nekateri medsebojni odnosi navedenih združb so prikazani v tabeli 2.

## 7. APPENDIX

In 1 or 2 relevés also: *Rosa sempervirens* +, *Cynosurus cristatus* + (1); *Fraxinus ornus* +, *Lonicera etrusca* + (2); *Urtica kioviensis* +.3, *Verbena officinalis* +, *Mentha aquatica* +, *Stachys palustris* + (3); *Urtica kioviensis* 2.3, *Glechoma hederacea* +, *Ajuga reptans* + (4); *Scrophularia nodosa* +, *Galium aparine* + (5); *Carpinus betulus* 1.2, *Euonymus verrucosa* +, *Viburnum lantana* +, *Brachypodium sylvaticum* +.2, *Galium sylvaticum* +, *Fragaria vesca* +, *Campanula trachelium* +, *Saponaria officinalis* +.3, *Cornus mas* +.2, *Ranunculus bulbosus* + (6); *Frangula alnus* +, *Solidago canadensis* + (7); *Carex gracilis* 2.3, *Valeriana dioica* +.2 (8); *Solidago canadensis* +, *Brachypodium pinnatum* 1.3, *Prunella vulgaris* +, *Viola hirta* +, *Veronica chamaedrys* +, *Calamagrostis epigeios* 2.3 (9); *Brachypodium pinnatum* 2.3, *Viola hirta* +, *Teucrium chamaedrys* + *Lythospermum*

Table 2 (Tabela 2): Comparison of the floristic related associations of the alliance Berberidion

Association	1	2	3
Total number of records:	16	210	98
Total number of registered species:	108	137	132
Total number of characteristic species:	20	37	36
Total number of companions:	89	100	96
Relationship of characteristic species:	%	%	%
<i>Cornus sanguinea</i>	94	91	87
<i>Ligustrum vulgare</i>	94	98	/
<i>Prunus spinosa</i>	81	88	93
<i>Euonymus europaeus</i>	69	27	58
<i>Rosa canina</i>	56	72	82
<i>Crataegus monogyna</i>	38	54	18
<i>Rhamnus cathartica</i>	25	26	29
<i>Berberis vulgaris</i>	25	23	v
<i>Rubus fruticosus</i>	25	12	26
<i>Sambucus nigra</i>	19	15	29
<i>Rubus discolor</i>	13	/	/
<i>Crataegus laevigata</i>	13	22	73
<i>Corylus avellana</i>	13	35	69
<i>Viburnum lantana</i>	6	22	2
<i>Clematis vitalba</i>	19	36	18
<i>Viburnum opulus</i>	19	/	/

1. *Corno-Ligustretum*; 2. *Pruno-Ligustretum*;  
3. *Rhamno-Cornetum sanguineae*

*officinale* +, *Viola reichenbachiana* +, *Calamagrostis epigeios* 2.3, *Selaginella helvetica* +.3 (10); *Glechoma hederacea* 1.3, *Scrophularia nodosa* +, *Ajuga reptans* 2.2, *Galium aparine* +, *Fragaria vesca* +.2, *Campanula trachelium* +, *Veronica chamaedrys* +, *Viola reichenbachiana* +, *Lonicera caprifolium* 1.1, *Pyrus communis* +, *Lamium maculatum* 3.3, *Stellaria holostea* 2.3, *Potentilla reptans* +, *Anemone nemorosa* 1.1, *Ficaria verna* 2.3, *Taraxacum officinale* +, *Euphorbia esula* 1.1, *Prunella vulgaris* 1.1, *Ranunculus acris* +, *Lamium orvala* 1.2 (11); *Agropyron* sp. + (12); *Sambucus ebulus* +, *Humulus lupulus* +, *Dactylis glomerata* +, *Dipsacus sylvester* +, *Bromus sterilis* +, *Poa pratensis* +, *Galega officinalis* +, *Carex vulpina* +, *Eupatorium cannabinum* + (13); *Eupatorium cannabinum* +.2, *Fraxinus ornus* +, *Fraxinus angustifolia* +, *Quercus cerris* + (14); *Phleum pratense* +, *Dactylis hispanica* + (15); *Pyracantha coccinea* +, *Arum italicum* + (16).

## 8. LITERATURE

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