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A new pioneer association of detrital substrata of the hilly and low-mountain belts in Central Apennines (Italy)

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Abstract

Plant communities dominated by *Petrosedum* ser. *Rupestria* in Italy have always been referred to the *Sedo albi-Scleranthetea biennis* Br.-Bl. 1955 class. This group of species was also often found more or less abundant in the garrigue and pasture vegetation. Some unusual plant communities dominated by *Petrosedum rupestre* (L.) P.V.Heath with a conspicuous presence of typical species of scree vegetation were found and sampled in the Abruzzo region, on more or less mobile debris. In order to classify such communities, syntaxonomic, structural, chorological and ecological analyses have been performed. All the *Petrosedum* ser. *Rupestria* dominated communities reported in Italy have been compared with the sampled vegetation. A new perennial pioneer association, linked to more or less mobile detrital substrata of the hilly and lower-mountane belts of the calcareous Central Apennines has been here described with the name *Linario purpureae-Petrosedetum rupestris*. Based on the syntaxonomic analysis, this association has been included in the *Linarion purpureae* alliance (*Scrophulario bicoloris-Helichrysetalia italici* order). The *Linario-Petrosedetum* has been divided into two subassociations: a typical one named *petrosedetosum rupestris* and a thermophilous one of the lower altitudes named *teucrietosum flavi*. The study revealed the originality of such communities and their appropriate classification in the *Thlaspietea rotundifolii* class. This is the first record in Italy of a *Petrosedum* ser. *Rupestria*-rich community framed in the scree vegetation class.

Keywords

debris, limestone, *Linarion purpureae*, plant community, phytosociology, *Petrosedum*, vegetation

Introduction

The vegetation dominated by *Petrosedum rupestre* (L.) P.V.Heath has been very little reported in the phytosociological literature (de Bolòs 1983), with particular reference to Italy (Poldini 1989; Mariotti 1995; Di Pietro et al. 2006; Pignatti and Pignatti 2016). It was always referred to the *Sedo albi-Scleranthetea biennis* Br.-Bl. 1955 class, even if this species was also found sometimes abundant in the garrigue communities of the *Cisto cretici-Micromerietea julianae* Oberdorfer ex Horvatić 1958 class (e.g. Pirone and Tammaro 1997), the chasmophytic vegetation of the *Asplenietea trichomanis* (Br.-Bl. in Meier & Br.-Bl. 1934) Oberdorfer 1977 class (e.g. Brullo and Spampinato 2003), and the perennial pastures of the *Festuco valesiacae-Brometea erecti* Br.-Bl. & Tüxen ex Br.-Bl. 1949 class (e.g. Biondi and Galdenzi 2012).

During phytosociological investigations on the vegetation that colonizes debris substrates in the Abruzzo region, some unusual communities dominated by *Petrosedum rupestre* and *Cephalaria leucantha* were found and sampled. Although *Petrosedum rupestre* is considered a diagnostic species of the *Sedo-Scleranthetea* class (Mucina et al. 2016; Biondi et al. 2014), a certain debris mobility together with the presence of several species considered as diagnostic of the scree vegetation of the *Thlaspietea rotundifolii* class, casted doubt upon an easy classification of the observed plant community. In order to properly understand and describe it, several kinds of analyses were performed together with a comparison with all other *Sedum* ser. *Rupestria*-dominated communities described in Italy.

Materials and methods

The vegetation survey has been carried out in several places of the Abruzzo region inside or just outside the "Gran Sasso and Laga Mountains" National Park, "Abruzzo, Lazio and Molise" National Park and "Sirente-Velino" Regional Park (Fig. 1). A complete list of the localities of sampling is provided in the Appendix I. The climate of the study areas was identified using published data of temperatures and rainfalls (Ufficio Idrografico e Mareografico di Pescara, 1971-2000) spatialized for the whole Abruzzo region (unpublished). According to Rivas-Martínez et al. (2011), the thermotypes were found to be ranging between Upper Mesotemperate and Lower Supratemperate while ombrotypes were found to be ranging between Upper Subhumid and Lower Humid.

Fourteen relevès were performed in the hilly-low mountain belt, from 400 to 1,170 m a.s.l., using the classic phytosociological method proposed by Braun-Blanquet (1964). Life forms and Chorotypes were drawn from Pignatti (1982). In order to make the chorological spectra easier to understand, some chorotypes were merged into categories with a widest phytogeographical meaning: Eurasian; S-European; C-European; Paleotemperate; Endemic; Illyrian; Orophyte (Orophyte-W-Mediterranean, Orophyte-S-European-W-Asiatic); Euri-Mediterranean (Euri-Mediterranean, N-Euri-Mediterranean, Mediterranean-W-Asiatic); Steno-Mediterranean (Steno-Mediterranean, E-Steno-Mediterranean, C-Mediterranean, N-Mediterranean). The life form spectra and the chorological spectra were both performed normal, frequency-based and weighted.

