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The *Rhamnetalia fallacis* P. Fukarek 1969 in the eastern Alps, the Dinarides and the Apennines

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Abstract

The present contribution was designed to deepen the knowledge of the Italian forest vegetation through its connection with the dynamic, pre-forest and mantle aspects relating to *Oreoherzogia fallax* (= *Rhamnus alpina* L. subsp. *fallax* (Boiss.) Maire et Petitm., = *Rhamnus fallax* Boiss.), a south-eastern European orophyte of the south-eastern Alps, the Balkan peninsula and the Apennines. Considering the quality of the historical relationships between the Italian flora and vegetation and that of the Balkan peninsula, the study investigated in detail the vegetation of the order *Rhamnetalia fallacis* P. Fukarek 1969 indicated for the Balkan peninsula. The results of this study of the pre-forest vegetation of the beech forests of the association *Polysticho aculeati-Fagetum sylvaticae* subass. *taxetosum baccatae* of Campo Imperatore plateau allowed the identification of the new association *Taxo baccatae-Juniperetum nanae*, which is proposed as *typus* of the new Apennine alliance *Junipero nanae-Oreoherzogion fallacis*, vicariant for the Apennines of the alliance *Lonicero-Rhamnion fallacis* of a Balkan distribution. The new alliance *Junipero nanae-Oreoherzogion fallacis* is referred to the order *Rhamnetalia fallacis* and the class *Rhamno catharticae-Prunetea spinosae*.

Key words: Apennines, *Rhamnetalia fallacis*, *Rhamno-Prunetea*, syntaxonomy.

Introduction

With the aim of completing the Prodrôme of Italian Vegetation (Biondi *et al.*, 2014), this contribution aims to deepen the knowledge of the Italian forest vegetation through its connection with the dynamical, pre-forest and mantle aspects relating to *Oreoherzogia fallax* (Boiss.) W. Vent (= *Rhamnus alpina* L. subsp. *fallax* (Boiss.) Maire & Petitm., = *Rhamnus fallax* Boiss.).

Oreoherzogia fallax is a south-eastern European montane shrub that is distributed through the south-eastern Alps (i.e., Julian Alps, Kamnik-Savinja Alps/Steiner Alps, Karavanke Mountains/ Karawanken), the Dinaric and Balkan Mountains, and the Apennine peninsula (Aeschmann *et al.*, 2004). Its distribution in Italy relates to the Apennines south of the Po Valley, down to Pollino.

In the Apennines, *Oreoherzogia fallax* is present in the supratemperate thermotype, with penetration into lower subalpine, on limestone substrates outcropping as blocks and/or as layers of debris with clasts of varying sizes. For the supratemperate thermotype, it is common in the pre-forest ecotonal shrub vegetation of beech forests (Biondi *et al.*, 1999, 2004; Allegrezza, 2003; Allegrezza *et al.*, 2013). Under conditions of hydrogeological instability, *Oreoherzogia fallax* can also be found (although often at low coverage) in *Juniperus communis* subsp. *nana* communities (Stanisci, 1997) and in *Juniperus communis* subsp. *nana* and *Juniperus communis* subsp. *hemisphaerica* communities

(Allegrezza *et al.*, 2013, 2016), referred to the alliance *Daphno oleoidis-Juniperion alpinae*.

Although sometimes without definitive attribution, the pre-forest communities with a dominance of *Oreoherzogia fallax* described in the literature for the Apennines (Biondi *et al.*, 1999, 2004; Allegrezza, 2003) were included in the alliance *Berberidion*, suballiance *Berberidenion* (Poldini, 2002; Cutini *et al.*, 2002), within the class *Rhamno catharticae-Prunetea spinosae*. The presence of a vicariant syntaxon for the Apennines, the alliance *Lonicero-Rhamnion fallacis* of the order *Rhamnetalia fallacis* described for the central Dinarids (Fukarek, 1969), has indeed been indicated repeatedly in several syntaxonomy studies (e.g., Stanisci, 1997; Biondi *et al.*, 1999; Poldini *et al.*, 2002).

Considering the quality of the historical relationships between the Italian flora and vegetation and that of the Balkan peninsula, it was decided to carry out a more detailed study of the vegetation of the order *Rhamnetalia fallacis* P. Fukarek 1969. In the European Prodrôme (Mucina *et al.*, 2016), this order was placed in the class *Betulo carpaticae-Alnetea viridis* Rejmánek ex Boeuf, Theurillat, Willner, Mucina and Simler by Boeuf *et al.* (2014). In the same study, this class was defined as follows: "Subalpine and subarctic herb-rich alder and willow scrub and krummholz of the Alps, the Carpathians, the Hercynicum, the Balkans, the Caucasus, northern Europe and Greenland". The order *Rhamnetalia fallacis* P. Fukarek 1969 was instead defined as: "Relict deciduous scrub in the mountains and subalpine belts

of the southern Alps, Dinarides and Apennines". This order lists two alliances: *Seslerio calcariae-Rhamnion fallacis* Dakskobler *et al.* 2013 ("Relict deciduous scrub in the mountains and subalpine belts of the southern Alps"); and *Lonicero-Rhamnion fallacis* P. Fukarek 1969 ("Relict deciduous scrub in the supramontane and subalpine belts of the Dinarides and Apennines"), the alliance *typus* of the order *Rhamnietalia fallacis*. Therefore, although there have not been any clear references in the Apennines to this syntaxon, it is evident that according to the European Prodrome, the second of these two alliances refers to the vegetation of *Oreoherzogia fallax* in the Apennines.

The study area

The territory investigated here is located in the southwestern sector of the Campo Imperatore plateau of Gran Sasso in Italy, at altitudes between 1,460 and 1,650 m a.s.l. (Fig. 1a). This plateau is at the foot of the main limestone mountains of the Gran Sasso d'Italia group, which were strongly shaped by glaciation and morphogenetic phenomena, mainly including karst, snow, wind and water (Calandra, 1999).

The plant landscape is represented by grasslands and limited beech woods that occupy the deep pockets of soil on the limestone outcrops. In the current phase of partial abandonment of the grasslands, these woods tend to recover their potential space, through mantle and pre-forest formations that favour their enlargement.

The bioclimatic classification according to Rivas-Martínez *et al.* (2011) indicates a temperate macroclimate, an oceanic bioclimate, and an upper supratermperate thermotype and humid ombrotype (Baldoni, 1999; Pesaresi *et al.*, 2014, 2017). Specifically for the thermo-pluvial station of Castel del Monte (1,325 m

a.s.l), which is adjacent to the study area, the bioclimatic classification according to Rivas-Martínez *et al.* (2008) indicates a sub-Mediterranean variant at the level of a temperate macroclimate (Fig. 2).

Materials and methods

The study of the vegetation was carried out following the phytosociological methods of the Zurich-Montpellier sigmatist school, as successively integrated (e.g., Rivas-Martínez, 2005; Biondi, 2011; Blasi *et al.*, 2011). The nomenclature of the species follows Bartolucci *et al.* (2018), with the exception of the genus *Juniperus*, which follows Flora Europaea (Tutin *et al.*, 1964). The biological forms of the species follow Flora d'Italia (Pignatti, 1982), while the chorology of the species follows Flora Alpina (Aeschmann, 2004).

The comparisons with the literature data made use of the synthetic columns related to the syntaxa with a dominance of *Oreoherzogia fallax* described for the Apennines (Biondi *et al.*, 1999, 2004; Allegrezza, 2003), the south-eastern Alps (Dakskobler *et al.*, 2013) and the north-western (Dakskobler *et al.*, 2013) and central (Fukarek, 1969) Dinarids.

The numerical comparisons were made using the VEGAN community ecology package for R (Oksanen *et al.*, 2012). The columns of the synthetic table compiled were compared using hierarchical classification and ordination, as Principal Coordinates Analysis (PCoA).

The phytosociological nomenclature follows the rules of the International Code of Phytosociological Nomenclature (Weber *et al.*, 2000). For the definition of the syntaxa, the Prodrome of Italian Vegetation was followed (Biondi *et al.*, 2014; see the specific interactive site of the Italian Botanical Society: <http://www.prodromo-vegetazione-italia.org/>), with reference to

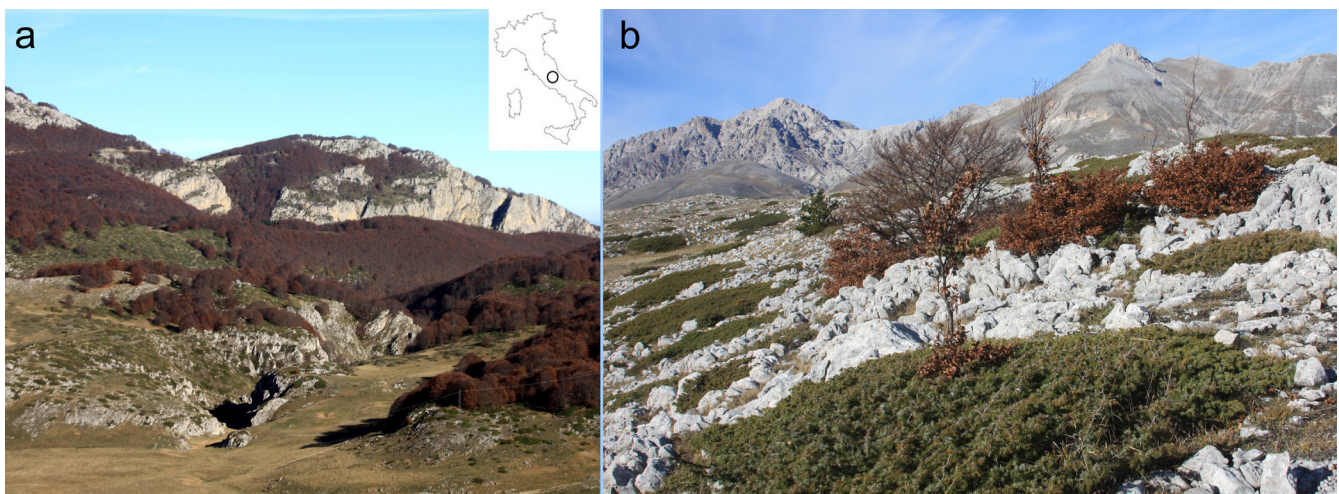


Fig. 1 - a) Beech woods in the southern sector of the Campo Imperatore plateau (Gran Sasso d'Italia) where the vegetation mantles in contact with the beech forest have been studied; b) the role of the *Juniperus communis* subsp. *nana* in the beech forest dynamic processes.

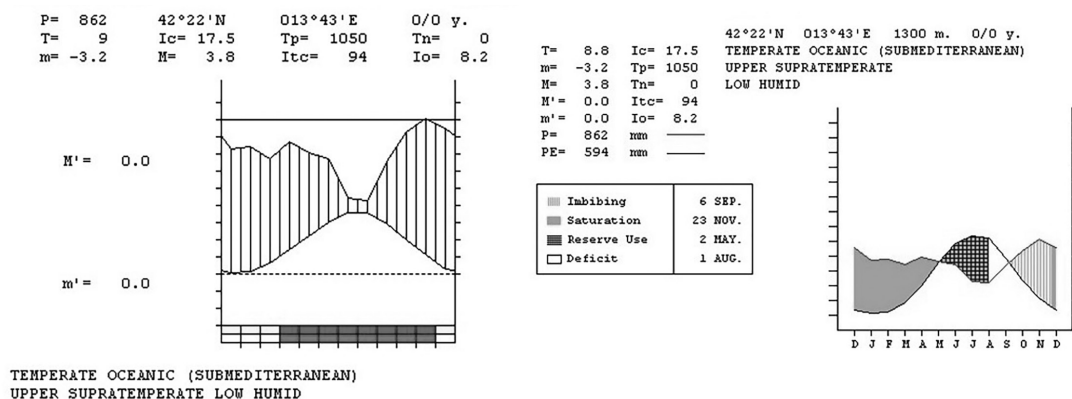


Fig. 2 - Bioclimatic and evapotranspiration diagrams from the Castel del Monte thermo-pluvial station.

Tab. 1 - *Taxo baccatae-Juniperetum nanae* ass. nova hoc loco (typus rel. n. 4).

Biological form	Chorotype	N. rel. Altitude (m a.s.l.) Slope (°) Aspect Area (m²) Coverage (%)							Presences
			1	2	3	4*	5	6	
		<i>Taxo baccatae-Juniperetum nanae</i> ass. nova hoc loco							
NP	EUROSIB.	<i>Juniperus communis</i> L. subsp. nana Syme	2.3	2.3	4.4	4.4	4.4	4.4	6
NP	MEDIT. MONT.	<i>Juniperus communis</i> L. subsp. hemisphaerica (J. Presl et C. Presl) Nyman	3.3	2.3	2.3	2.3	2.3	1.2	6
P scap	EUR./SW-ASIAT.	<i>Taxus baccata</i> L.	1.3	3.4	1.1	3.4	2.3	3.4	6
H scap	NE-MEDIT.-MONT.	<i>Digitalis ferruginea</i> L.	2.2	2.3	3.4	2.3	3.3	2.3	6
P caesp	EUR./SW-ASIAT.	<i>Amelanchier ovalis</i> Medik. subsp. ovalis	+2	.	+	2.3	2.2	3.4	5
		<i>Junipero nanae-Oreohertzogion fallacis</i> all. nova hoc loco							
P caesp	SE-EUR.-MONT.	<i>Oreohertzogia fallax</i> (Boiss.) W.Vent	3.3	3.4	2.2	3.4	2.3	2.3	6
H scap	ENDEM.	<i>Siler montanum</i> Crantz subsp. siculum (Spreng.) Iamónico, Bartolucci & F.Conti	1.2	2.2	+	1.1	1.1	1.2	6
NP	EUROSIB.	<i>Rubus idaeus</i> L. subsp. idaeus	3.4	1.2	2.3	2.3	2.3	1.2	6
NP	EUR./W ASIAT.	<i>Daphne mezereum</i> L.	1.2	.	1.2	2.2	.	.	3
		<i>Rhamnetalia fallacis</i>							
P caesp	S-EUR.-MONT.	<i>Lonicera alpigena</i> L. subsp. alpigena	2.3	4.5	.	.	.	.	2
NP	EUR./SW- ASIAT.	<i>Cotoneaster pyrenaicus</i> Gand.	3.3	2.2	.	.	.	.	2
		<i>Rhamno-Prunetea</i>							
P caesp	S-EUR./SW ASIAT.	<i>Prunus mahaleb</i> L. subsp. mahaleb	2.3	4.5	2.3	2.3	2.3	2.3	6
NP	EURASIAT.	<i>Rosa canina</i> L. s.l.	2.2	+2	3.4	2.3	3.4	2.2	6
NP	EURASIAT.	<i>Rosa spinosissima</i> L.	.	.	+	+	1.2	1.2	4
P caesp	EURASIAT.	<i>Juniperus communis</i> L. subsp. communis	+2	.	+	1.2	.	.	3
NP	EURASIAT.	<i>Ribes uva-crispa</i> L.	.	1.2	+	.	.	.	2
		Other							
P scap	EUR.	<i>Fagus sylvatica</i> L. subsp. sylvatica	2.3	3.4	2.1	1.2	2.1	2.2	6
P caesp	EUR.-MONT.	<i>Sorbus aria</i> (L.) Crantz	+	+	+2	+	+	1.1	6
H scap	EUR.	<i>Euphorbia cyparissias</i> L.	+2	+	2.2	+	2.2	1.2	6
H caesp	EUROP. MONT.	<i>Brachypodium genuense</i> (DC.) Roem. et Schult.	1.2	.	1.2	2.2	1.2	1.2	5
H scap	EUROSIB. (-SUBCOSMOP.)	<i>Hypericum perforatum</i> L. s.l.	1.1	+	.	+	1.2	+2	5
H caesp	EUR.	<i>Bromopsis erecta</i> (Huds.) Fourr. subsp. erecta	.	1.2	1.2	.	2.2	1.2	4
H scap	EURASIAT.	<i>Veronica chamaedrys</i> L.	+	1.2	+2	1.2	.	.	4
Ch suffr	EUR.	<i>Helianthemum nummularium</i> (L.) Miller ssp. obscurum (Celak.) Holub	.	+	.	1.2	.	2.3	3
H scap	EUROSIB.	<i>Galium verum</i> L.	.	.	1.1	+	2.2	.	3
		Sporadic species	13	14	14	14	4	9	