To better understand the ecology of the surveyed vegetation for each group of relevès, the Ellenberg indicator values (Pignatti, 2005) were calculated in three different ways: normal (based on the presence/absence of species in the relevès group), frequency-based (based on the occurrences of the species within the group) and weighted by cover of each species.

We used the species indicated by Mucina et al. (2016) as diagnostic of the vegetation classes to develop syntaxonomical spectra of the surveyed vegetation, that were also calculated normal, frequency-based and weighted.

A synoptic table including all the relevès available in the Italian phytosociological literature, having taxa belonging to *Petrosedum* ser. *Rupestria* as dominant species, was built in order to highlight possible floristic differences among different geographical areas.

Finally, we compared the results of all these analyses with the diagnoses of the alliances, orders and classes in Biondi et al. (2014) and Mucina et al. (2016), in order to identify the most suitable syntaxonomic frame for the surveyed vegetation, in terms of structural, bioclimatic, phytogeographical, ecological and floristic features.

For the syntaxonomic references at the ranks of alliance, order and class, we referred to Biondi et al. (2014). Plant species nomenclature follows Bartolucci et al. (2018).

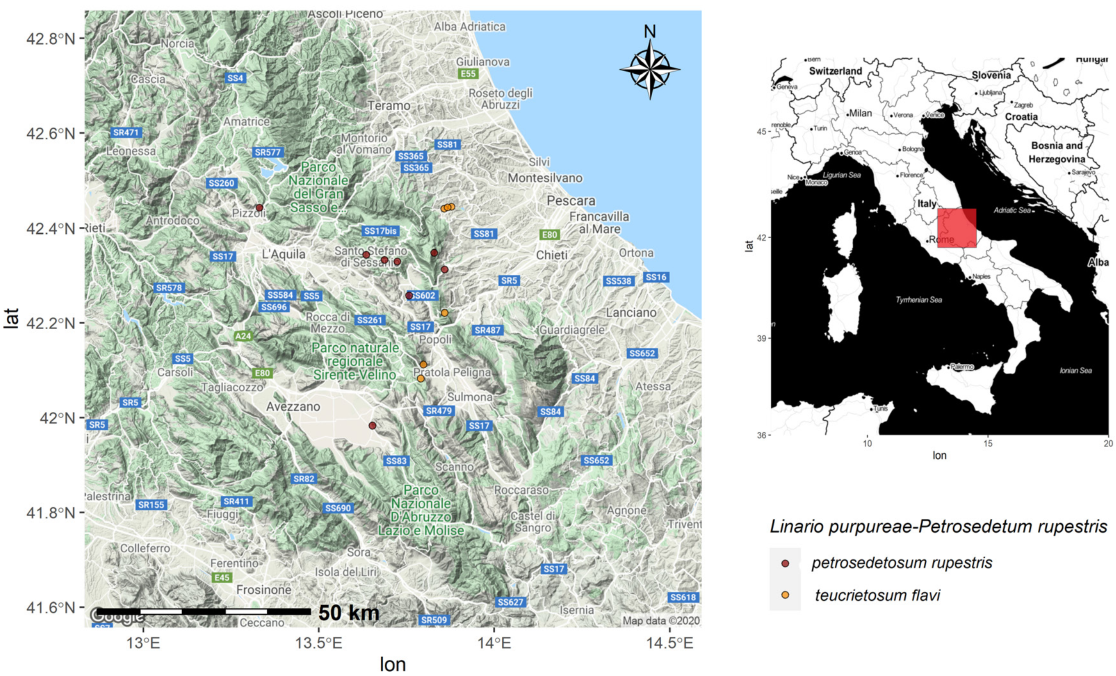

Figure 1. Sampling sites; the background maps were extrapolated from Google using the function get_map from ggmap package (Kahle and Wickham 2013).

Results

The performed vegetation relevés are reported in Table 1. The floristic composition of the investigated communities shows the presence of several species typical of loose and mobile debris substrates, belonging to *Thlaspietea rotundifolii* Br.-Bl. 1948. Several species of the garrigues of *Cisto-Micromerietea* Oberdorfer ex Horvatić 1958 (e.g. *Satureja montana* subsp. *montana*, *Euphorbia spinosa*, *Fumana thymifolia*, *Helianthemum apenninum* subsp. *apenninum*, *Artemisia alba*, *Stachys italica*, etc.) occur only in the second group of relevès (rel. 9-13), representing a good set of differential taxa compared to the first group (rel. 1-8). The more abundant presence of chamaephytes, that are typical of garrigue vegetation, in the second group is to be correlated with the lower altitude at which they spread.