the Prodrome of European Vegetation (Mucina *et al.*, 2016).

Results and discussion

Pre-forest vegetation in the study area

TAXO BACCATAE-JUNIPERETUM NANAE ass. nova *hoc loco* (*holotypus*: rel. 4 of Tab. 1)

In the ecotonal positions of the beech forests of the association *Polysticho aculeati-Fagetum sylvaticae*, subass. *taxetosum baccatae* described for the Campo Imperatore plateau (Biondi *et al.*, 1999) there is high-shrub pre-forest vegetation with a maximum height of 2-3 m. This is characterised by the constant presence of *Taxus baccata*, *Oreohertzogia fallax*, *Prunus mahaleb*, *Amelanchier ovalis*, *Sorbus aria*, *Rosa canina*, *Fagus sylvatica* and *Rubus idaeus* (Tab. 1). These are inserted on a carpet of *Juniperus communis* subsp. *nana* that is sometimes interpenetrated by *Juniperus communis* subsp. *hemisphaerica*, and by herbaceous edge species (e.g., *Digitalis ferruginea*, *Siler montanum* subsp. *siculum*) and grassland species (e.g., *Bromopsis erecta*, *Euphorbia cyparissias*). *Fagus sylvatica* is always present both in the shrub layer and with sparse trees that are 10-12 m in height.

Juniperus communis subsp. *hemisphaerica* is of particular interest here, and was previously reported for the territory in question by Biondi *et al.* (1999). It is a polyhormous plant that can reach a height of over 2 m and is found in the north-western mountainous areas of Africa (i.e., Morocco, Algeria), in the continental areas of the Iberian peninsula (i.e., Spain, Portugal), in some of the western and central Mediterranean islands (e.g., Balearic, Corsica, Sardinia, Sicily), and in the south of the Balkan peninsula (i.e., Albania, Macedonia, Greece, Bulgaria) (Jalas & Souminen, 1972). In Italy, in addition to the two major islands indicated, it is also found in the mountainous areas of the Apennines, reaching its northern limit of distribution in the northern part of the Sibillini Mountains (central Italy) (Allegrizza *et al.*, 2013) and in the southern area of the Italian peninsula, in Aspromonte (Brullo *et al.*, 2001).

The processing of the data in Tab. 1 and the comparison with the literature data (Tab. 2) allowed the proposal of the new association *Taxo baccatae-Juniperetum nanae* ass. nova *hoc loco* (*holotypus* rel. 4 of Tab. 1), for which the characteristic and differential species are considered to be: *Juniperus communis* L. subsp. *nana* Syme; *J. communis* L. subsp. *hemisphaerica* (J. Presl et C. Presl) Nyman; *Taxus baccata* L.; *Digitalis ferruginea* L.; and *Amelanchier ovalis* Medik. subsp. *ovalis*.

At a class syntaxonomic level, this vegetation belongs to the class *Rhamno catharticae-Prunetea spinosae* through both the diversity and cover of species of the syntaxon: e.g., *Prunus mahaleb*, *Amelanchier ovalis*, *Rosa canina*, *R. spinosissima*, *Rubus idaeus*, and *Juni-*

perus communis subsp. *communis*. The assignment at the order and alliance levels is more complex.

The proposal for a new Apennine alliance for the Oreohertzogia fallax vegetation

The dendrogram obtained from the classification of the groups of the relevés (Fig. 3) related to the different syntaxa described in the literature (Tab. 2) separates three groups of relevés that correspond to three distinct biogeographical contexts: Alpine (cluster Ia, except for the n. 13, *Lunario redivivae-Rhamnetum fallacis* association, described for NW Dinarids), Dinaric (cluster Ib), and Apenninic (cluster Ic). The

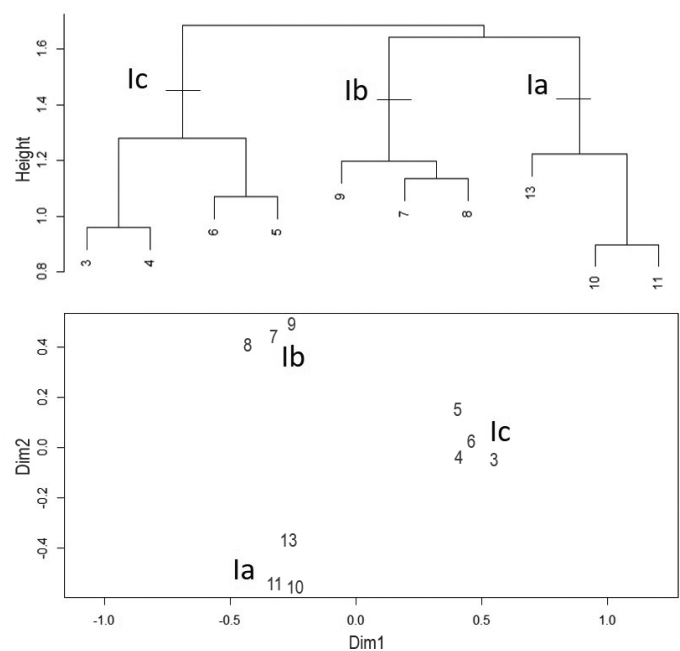


Fig. 3 - Dendrogram and Principal Coordinates Analysis ordination from the communities with a dominance of *Oreohertzogia fallax* in south-eastern Europe that belong to the order *Rhamnetalia fallacis* (at the level of alliance). Ia: *Seslerio calcariae-Rhamnion fallacis* Dakskobler *et al.* 2013 [(n.11. *Polysticho lonchitis-Rhamnetum fallacis* Dakskobler *et al.* 2013 (from Tab. 5, column 2 in Dakskobler *et al.*, 2013), n. 10. *Laserpitio latifolii-Rhamnetum fallacis* Dakskobler *et al.* 2013 (from Tab. 5, column 1 in Dakskobler *et al.*, 2013)]; Ib: *Lonicero-Rhamnion fallacis* Fukarek 1969 [(n. 7. *Cynancho-Rhamnetum* Fukarek & Stefanovic 1958 em. Fukarek 1969 (in Fukarek, 1969), n. 8. *Ribesieto-Loniceretum* Fukarek 1969 (in Fukarek, 1969), n. 9. *Berberidi-Rhamnetum* Horvat 1962 em. Fukarek 1969 (in Fukarek, 1969); n. 13. *Lunario redivivae-Rhamnetum fallacis* Dakskobler *et al.* 2013 (from Tab. 5, column 4 in Dakskobler *et al.*, 2013)]; Ic: *Junipero nanae-Oreohertzogion fallacis* all. nova *hoc loco* [(n. 3. *Taxo baccatae-Juniperetum nanae* ass. nova *hoc loco* Tab. 1 in this paper, n. 4. *Rubus idaei-Rhamnetum fallacis* (Tab. 3 in Biondi *et al.*, 1999), n. 6. *Daphno laureolae-Rhamnetum fallacis* (Tab. 11 in Biondi *et al.*, 2004), n. 5. *Rhamnetum infectorii-fallacis* (Tab. 32 in Allegrizza, 2003)].