Table 1. Phytosociological table.

		N°	1*	2	3	4	5	6	7	8	9	10	11	12	13	14*
		Elevation (m s.l.m.)	1170	970	895	745	550	950	1150	750	400	460	450	420	525	430
		Aspect	SE	E	ESE	OSO	E	E	O	E	ESE	SSE	SO	E	S	ESE
		Slope (°)	35	40	35	45	40	35	30	35	45	40	40	45	45	35
Bio.		Vegetation cover (%)	60	45	50	40	35	30	50	40	40	40	40	30	30	70
Form	Chorotype	Area (m^2)	15	12	15	20	15	6	20	15	30	40	10	30	40	45
		Linario purpureae-Petrosedetum rupestris ass. nova ***petrosedetosum rupetris*** subass. nova														
Ch	W-Centroe-urop	*Petrosedum rupestre* (L.) P.V.Heath	3.4	2.3	3.3	3.3	2.2	2.2	3.3	2.2	2.2	1.2	3.3	1.2	2.2	3.3
H	S-Europ	*Cephalaria leucantha* (L.) Roem. & Schult.	2.2	1.2	2.2	3.3	2.2	2.2	.	3.2	2.3	2.3	2.3	2.3	2.3	2.3
		teucrietosum flavi subass. nova														
Ch	Steno-Medit	*Teucrium flavum* L. ssp. *flavum*	.	.	.	.	.	.	.	.	+	+.2	+.2	+.2	1.2	2.3
Ch	N-Medit	*Euphorbia spinosa* L.	.	.	.	.	.	.	.	.	.	.	+.2	+.2	+.2	1.2
T	Euri-Medit	*Geranium purpureum* Vill.	.	.	.	.	.	.	.	.	.	+.2	.	.	.	.
Ch	Steno-Medit	*Fumana thymifolia* (L.) Spach ex Webb	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2
Ch	Center-Medit	*Cistus creticus* L. ssp. *creticus*	.	.	.	.	.	.	.	.	.	.	.	.	.	+
		Linarion purpureae, Scrophulario-Helichrysetalia														
H	Endem	*Linaria purpurea* (L.) Mill.	1.1	1.2	+	+	1.2	+.2	+.2	1.1	+	.	+	2.2	+.2	+
H	Euri-Medit	*Scrophularia canina* L.	1.2	2.2	+.2	1.2	1.2	.	+.2	+	1.1	1.2	.	+	+	+.2
H	Orof. S-Europ-W-Asiat	*Rumex scutatus* L. ssp. *scutatus*	2.3	1.2	+	+	.	1.2	2.2	.	1.2	.	2.3	+.2	1.2	1.2
Ch	S-Europ	*Helichrysum italicum* (Roth) G.Don ssp. *italicum*	.	.	+.2	.	.	.	.	.	.	+.2	.	.	.	.
		Thlaspietea rotundifolii														
T	N-Medit	*Galeopsis angustifolia* Ehrh. ex Hoffm. ssp. *angustifolia*	1.2	+	.	.	.	1.1	2.2	2.1	.	.	1.2	.	1.2	.
H	Medit-W-A-siat	*Lactuca viminea* (L.) J.Presl & C.Presl ssp. *chondrilliflora* (Boreau) St.-Lag.	1.1	.	+	.	+	.	.	+	.	+	.	+	.	.
H	Eurasiat	*Vincetoxicum hirundinaria* Medik. ssp. *hirundinaria*	.	+	.	.	.	.	.	.	.	.	.	.	+.2	.
		Other species														
T	Euri-Medit	*Odontites luteus* (L.) Clairv. ssp. *luteus*	.	+	.	.	.	+	.	.	+	+	.	+	+.2	1.1
Ch	Orof-W-Medit	*Satureja montana* L. ssp. *montana*	.	.	.	1.2	+.2	+.2	+.2	+.2	.	.	1.2	.	.	1.2
H	Euri-Medit	*Asperula cynanchica* L. ssp. *cynanchica*	1.2	+	+.2	+.2	.	.	.	.	.	.	.	+.2	.	+.2
H	Italo-Illir (Anfiadriat)	*Dianthus ciliatus* Guss. ssp. *ciliatus*	+	.	+	.	.	.	.	+	.	+.2	+.2	.	.	1.1
H	Steno-Medit	*Galium corrudifolium* Vill.	.	.	+.2	+.2	+.2	.	.	+	.	+.2	1.2	.	.	.
H	Endem	*Phleum hirsutum* Honck. subsp. *ambiguum* (Ten.) Cif. & Giacom.	+.2	1.2		+.2	.	.	.	.	.	.	+.2	.	.	.
H	Endem	*Festuca inops* De Not.	+.2	.	+.2	.	.	.	.	.	+.2	.	.	.	.	+.2
H	Paleotemp	*Poterium sanguisorba* L. s.l.	.	+	+	.	+	.	.	+	.	.	.	.	.	.
H	Steno-Me-dit-Or.	*Convolvulus elegantissimus* Mill.	.	.	.	.	+	.	.	+	+	.	+	.	.	.
Ch	Euri-Medit	*Sedum album* L. ssp. *album*	.	+.2	.	.	.	.	.	.	1.2	.	+.2	.	.	.
Ch	Endem	*Stachys italica* Mill.	+.2	.	.	+.2	.	.	.	.	.	.	.	.	.	.
H	Paleotemp	*Bromopsis erecta* (Huds.) Fourr. subsp. *erecta*	.	.	+.2	.	.	.	.	.	.	.	+.2	.	.	.
Ch	Endem	*Micromeria graeca* (L.) Benth. ex Rchb. ssp. *tenuifolia* (Ten.) Nyman	.	.	.	.	+	.	.	.	.	.	.	.	.	1.2
P	Euri-Medit	*Clematis flammula* L.	.	.	.	.	.	.	.	.	+	.	.	.	.	+
G	Paleotemp	*Allium sphaerocephalon* L. ssp. *sphaerocephalon*	.	.	.	.	.	.	.	.	.	.	+	.	.	+