Tab. 2 - Group of syntaxa belong to the *Rhamnetalia fallacis* order in the eastern Alps, the Dinarides and the Apennines (the number of groups and the references are the same as Fig. 3).

Chorotype	N. Column N. group from dendrogram and PCoA (Fig.3)	7	8	9	13	11	10	3	4	6	5	Pres.
		1b	1b	1a	1a	1a	1c	1c	1c	1c	1c	
	<i>Cynancho-Rhamnetum</i> Fukarek & Stefanovic 1958 em. Fukarek 1969											
EURASIAT.	<i>Juniperus communis</i> var. <i>intermedia</i>	3	.	.	.	.	.	.	.	.	.	1
ILLYR./E-ALP.	<i>Scabiosa cinerea</i>	4	.	.	.	.	.	.	.	.	.	1
SE-EUR.	<i>Scutellaria altissima</i>	4	.	.	.	.	.	.	.	.	.	1
	<i>Ribesieto-Loniceretum</i> Fukarek 1969											
S.EUR.-MONT	<i>Gentiana asclepiadea</i>		5	.	.	3	.	.	.	.	.	2
S-EUR.-MONT	<i>Luzula luzulina</i>		4	.	.	.	.	.	.	.	.	1
EUROSIB.	<i>Vaccinium myrtillus</i>		3	.	.	.	.	.	.	.	.	1
	<i>Berberidi-Rhamnetum fallacis</i> Horvat 1962 em. Fukarek 1969											
E-EUR.	<i>Euonymus verrucosus</i> var.			3	.	.	.	.	.	.	.	1
ENDEM.	<i>Moltkia petraea</i>			3	.	.	.	.	.	.	.	1
	<i>Lunario redivivae-Rhamnetum fallacis</i> Dakskobler et al. 2013											
EUR.	<i>Sambucus racemosa</i>			5	.	.	3	2	.	.	.	3
SUBCOSMOP.	<i>Urtica dioica</i>			5	.	.	3	2	.	.	.	3
SE-EUROP.	<i>Sedum hispanicum</i>			5	.	.	2	.	.	.	.	2
EUROP.	<i>Lunaria rediviva</i>			5	.	.	.	.	.	.	.	1
EUROSIB.	<i>Polypodium vulgare</i>			3	.	.	.	.	.	.	.	1
	<i>Polysticho lonchitis-Rhamnetum fallacis</i> Dakskobler et al. 2013											
E-ALP.	<i>Rhododendron hirsutum</i>					3	2	.	.	.	.	2
S-EUR.-MONT	<i>Aconitum lycoctonum</i> subsp. <i>ranunculifolium</i> s.l.					5	3	.	.	.	.	2
EUROSIB./N-AM.	<i>Polystichum lonchitis</i>					4	.	.	.	.	.	1
	<i>Laserpitio latifolii-Rhamnetum fallacis</i> Dakskobler et al. 2013											
EUR./SW-ASIAT.	<i>Rumex scutatus</i>		4	.	.	2	4	.	.	.	.	3
S-EUR.-MONT.	<i>Scrophularia juratensis</i>					2	3	.	.	.	.	2
EURASIAT.	<i>Convallaria majalis</i>					2	3	.	.	.	.	2
EUR.	<i>Laserpitium latifolium</i>						4	.	.	.	.	1
S-EUR./W-ASIAT.	<i>Primula veris</i> subsp. <i>columnae</i>						3	.	.	.	.	1
SE-EUR.-MONT.	<i>Lilium carnolicum</i>						3	.	.	.	.	1
	<i>Taxo baccatae-Juniperetum nanae</i> ass. nova hoc loco											
EUR./SW-ASIAT.	<i>Amelanchier ovalis</i> subsp. <i>ovalis</i>						2	4	2	.	.	3
MEDIT.MONT.	<i>Juniperus communis</i> subsp. <i>hemisphaerica</i>							5	.	.	.	1
NE-MEDIT.-MONT.	<i>Digitalis ferruginea</i>							5	.	.	.	1
EUR./SW-ASIAT.	<i>Taxus baccata</i>							5	.	.	.	1
EURASIAT.	<i>Ribes uva-crispa</i>							2	.	.	.	1
	<i>Rubo idaei-Rhamnetum fallacis</i> Biondi et al. 1999											
EUROSIB.	<i>Rubus idaeus</i>			3	4	2	5	5	.	.	.	5
SE-EUR.-MONT.	<i>Doronicum columnae</i>							3	.	.	.	1
SE-EUR.-MONT./SW-ASIAT.	<i>Rosa villosa</i>							2	.	.	.	1
S-EUR.-MONT.	<i>Rosa montana</i>							2	.	.	.	1
	<i>Daphno laureolae-Rhamnetum fallacis</i> Biondi et al. 2004											
W-EUR./MEDIT.	<i>Daphne laureola</i>								4	.	.	1
N-EURIMEDIT.	<i>Rubus canescens</i>								3	.	.	1
	<i>Rhamnetum infectorii-fallacis</i> Allegrezza 2003											
S-EUR.	<i>Rhamnus saxatilis</i> ssp. <i>infectoria</i>										3	1
ILLYRICO-APEN.	<i>Sesleria apennina</i>										2	1
S-EUR.-MONT.	<i>Bupleurum falcatum</i> subsp. <i>cernuum</i>										2	1
	<i>Seslerio calcariae-Rhamnetum fallacis</i> Dakskobler et al. 2013											
EUR.	<i>Sesleria caerulea</i> subsp. <i>calcaria</i>					4	4	.	.	.	.	2
SE-EUR.-MONT.	<i>Pinus mugo</i>					2	3	.	.	.	.	2
	<i>Linum juleicum</i>					2	4	.	.	.	.	2
E-ALP.	<i>Aconitum angustifolium</i>					2	3	.	.	.	.	2
ALP./CARPAT.	<i>Larix decidua</i>					3	.	.	.	.	.	1
	ingressive species											
EUR.-MONT.	<i>Calamagrostis varia</i>			2		3	5	.	.	.	.	3
S-EUR.-MONT.	<i>Bupthalmum salicifolium</i>					3	5	.	.	.	.	2
S-EUR.-MONT.	<i>Cirsium erisithales</i>					4	4	.	.	.	.	2
S-EUR.-MONT.	<i>Cyclamen purpurascens</i>					3	5	.	.	.	.	2
E-ALP/ILLYR.	<i>Salix glabra</i>					3	2	.	.	.	.	2
S-EUR.-MONT.	<i>Erica carnea</i>					2	2	.	.	.	.	2
EUR.-MONT.	<i>Picea abies</i>					3	2	.	.	.	.	2
	<i>Junipero nanae-Oreohertzogion fallacis</i> all. nova hoc loco											
S-EUR./W ASIAT.	<i>Centaurea triumfettii</i>				2	2	1	.	2	2	.	5
EUR./W ASIAT.	<i>Daphne mezereum</i>				2	4	2	3	3	.	.	5
ENDEM	<i>Siler montanum</i> subsp. <i>siculum</i>							5	2	1	3	4
EUROSIB.	<i>Junipers communis</i> subsp. <i>nana</i>					3		5	5	.	.	3
S-EUR./SW ASIAT.	<i>Prunus mahaleb</i>							5	1	1	.	3