The synoptic table reported in Table 2 was built including all the *Petrosedum* ser. *Rupestria*-dominated vegetation types described in Italy (Poldini 1989; Di Pietro et al. 2006; Pignatti and Pignatti 2016). It shows the autonomy and the peculiar floristic composition of the studied vegetation, that results clearly characterized by a significant presence of diagnostic species of the class *Thlaspietea rotundifolii*. These species are almost completely absent in the communities surveyed on Prenestini Mts (Di Pietro et al. 2006), on Dolomites (Pignatti and Pignatti 2016) and in Friuli (Poldini 1989). On the contrary, the diagnostic species of the *Sedo-Scleranthetea* class are well represented in the *Sedetum sexangularo-rupestris* Di Pietro, Burrascano & Blasi 2006 of the Prenestini Mts. and in the *Sedetum montani* Br.-Bl. 1955 of the Dolomites, but extremely scarce in both the surveyed vegetation and in the *Sedum montanum/orientale* phytocoenon found in Friuli region. The species of the *Cisto-Micromerietea* are represented in our relevés more than in the other communities, while the species of the *Festuco-Brometea* are mostly represented in the *Sedetum montani* and, secondly, in the studied vegetation where, however, they show low frequency values.

The syntaxonomical spectra of the Abruzzo communities, calculated in order to establish the relative weight of the various groups of species (see Appendix II), show the prevalence of the species of the *Festuco-Brometea* class in the normal spectrum, while the species of the *Thlaspietea rotundifolii* class are prevalent in the frequency-based spectrum. Those of the *Sedo-Scleranthetea* and *Cisto-Micromerietea* classes prevail in the spectrum weighted on cover values.

The life form spectra show the prevalence of hemicryptophytes both in the normal and in the frequency-based spectra, while chamaephytes prevail in the weighted spectrum (Figure 2).

The chorological spectra reveal the prevalence of the Mediterranean species in all the cases, with a significant presence of the S-European species mostly in the spectrum weighted on cover values (Figure 3).

The application of the Ellenberg indicator values (Pignatti 2005) to the two groups of relevès of Table 1 (see Appendix III) shows a high light intensity (L) and moderately high values of temperature (T), both of them with maximum values in the second group of relevés; moderately high values of continentality (C), very low values of humidity (U), high values of soil pH (R), and very poor nutrient conditions (N).

Discussion

As shown in the synoptic table (Table 2), the coenological autonomy and floristic identity of the surveyed vegetation are evident. A high number of *Thlaspietea rotundifolii* diagnostic species allow the Abruzzo communities to be distinguished from similar communities described for other Italian areas.

Table 2. Synoptic table of the Italian *Sedum* ser. *Rupestria* dominated communities.