	<i>Rhamnetalia fallacis</i> Fukarek 1969											
SE-EUR.-MONT.	Oreohertzogia fallax	5	3	5	5	5	5	5	3	10		
EURASIAT.	Vincetoxicum hirundinaria	5	3	5	2			1		6		
S-EUR.-MONT.	Lonicera alpigena	4	3		2	3		2		5		
EUR./SW- ASIAT.	Ribes alpinum	4	5	5	3	3				5		
EUR./SW- ASIAT.	Cotoneaster pyrenaicus	3					2	1		4		
EUR.	Sedum maximum			5		2	3			3		
N-EUR.-ALP.	Lonicera coerulea		5			2				2		
SE-EUR.-MONT.	Sorbus austriaca	5				2				2		
	Lonicera glutinosa			4						1		
EUR./S- ASIAT.	Viburnum maculatum			5						1		
	Rosa div.sp. Illyrian			5						1		
	Berberis illyrica			3						1		
	Ingressive species											
S-EUR.-MONT.	Salix appendiculata	4	4		2	3	3			5		
	<i>Rhamno-Prunetea</i>											
EUR.-MONT.	Sorbus aria				3	3	5	3	3	6		
EURASIAT.	Rosa canina (s.l.)				2	2	5	2	4	5		
EURASIAT.	Juniperus communis				2	2	3			4		
EUR.	Corylus avellana				3	2	2			4		
EUROSIB.	Lonicera xylosteum				3	3	2		1	4		
EUROSIB.	Rubus saxatilis		2			3	2			3		
S-EUR./W-ASIAT.	Berberis vulgaris					2		1		2		
EUR.	Clematis vitalba					2	2			2		
EUR.	Crataegus laevigata								1	1		
S-EUR.-MONT.	Laburnum alpinum						2			1		
EUR./W-ASIAT.	Prunus spinosa								1	1		
EUR./W-ASIAT.	Crataegus monogyne								1	1		
S-EUR.-MONT.	Lonicera nigra						2			1		
EUR.	Sambucus nigra					2				1		
EURASIAT.	Rosa spinosissima							3		1		
EURI-MEDIT.	Rubus ulmifolius									1		
	Other species											
EUR.	Fagus sylvatica				2	2	2	5		4	6	
EURASIAT./N-AM	Geranium robertianum				5	3	2		1	1	5	
MEDIT.	Galium lucidum					2	3	2	1		4	
EURASIAT.	Epilobium montanum				5	2		2	1		4	
EURASIAT.	Origanum vulgare	5				3	2	1			4	
EURASIAT.	Mycelis muralis				2	3	2	2			4	
EURASIAT.	Campanula trachelium				3	3	2			1	4	
S-EUR./W-ASIAT.	Fraxinus ornus						2	1			3	
EUROSIB./N-AM	Solidago virgaurea					3	2	1			3	
EUR./W-ASIAT.	Acer pseudoplatanus				4	4	3				3	
S-EUR.-MONT.	Adenostyles glabra					4	2		1		3	
EUROSIB.	Sorbus aucuparia s.l.		4			2		2			3	
EUR./W-ASIAT.	Acer platanoides					2		1	1		3	
EURASIAT./AM	Dryopteris filix-mas				5	5	2				3	
OROF.-S-EUROP.	Dryopteris villarii		5			3	2				3	
S-EUR.-MONT.	Galeobdolon flavidum				5	3	2				3	
EUR.	Melica uniflora							1	1	3	3	
EUR./SW-ASIAT.	Mercurialis perennis				4	4	3				3	
S-EUR.-MONT.	Moehringia muscosa				2	2	2				3	
EURASIAT.	Paris quadrifolia				3	3	2				3	
EUR.	Bromopsis erecta							3	1	1	3	
EUR.	Euphorbia cyparissias						2	5	1		3	
MEDIT.	Arabis turrita					2			2	3	3	
SE-EUROP.-MONT.	Carlina acaulis s.l.				2	3	1				3	
COSMOP.	Cystopteris fragilis				2	2		2			3	
MEDIT.	Sedum album					3	2	1			3	
EUROSIB.	Angelica sylvestris				2	3	2				3	
EURASIAT.	Fragaria vesca					3			2	1	3	
EURASIAT.	Geum urbanum					2			1	1	3	
EUR.	Heracleum sphondylium				5		2		1		3	
S-EUR.-MONT.	Hesperis matronalis subsp. nivea				3	2	2				3	
EURASIAT.	Lilium martagon				2	2	2				3	
S-EUR.-MONT.	Pteroselinum austriacum					2	3	2			3	
EURASIAT.	Polygonatum verticillatum				2	3	2				3	
E-EUR.	Senecio ovatus				4	3	2				3	
EURASIAT.	Silene vulgaris (s.l.)					2	3				2	3
EUROSIB.	Solanum dulcamara				2	2	2				3	
S-EUR.-MONT.	Rosa pendulina					3	2		1		3	
EUROP.	Thalictrum aquilegifolium					3	3		1		3	
	Sporadic species	1	-	-	13	84	67	15	5	8	5	

PCoA ordination (Fig. 3) confirms the separation of the groups obtained with the classification and the trend of floristic variations from the typically alpine floristic context expressed by the alliance *Seslerio calcariae-Rhamnion fallacis*, to the Dinaric context of the alliance *Lonicero-Rhamnion fallacis*, *typus* of the order *Rhamnetalia fallacis*, to the Apenninic context, for which (also on the basis of the elaboration of the data of Tab. 2) the new alliance *Junipero nanae-Oreoherzogion fallacis* is proposed, of which the new association *Taxo baccatae-Juniperetum nanae* represents the *typus*.

JUNIPERO NANAE-OREOHERZOGION FALLACIS

all. nova *hoc loco*

(*holotypus: Taxo baccatae-Juniperetum nanae* ass. nova *hoc loco*)

The new alliance refers to the secondary shrubby communities of *Oreoherzogia fallax* that develop on calcareous outcropping substrates and lithosols of the Apennine reliefs from lower to upper supratemperate thermotype, in dynamic connection with beech woods of the alliances *Aremonio-Fagion sylvaticae* and *Geranio striati-Fagion sylvaticae* in the more rocky aspects. The abundant and frequent species of the new syntaxon are: *Oreoherzogia fallax*, *Siler montanum* subsp. *siculum*, *Sorbus aria*, *Cotoneaster pyrenaicus*, *Fagus sylvatica*, and *Prunus mahaleb*.

The diagnostic species of the proposed new alliance are considered to be: *Oreoherzogia fallax*, *Siler montanum* subsp. *siculum*, *Rubus idaeus*, *Daphne mezereum*, *Amelanchier ovalis*, *Juniperus communis* subsp. *hemisphaerica*, *J. communis* subsp. *nana*, *Rhamnus saxatilis*, *Prunus mahaleb*, and *Centaurea triumfettii*.

At its altitude limit of distribution, the pre-forest communities of the new alliance *Junipero nanae-Oreoherzogion fallacis* is in chain contact with *Juniperus communis* subsp. *nana* communities, which are highlighted for the most rocky aspects by the ingression of shrub species of the alliance *Daphno oleoidis-Juniperion alpinae*. Under conditions of severe hydrogeological instability, and following vegetative regression, these communities can sometimes also assume the role of permanent populations of a sub-prime nature.

The new alliance *Junipero nanae-Oreoherzogion fallacis* is referred to the order *Rhamnetalia fallacis* and represents the Apennine vicariant of the alliance *Lonicero-Rhamnion fallacis* Fukarek 1969 of the Dinarids (Mucina *et al.*, 2016). The Apennine coenoses with a dominance of *Oreoherzogia fallax* at its western limit of distribution are distinguished by the purely mountainous and sometimes sub-Mediterranean character that is linked to the same area of *Oreoherzogia fallax* in the Apennines of its central-southern sector. It is interesting to note, however, that despite the different floristic compositions of the different biogeo-

graphical and bioclimatic contexts, the physiognomy and ecology of these communities described in the literature are similar.

At the class level, the order *Rhamnetalia fallacis* is here classified in the class *Rhamno catharticae-Prunetea spinosae*, which is defined according to the European Prodrome as "Scrub and mantle vegetation seral or marginal to broad-leaved forests in the nemoral zone and the submediterranean regions of Europe" according to the shrub physiognomy of the communities described and the prevailing syndynamic significance, with the deciduous woods highlighted in the different syntaxa described in the literature and used in the comparisons for Tab. 2 (Fukarek, 1969; Biondi *et al.*, 1999, 2004; Allegrizza, 2003; Dakskobler *et al.*, 2013). Our proposal is not in agreement with recent interpretations that include the order *Rhamnetalia fallacis* Fukarek 1969, for which the alliance *Lonicero-Rhamnion fallacis* represents the *typus* (Dakskobler *et al.*, 2013), in the class *Quercu-Fagetea* (Trinajstić, 2008; Dakskobler *et al.*, 2013) or in the class *Betulo carpaticae-Alnetea viridis* (Mucina *et al.*, 2016; Škvorc *et al.*, 2017).

In the original proposal, Fukarek (1969) followed the suggestion of Horvat (1962), and proposed the order *Rhamnetalia fallacis* Fukarek 1969 and the alliance *Lonicero-Rhamnion fallacis* for the Balkans, with the vicariant of the order *Prunetalia spinosae* and the alliance *Berberidion* with a contingent of differential species, such as: *Oreoherzogia fallax*; *Berberis illyrica*; *Lonicera alpigena* subsp. *glandulifera*; *Ribes alpinum* subsp. *pallidigemmum*; *Rosae* div. sp. *illyricae*; *Salix appendiculata*; *Lonicera glutinosa*; and *Viburnum maculatum*. These shrubby coenoses with a dominance of *Oreoherzogia fallax* were classified by Trinajstić (2008) into the class *Quercu-Fagetea*, in terms of the floristic affinity with the beech woods. The present proposal of classification of the order *Rhamnetalia fallacis* into the class *Rhamno catharticae-Prunetea spinosae* is based not only on the shrub-like physiognomy, but also on the community syndynamics that are evident also in the floristic composition of the original association *Cynancho vincetoxici-Rhamnetum fallacis* P. Fukarek & Stefanović 1958 (in Fukarek & Stefanović, 1958: 139) indicated as association *typus* of the alliance (Dakskobler *et al.*, 2013), and therefore of the order, for the presence of common species in the pre-forest communities that are dynamically linked to the high-mountain edafo-xerophilous beech woods, like *Sorbus aria*, *Cotoneaster pyrenaicus*, *Vincetoxicum hirundinaria*.

For the classification of the order *Rhamnetalia fallacis* into the class *Betulo carpaticae-Alnetea viridis* ("Subalpine and subarctic herb-rich alder and willow scrub and krummholz of the Alps, the Carpathians, the Hercynicum, the Balkans, the Caucasus, northern

Europe and Greenland") proposed by Mucina *et al.* (2016) and also adopted by the current Prodrómo of Croatia (Škvorc *et al.*, 2017), this would not appear feasible at present on the basis of the published data, as also indicated by Dakskobler *et al.* (2013), because with the exception of *Salix appendiculata* (with low presence and cover value), the characteristic species of the class are absent.

Future phytosociological studies on *Oreoherzogia fallax* vegetation in the southern Balkans (e.g., Macedonia) will help to complete the syntaxonomic scheme of the order *Rhamnetalia fallacis* and to deepen the ecology of *Oreoherzogia fallax* at its southern limit of distribution in Europe.

Based on the recent classification of the EUNIS habitats (Schaminée *et al.*, 2014), the alliance *Lonicero-Rhamnion fallacis* Fukarek 1969 is part of the habitat code S2-5 of "Subalpine deciduous scrub", which is defined as: "Low scrub, including krummholz, dominated with various deciduous trees and shrubs, on moist but free-draining, sometimes quite fertile, soils on high mountain slopes throughout Europe, often with long snow-lie and prone to natural disturbance due to avalanches and scree slides, after which it is well able to recover and recolonise. The associated flora can be rich in tall mountain herbs. It can also be found as a secondary succession stage in abandoned subalpine pastures and meadows". Among the diagnostic species indicated for this habitat (i.e., *Alnus viridis*, *Viola biflora*, *Peucedanum ostruthium*, *Adenostyles alliariae*, *Saxifraga rotundifolia*, *Salix waldesteiniana*, *Salix appendiculata*, *Rumex alpestris*, *Salix helvetica*, *Geranium sylvaticum*, *Athyrium distentifolium*, *Achillea macrophylla*, *Aconitum napellus*, *Chaerophyllum villarsii*, Alpine grasshopper, *Rhododendron hirsutum*, *Polystichum lonchitis*, *Epilobium alpestre*, *Veratrum album*, *Cymbalaria hepaticifolia*), only *Salix appendiculata* is present in the syntaxa of

the Dinaric alliance. *Rhamnus alpinus* is indeed only indicated among the dominant species, and does not assume the diagnostic value of the habitat. The reference to the habitat code S2-5 "Subalpine deciduous scrub" might be more consistent with the alliance *Seslerio calcariae-Rhamnion fallacis* Dakskobler *et al.* 2013 that was described for the south-eastern Alps through the presence in the floristic composition of some of the diagnostic species indicated for the habitat in question (Tab. 2). Finally, the new Apennine alliance *Junipero nanae-Oreoherzogion fallacis* described here does not fall within the S2-5 "Subalpine deciduous scrub" habitat due to the absence of the indicated diagnostic species, which reflects the typically mountain and high-mountain position of the phytocoenosis described.

Conclusions

This study has made it possible to deepen the knowledge of the pre-forest and mantle vegetation relating to *Oreoherzogia fallax* (= *Rhamnus alpina* L. subsp. *fallax* (Boiss.) Maire et Peting.), a south-eastern orophyte that is distributed in the south-eastern Alps, the Balkan peninsula and the Apennines. These data on the pre-forest vegetation of the beech forests of the association *Polysticho aculeati-Fagetum sylvaticae* subass. *taxetosum baccatae* present on the Campo Imperatore plateau has allowed the identification of the new association *Taxo baccatae-Juniperetum nanae* that is proposed as *typus* of the new Apennine alliance *Junipero nanae-Oreoherzogion fallacis*, vicariant for the Apennines of the alliance *Lonicero-Rhamnion fallacis* with a Balkan distribution. The new alliance *Junipero nanae-Oreoherzogion fallacis* is referred to the order *Rhamnetalia fallacis* and the class *Rhamno catharticae-Prunetea spinosae*.