Community	*Linario purpureae-Petrosedetum rupestris petrosedetosum*	*Linario purpureae-Petrosedetum rupestris teucrietosum*	*Sedetum sexangularo-rupestris*	*Sedetum montani*	*Sedum orientale/montanum* phytocoenon
No. of relevès	8	4	8	14	5
Petrosedum rupestre s.l.	V	V	V	IV	.
Petrosedum thartii	.	.	.	.	V
Linarion purpureae/Scrophulario-Helichrysetalia/Thlaspietea rotundifolii					
Linaria purpurea	V	V	.	.	.
Scrophularia canina	V	V	II	.	.
Rumex scutatus ssp. *scutatus*	IV	V	.	.	.
Galeopsis angustifolia ssp. *angustifolia*	IV	II	.	.	.
Lactuca viminea ssp. *chondrilliflora*	III	II	.	.	.
Vincetoxicum hirundinaria ssp. *hirundinaria*	I	I	.	.	.
Euphorbia spinosa	.	IV	.	.	.
Geranium purpureum	.	I	.	.	.
Trisetaria argentea	.	.	.	II	.
Sedo-Scleranthetea					
Sedum album ssp. *album*	I	II	.	III	.
Sedum sexangulare	.	.	V	III	I
Clinopodium acinos s.l.	.	.	IV	II	.
Sedum acre	.	.	I	III	.
Aethionema saxatile	.	.	IV	.	.
Sempervivum arachnoideum	.	.	.	IV	.
Hylotelephium maximum ssp. *maximum*	.	.	.	IV	.
Sedum dasyphyllum ssp. *dasyphyllum*	.	.	.	III	.
Arenaria serpyllifolia ssp. *serpyllifolia*	.	.	.	III	.
Petrorhagia saxifraga ssp. *saxifraga*	.	.	.	II	.
Potentilla argentea	.	.	.	II	.
Scleranthus polycarpos	.	.	.	I	.
Herniaria glabra ssp. *glabra*	.	.	.	I	.
Sempervivum tectorum	.	.	.	I	.
Scleranthus annuus	.	.	.	I	.
Sedum annuum	.	.	.	I	.
Cisto-Micromerietea					
Satureja montana ssp. *montana*	IV	II	.	.	IV
Helichrysum italicum ssp. *italicum*	I	I	II	.	.
Cephalaria leucantha	V	V	.	.	.
Micromeria graeca ssp. *tenuifolia*	I	I	.	.	.
Teucrium flavum ssp. *flavum*	.	V	.	.	III
Fumana thymifolia	.	I	.	.	.

Table 2. Continuation.

Community	*Linario purpureae-Petrosedetum rupestris petrosedetosum*	*Linario purpureae-Petrosedetum rupestris teucrietosum*	*Sedetum sexangularo-rupestris*	*Sedetum montani*	*Sedum orientale/montanum* phytocoenon
No. of relevès	8	4	8	14	5
Cistus creticus ssp. *creticus*	.	I	.	.	.
Ononis pusilla ssp. *pusilla*	.	.	IV	.	.
Micromeria graeca ssp. *graeca*	.	.	II	.	.
Fumana procumbens	.	.	.	I	.
Teucrium montanum	.	.	.	I	.
Salvia officinalis ssp. *officinalis*	.	.	.	.	II
Festuco-Brometea					
Galium corrudifolium	III	II	V	.	.
Bromopsis erecta s.l.	I	I	II	.	.
Phleum hirsutum subsp. *ambiguum*	II	I	II	.	.
Poterium sanguisorba s.l.	III	.	II	I	.
Allium sphaerocephalon ssp. *sphaerocephalon*	.	II	I	I	.
Odontites luteus ssp. *luteus*	II	V	.	.	.
Asperula cynanchica ssp. *cynanchica*	III	II	.	.	.
Dianthus ciliatus ssp. *ciliatus*	II	III	.	.	.
Festuca inops	II	II	.	.	.
Convolvulus elegantissimus	II	II	.	.	.
Teucrium chamaedrys	.	.	IV	I	.
Dianthus gr. *sylvestris*	.	.	III	I	.
Brachypodium rupestre	.	.	I	I	.
Stachys italica	II	.	.	.	.
Seseli montanum ssp. *montanum*	.	.	IV	.	.
Tragopogon samaritani	.	.	III	.	.
Thymus longicaulis	.	.	II	.	.
Catapodium rigidum s.l.	.	.	II	.	III
Koeleria splendens	.	.	II	.	.
Arabis collina ssp. *collina*	.	.	II	.	.
Hippocrepis comosa ssp. *comosa*	.	.	II	.	.
Anthyllis vulneraria s.l.	.	.	II	.	.
Helictochloa praetutiana ssp. *praetutiana*	.	.	II	.	.
Crupina vulgaris	.	.	II	.	.
Thymus oenipontanus	.	.	.	III	.
Potentilla verna	.	.	.	III	.
Festuca stricta ssp. *sulcata*	.	.	.	II	.
Festuca valesiaca ssp. *valesiaca*	.	.	.	II	.
Koeleria macrantha ssp. *macrantha*	.	.	.	II	.

Table 2. Continuation.