Syntaxonomic scheme

RHAMNO CATHARTICAE-PRUNETEA SPINOSAE Rivas Goday & Borja ex Tüxen 1962

RHAMNETALIA FALLACIS Fukarek 1969

Lonicero-Rhamnion fallacis Fukarek 1969

Cynancho-Rhamnetum Fukarek & Stefanovic 1958 em. Fukarek 1969

Ribesieto-Loniceretum Fukarek 1969

Berberidi-Rhamnetum Horvat 1962 em. Fukarek 1969

Lunario redivivae-Rhamnetum fallacis Dakskobler, Wilfried & Rozman 2013

Seslerio calcariae-Rhamnion fallacis Dakskobler, Wilfried & Rozman 2013

Polysticho lonchitis-Rhamnetum fallacis Dakskobler, Wilfried & Rozman 2013

Laserpitio latifolii-Rhamnetum fallacis Dakskobler, Wilfried & Rozman 2013

Junipero nanae-Oreoherzogion fallacis all. nova *hoc loco*

Taxo baccatae-Juniperetum nanae ass. nova *hoc loco*

Rubo idaei-Rhamnetum fallacis Biondi, Ballelli, Allegranza, Taffetani, Frattaroli, Guitian & Zuccarello 1999

Daphno laureolae-Rhamnetum fallacis Biondi, Pinzi & Gubellini 2004

Rhamnetum infectorii-fallacis Allegranza 2003

Other syntaxa quoted in the text

Aremonio-Fagion (Horvat 1950) Borhidi in Torok *et al.* 1989; *Betulo carpaticae-Alnetea viridis* Rejmanek ex Boeuf, Theurillat, Willner, Mucina et Simler in Boeuf *et al.* 2014; *Berberidion vulgaris* Br.-Bl. ex Tx. 1952 nom. conserv. propos. Mucina *et al.* 2016; *Daphno oleoidis-Juniperion alpinae* Stanisci 1997; *Geranio striati-Fagion* Gentile 1970; *Polysticho aculeati-Fagetum sylvaticae* Feoli & Lagonegro ex Biondi *et al.* 1999 subass. *taxetosum baccatae* Biondi *et al.* 1999; *Prunetalia spinosae* Tx. 1952.

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Appendix I: sporadic species in Table 1

Rel. 1: *Valeriana tuberosa* L. 2.2, *Fraxinus ornus* L. subsp. *ornus* (+.2), *Knautia collina* Jord. +, *Festuca circummediterranea* Patzke +.2, *Acer opalus* Mill. subsp. *obtusatum* (Waldst. et Kit. ex Willd.) Gams +, *Ostrya carpinifolia* Scop. (+.2), *Pinus nigra* J.F. Arnold subsp. *nigra* +, *Pteroselinum austriacum* (Jacq.) Rchb. +, *Galium lucidum* All. +, *Phleum hirsutum* Honck. subsp. *ambiguum* (Ten.) Cif. & Giacom. +.2, *Campanula micrantha* Bertol. +, *Digitalis micrantha* Roth ex Schweigg. +, *Epilobium montanum* L. +; rel. 2: *Paeonia officinalis* L. subsp. *italica* N. G. Passal. & Bernardo 1.2, *Mycelis muralis* (L.) Dumort. subsp. *muralis* +, *Acer opalus* Mill. subsp. *obtusatum* (Waldst. et Kit. ex Willd.) Gams +, *Ostrya carpinifolia* Scop. (+.2), *Sorbus aucuparia* L. 2.2, *Teucrium chamaedrys* L. +, *Pteroselinum austriacum* (Jacq.) Rchb. +.2, *Galium lucidum* All. 1.2, *Hordelymus europaeus* (L.) Harz +, *Centaurea triumfettii* All. +, *Origanum vulgare* L. +, *Lilium bulbiferum* L. subsp. *croceum* (Chaix) Jan +, *Delphinium fissum* Waldst. & Kit. subsp. *fissum* +, *Sesleria nitida* Ten. subsp. *nitida* 1.2; rel. 3: *Plantago major* L. +.2, *Lamium garganicum* L. +, *Cirsium morisianum* Rchb.f. +, *Arrhenatherum elatius* (L.) Presl 1.2, *Abies alba* Miller +, *Helictochloa praetutiana* (Parl. ex Arcang.) Bartolucci, F. Conti, Peruzzi & Banfi subsp. *praetutiana* 1.2, *Armeria gracilis* Ten. subsp. *majel-*

lensis (Boiss.) Arrigoni 1.1, *Carlina acaulis* L. subsp. *caulescens* (Lam.) Schübl. & G. Martens 1.1, *Gentiana cruciata* L. subsp. *cruciata* +, *Silene ciliata* Pourr. subsp. *graefferi* (Guss.) Nyman +, *Phleum pratense* L. 1.2, *Teucrium chamaedrys* L. +, *Campanula micrantha* Bertol. +, *Gentiana lutea* L. subsp. *lutea* +.2; rel. 4: *Verbascum mallophorum* Boiss. et Heldr. +, *Linaria purpurea* (L.) Miller +, *Geranium dissectum* L. +.2, *Arabis alpina* L. subsp. *caucasica* (Willd.) Briq. +.2, *Potentilla micrantha* Ramond ex DC. +, *Hypericum montanum* L. 1.2, *Cruciata glabra* (L.) C. Bauhin ex Opiz +, *Betonica* cfr. *alopecuros* L. +.2, *Sorbus aucuparia* L. +, *Daphne oleoides* Schreb. subsp. *oleoides* 1.2, *Carex macrolepis* DC. 2.3, *Gentiana lutea* L. subsp. *lutea* +, *Digitalis micrantha* Roth ex Schweigg. 1.2, *Epilobium montanum* L. 1.1; rel. 5: *Solidago virgaurea* L. +, *Acer platanoides* L. +, *Arctostaphylos uva-ursi* +.2, *Hieracium murorum* L. (s.l.) +; rel. 6: *Sedum album* L. subsp. *micranthum* (Bast. ex DC.) Syme 1.2, *Helianthemum oelandicum* (L.) Dum.Cours. subsp. *incanum* (Willk.) G. López 1.2, *Filipendula vulgaris* Moench +.2, *Arctostaphylos uva-ursi* +.2, *Betonica* cfr. *alopecuros* L. +.2, *Daphne oleoides* Schreb. subsp. *oleoides* 2.2, *Pinus nigra* J.F. Arnold subsp. *nigra* +, *Hieracium murorum* L. (s.l.) +, *Carex macrolepis* DC. 2.3, *Phleum hirsutum* Honck. subsp. *ambiguum* (Ten.) Cif. & Giacom. 1.2.

Appendix II: data source of Table 2

N. 7 - *Cynancho-Rhamnetum* (in Fukarek 1969), Bosnia and Herzegovina, Perucice, central Dinaric; n. 8 - *Ribesieto-Loniceretum* (in Fukarek 1969), Bosnia and Herzegovina, Maglic, central Dinaric; n. 9 - *Berberidi-Rhamnetum fallacis* (in Fukarek 1969), Bosnia and Herzegovina-Montenegro, south-western Dinaridic (Orjenu planini); n. 13 - *Lunario redivivae-Rhamnetum fallacis* (from Table 5 column 4 in Dakskobler et al. 2013), Slovenia, northwestern Dinaric (Trnovski gozd plateau); n. 11 - *Polysticho lonchitis-Rhamnetum fallacis* (from Table 5 column 2 in Dakskobler et al. 2013), Southeastern Alps (the Julian Alps and the Karavanke/Karawanken); n. 10 - *Laserpitio latifolii-Rhamnetum fallacis* (from Table 5 column 1 in Dakskobler et al. 2013), Southeastern Alps (the Julian Alps and the Karavanke/Karawanken); n. 3 - *Taxo baccatae-Juniperetum nanae* ass. nova hoc loco (Tab. 1 in this paper), central Apennines; n. 4 - *Rubo idaei-Rhamnetum fallacis* (from Tab. 3 rels 1-5, in Biondi et al. 1999) central Apennines (Campo Imperatore plateau); n. 6: *Daphno laureolae-Rhamnetum fallacis* (from Tab. 11 in Biondi et al., 2004), central Apennines (Mt. Cucco group), n. 5: *Rhamnetum infectorii-fallacis* (from Tab. 32 in Allegranza 2003), central Apennines (Mt. San Vicino group).

Appendix III: sporadic species in Table 2

Col. 1: *Hypericum alpestre* 4, *Melica ciliata* 5; Col. 4: *Veratrum album* 2, *Ranunculus platanifolius* 2, *Poa nemoralis* 3, *Hypericum maculatum* 2, *Cardamine bulbifera* 5, *Cardamine enneaphyllos* 5, *Doronicum austriacum* 2, *Corydalis cava* 3, *Asplenium ruta-muraria* 2, *Asplenium trichomanes* 2, *Aconitum degenii* subsp. *paniculatum* 3, *Actaea spicata* 4, *Polygonatum multiflorum* 3, *Adoxa moschatellina* 3; Col. 5: *Veratrum album* 2, *Ranunculus platanifolius*, *Poa nemoralis* 3, *Hypericum maculatum* 3, *Cardamine bulbifera* 2, *Cardamine enneaphyllos* 2, *Doronicum austriacum* 2, *Corydalis cava* 3, *Asplenium ruta-muraria* 2, *Asplenium trichomanes* 3, *Aconitum degenii* subsp. *paniculatum* 3, *Actaea spicata* 3, *Gentiana lutea* 2, *Veronica urticifolia* 2, *Viola biflora* 2, *Viola pyrenaica* 2, *Verbascum lanatum* 2, *Thymus praecox* 2, *Trisetum argenteum* 2, *Valeriana tripteris* 3, *Valeriana wallrothii* 2, *Rhodiola rosea* 3, *Rumex arifolius* 2, *Saxifraga hostii* 2, *Silene hayekiana* 2, *Silene nutans* 2, *Stachys recta* 2, *Taraxacum officinale* 2, *Polygonatum odoratum* 2, *Primula auricula* 2, *Primula elatior* 2, *Petasites paradoxus* 2, *Pleurospermum austriacum* 2, *Melica nutans* 4, *Knautia drymeia* 2, *Koeleria pyramidata* 2, *Laserpitium peucedanoides* 2, *Laserpitium siler* 2, *Lathyrus pratensis* 2, *Lathyrus vernus* subsp. *vernus* 2, *Seseli libanotis* 2, *Ligusticum seguieri* 2, *Betonica alopecuros* 4, *Biscutella laevigata* 2, *Myosotis sylvatica* 3, *Valeriana montana* 2, *Vicia cracca* 2, *Carex ferruginea* 2, *Achillea clavenae* 2, *Achillea distans* 2, *Allium ericetorum* 3, *Allium victorialis* 2, *Anemone trifolia* 2, *Aquilegia nigricans* 2, *Calamintha einseleana* 2, *Campanula cespitosa* 2, *Carduus defloratus* subsp. *crassifolius* 2, *Carduus defloratus* 2, *Carex ornithopoda* 2, *Clematis alpina* 2, *Crocus albiflorus* 2, *Euphorbia amygdaloides* 2, *Festuca calva* 3, *Festuca laxa* 2, *Fraxinus excelsior* 2, *Galium album* 3, *Gymnadenia conopsea* 2, *Gymnocarpium robertianum* 3, *Helleborus niger* 3, *Heracleum pollinianum* 4, *Hieracium porrifolium* 2, *Hieracium villosum* 2, *Brachypodium sylvaticum* 2, *Anemone nemorosa* 2, *Abies alba* 2, *Hepatica nobilis* 2, *Silene dioica* 3, *Polystichum aculeatum* 3, *Poa alpina* 3, *Paederota lutea* 3, *Homogyne sylvestris* 3, *Geranium sylvaticum* 3, *Festuca nitida* 3, *Agropyron caninum* 3; Col. 6: *Melica ciliata* 2, *Veronica urticifolia* 2, *Viola biflora* 2, *Viola pyrenaica* 2, *Veronica chamaedry* 2, *Verbascum lanatum* 2, *Thymus praecox* 2, *Trisetum argenteum* 2, *Valeriana tripteris* 3, *Valeriana wallrothii* 2, *Rhodiola rosea* 3, *Rumex arifolius* 2, *Saxifraga hostii* 3, *Silene hayekiana* 2, *Silene nutans* 2, *Stachys recta* 2, *Taraxacum officinale* 2, *Polygonatum odoratum* 3, *Primula auricula* 3, *Primula elatior* 2, *Petasites paradoxus* 2, *Pleurospermum austriacum* 2, *Melica nutans* 2, *Knautia drymeia* 2, *Koeleria pyramidata* 2, *Laserpitium peucedanoides* 2, *Laserpitium siler* 3, *Lathyrus pratensis* 2, *Lathyrus vernus* subsp. *vernus* 2, *Seseli libanotis* 3, *Ligusticum seguieri* 2, *Betonica alopecuros* 4, *Biscutella laevigata* 2, *Myosotis sylvatica* 3, *Valeriana montana* 2, *Vicia cracca* 2, *Carex ferruginea* 2, *Achillea clavenae* 2, *Achillea distans* 2, *Allium ericetorum* 2, *Allium victorialis* 2, *Anemone trifolia* 2, *Aquilegia nigricans* 2, *Calamintha einseleana* 2, *Campanula cespitosa* 2, *Carduus defloratus* subsp. *crassifolius* 2, *Carduus defloratus* 2, *Carex ornithopoda* 3, *Clematis alpina* 2, *Crocus albiflorus* 2, *Euphorbia amygdaloides* 2, *Festuca calva* 3, *Festuca laxa* 2, *Fraxinus excelsior* 2, *Galium album* 3, *Gymnadenia conopsea* 2, *Gymnocarpium robertianum* 2, *Helleborus niger* 3, *Heracleum pollinianum* 3, *Hieracium porrifolium* 2, *Hieracium villosum* 2, *Acinos alpinus* 3, *Ostrya carpinifolia* 2, *Ranunculus carinthiacus* 3, *Leucanthemum adustum* 3, *Centaurea haynaldi* 3, *Hippocrepis comosa* 3; Col. 7: *Gentiana lutea* 2, *Carex macrolepis* 2, *Veronica chamaedrys* 3, *Teucrium chamaedrys* 2, *Paeonia officinalis* subsp. *italica* 1, *Hypericum montanum* 1, *Hypericum perforatum* 4, *Hieracium murorum* (group) 2, *Daphne oleoides* subsp. *oleoides* 2, *Helianthemum nummularium* subsp. *obscurum* 3, *Abies alba* 1, *Brachypodium genuense* 4, *Helictochloa praetutiana* 1, *Digitalis micrantha* 2, *Ostrya carpinifolia* 1; Col. 8: *Hypericum montanum* 2, *Cruciata laevipes* 1, *Brachypodium sylvaticum* 1, *Anemone nemorosa* 1, *Brachypodium genuense* 3; Col. 9: *Hieracium murorum* (group) 1, *Helianthemum nummularium* subsp. *obscurum* 1, *Cruciata laevipes* 1, *Acinos alpinus* 2, *Hepatica nobilis* 2, *Daphne oleoides* subsp. *oleoides* 1, *Digitalis micrantha* 1, *Viola reichenbachiana* 3; Col. 10: *Carex macrolepis* 2, *Teucrium chamaedrys* 1, *Paeonia officinalis* subsp. *italica* 1, *Helictochloa praetutiana* 1.