Community	*Linario purpureae-Petrosedetum rupestris petrosedetosum*	*Linario purpureae-Petrosedetum rupestris teucrietosum*	*Sedetum sexangularo-rupestris*	*Sedetum montani*	*Sedum orientale/montanum* phytocoenon
No. of relevès	8	4	8	14	5
Centaurea stoebe	.	.	.	II	.
Poa angustifolia	.	.	.	II	.
Seseli kochii	.	.	.	.	III
Galium lucidum ssp. *lucidum*	.	.	.	.	III
Euphorbia fragifera	.	.	.	.	II
Tuberarietea guttatae					
Trifolium campestre	.	.	II	I	.
Coronilla scorpioides	.	.	V	.	.
Linum strictum s.l.	.	.	III	.	.
Polygala monspeliaca	.	.	III	.	.
Crepis neglecta s.l.	.	.	II	.	.
Bupleurum baldense	.	.	II	.	.
Trifolium stellatum s.l.	.	.	II	.	.
Trifolium arvense ssp. *arvense*	.	.	.	II	.
Other species					
Dactylis glomerata s.l.	.	.	II	I	.
Cerastium arvense ssp. *arvense*	.	.	II	I	.
Plantago lanceolata	.	.	II	I	.
Silene vulgaris s.l.	.	.	II	I	.
Asplenium ceterach s.l.	.	.	I	I	.
Clematis flammula	.	II	.	.	.
Cota tinctoria s.l.	.	.	V	.	.
Reichardia picroides	.	.	III	.	.
Poa bulbosa s.l.	.	.	II	.	.
Picris hieracioides s.l.	.	.	II	.	.
Sonchus tenerrimus	.	.	II	.	.
Clematis vitalba	.	.	II	.	.
Orlaya grandiflora	.	.	II	.	.
Veronica fruticans	.	.	.	II	.
Saxifraga paniculata	.	.	.	II	.
Geranium columbinum	.	.	.	II	.
Galium album s.l.	.	.	.	II	.
Asplenium trichomanes s.l.	.	.	.	II	.
Asplenium septentrionale ssp. *septentrionale*	.	.	.	II	.
Campanula pyramidalis	.	.	.	.	IV
Allium horvatii	.	.	.	.	II

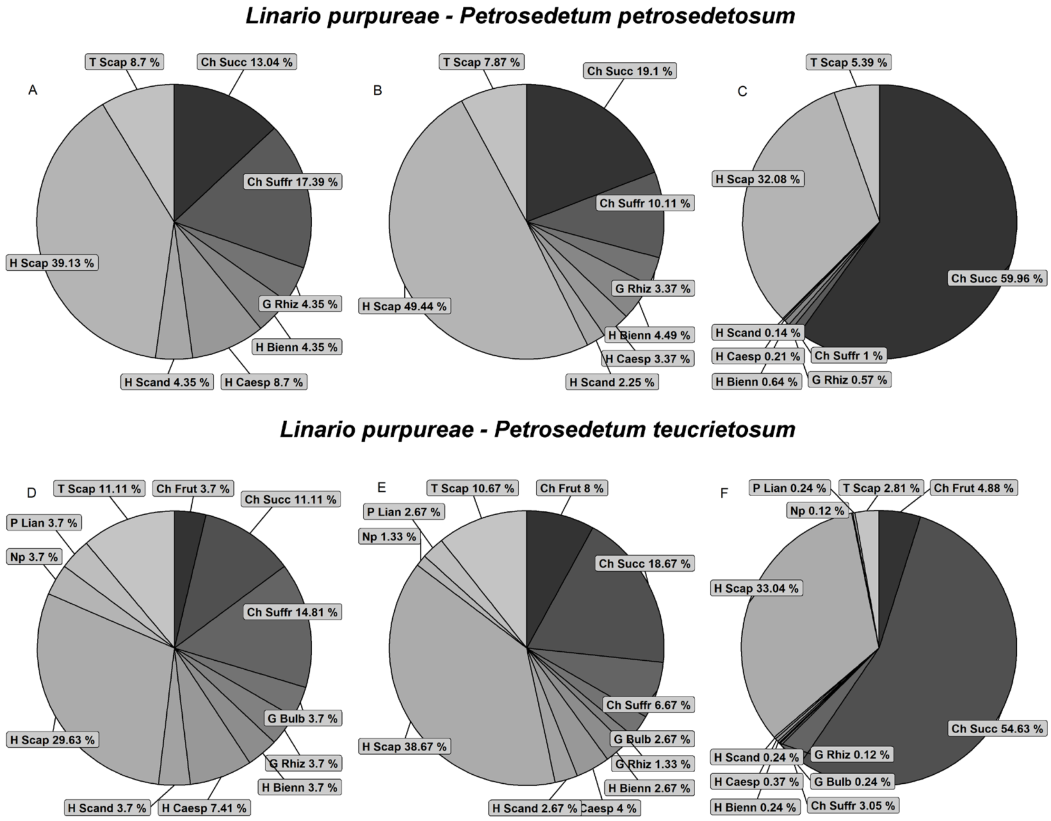

Figure 2. Life form spectra of the two detected subassociations (A, D = normal; B, E = frequency-based; C, F = weighted).

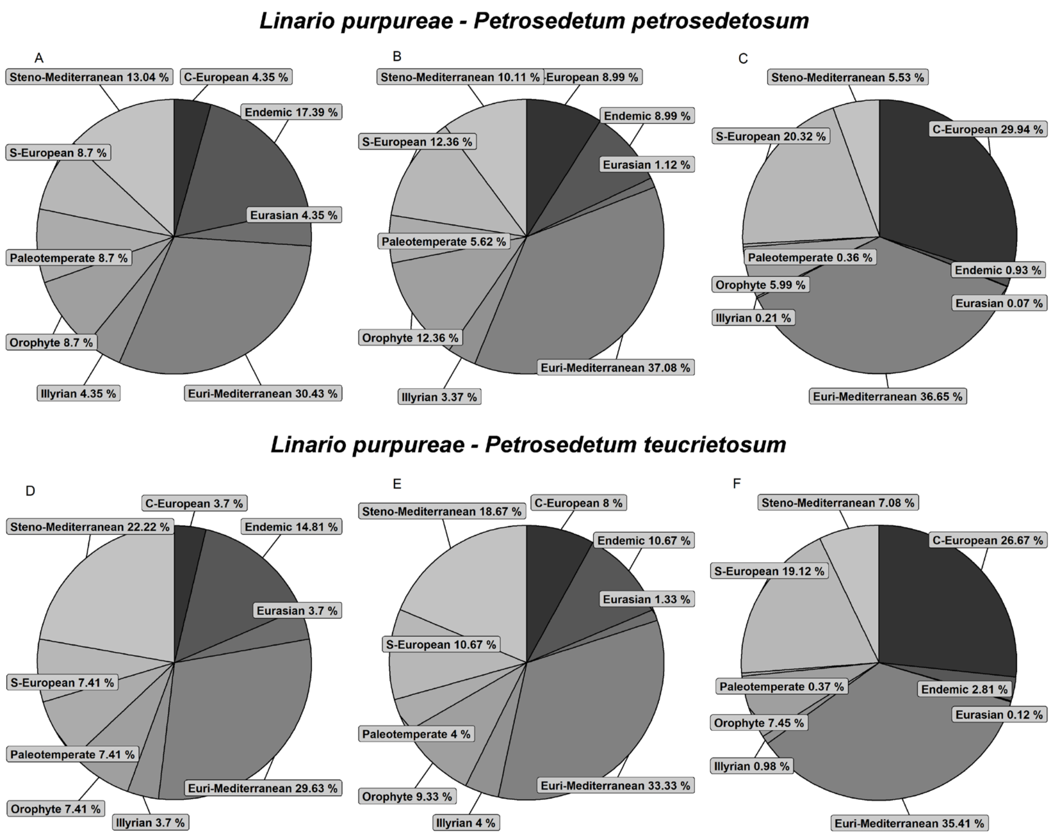

Figure 3. Chorological spectra of the two detected subassociations (A, D = normal; B, E = frequency-based; C, F = weighted).

The syntaxonomical spectra were analyzed in order to weigh the different role of taxa with reference to the various vegetation classes (see Appendix II). They show that the *Festuco-Brometea* is represented by a high number of species, showing low frequency values and even lower coverage values. The species of the *Thlaspietea rotundifolii* class are clearly prevalent in the frequency-based spectrum, while those of the *Sedo-Scleranthetea* and *Cisto-Micromerietea* classes prevail in the spectrum weighted on cover values. Obviously, the dominance of *Petrosedum rupestre* drives the role of *Sedo-Scleranthetea* prevailing in the weighted life form spectrum (Fig. 2C and 2F), while the high values of *Cisto-Micromerietea* of the second group of relevés (9-13 of Tab. 1) is due to the greater contribution of the chamaephytes in this group. The high values of the diagnostic species of *Thlaspietea rotundifolii* are linked to the mobility of the debris on which the surveyed vegetation preferentially grows. For these reasons, we include the surveyed vegetation in this last class. Subordinate syntaxa may be represented by *Linario-Festucion dimorphae* Avena & Bruno 1975 and *Thlaspietalia stylosi* Avena & Bruno 1975 which are widely spread in Central Apennines (cf. Feoli Chiapella and Feoli 1977; Feoli Chiapella 1983; Biondi et al. 2000; Di Pietro et al. 2001, 2008; etc.). Other alliances and/or orders reported for the Apennines such as *Petasition paradoxi* Zollitsch ex Lippert 1966 (*Polystichetalia lonchitis* Rivas-Martínez, T.E. Diaz, F. Prieto, Loidi & Penas 1984), *Violo magellensis-Cerastion thomasii* Biondi, Blasi and Allegrezza in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge and Blasi 2014 (*Thlaspietalia stylosi*), and *Epilobion fleischeri* G. Braun-Blanquet ex Br.-Bl. 1949 (*Epilobietalia fleischeri* Moor 1958) are to be disregarded due to the altitudinal location and ecological features of the studied vegetation (see Appendix III). We also do not include the alliance *Stipion calamagrostis* Jenny-Lips ex Quantin 1932 (*Stipetalia calamagrostis* Oberdorfer & Seibert in Oberdorfer 1977) since it is associated with the *Stipa calamagrostis*-dominated communities (Biondi et al. 2014). The communities of *Linario-Festucion dimorphae* which are normally found in the montane and subalpine belts of Central Apennines are characterized by the prevalence of Apennine Endemic, South-European Orophyte and Eurasian elements (e.g. Conti and Manzi 1992; Petriccione 1993; Biondi et al. 1999; Di Pietro et al. 2004). On the contrary, the analysis of the chorological spectra of the studied vegetation, as noticed, reveals a clear prevalence of the Mediterranean element, with relevant percentages of Steno-Mediterranean species, mostly in the normal and frequency-based spectra and in the second group of relevés (Figure 3). Such occurrence makes this collocation difficult.

A more consistent option is the order *Scrophulario bicoloris-Helichrysetalia italici* described by Brullo et al. (1998) for Sicily, recently used to classify some communities found in Central Italy. In fact, Di Pietro et al. (2017) provisionally referred to this order the association *Helichryso italici-Dittrichietum viscosae* Trinajstić ex Di Pietro, Germani and Fortini 2017, found on Cornicolani Mts. in southern Lazio, in the alliance *Linarion purpureae* Brullo 1984. Moreover, the vegetation of *Artemisio variabilis-Helichrysetum italici* Brullo and Spampinato 1990, reported for the terraces of the Trigno river (central Italy), was also referred to *Scrophulario-Helichrysetalia*, in the alliance *Artemision variabilis* Biondi, Ballelli, Allegrezza, Taffetani & Francalancia 1994 (Pirone et al. 2009). The *Linarion purpureae* alliance includes the pioneer communities of carbonatic or pyroclastic volcanic screes which mainly develop in mountain areas of Southern Italy and Sicily (Brullo 1984), while *Artemision variabilis* includes the chamaephytic nitrophilous communities growing on river terraces and other gravelly incoherent substrata, in the Thermomediterranean and Mesomediterranean thermotypes of Southern Italy (Biondi et al. 2014).

The studied vegetation shows similar ecological features to *Linarion purpureae*, together with the presence of the diagnostic species *Linaria purpurea* and *Rumex scutatus* subsp. *scutatus*, and others similarly linked to mobile debris with a Mediterranean distribution (*Scrophularia canina*, *Galeopsis angustifolia* susbp. *angustifolia*, *Lactuca viminea* subsp. *chondrilliflora*).

On the basis of these considerations, we describe here a new association, with two subassociations, classified in the *Linarion purpureae* alliance and *Scrophulario bicoloris-Helichrysetalia italici* order. They are hereafter characterized.

Mucina et al. (2016), include this order in the Balkanic *Drypidetea spinosae*, whereas Biondi et al. (2014) include it in *Thlaspietea rotundifolii*. In this paper we have preferred to follow the syntaxonomical interpretation provided by Biondi et al. (2014), since the species that are indicated as diagnostic of the *Drypidetea spinosae* class by Mucina et al. (2016) are almost absent in Central and Southern Italy, while the species of the *Thlaspietea rotundifolii* class are well represented both in our relevés and in those from Southern Italy.

Linario purpureae-Petrosedetum rupestris ass. nova, *petrosedetosum rupestris* subass. nova, *typicum* (Table 1, rels. n. 1-8; *holotypus*: rel. n. 2).

Physiognomy and structure. Discontinuous vegetation with hemicryptophytes and chamaephites, with dominance of *Petrosedum rupestre*, *Cephalaria leucantha*, *Linaria purpurea* and *Scrophularia canina*.
Diagnostic species. *Petrosedum rupestre* and *Cephalaria leucantha*. The first is a succulent chamaephyte with a Central-W-European distribution, linked to stony, rocky and debris habitats; the second is a semi-rosette hemicryptophyte with a S-European distribution, which lives mostly in garrigues, stony pastures and other debris environments (Pirone and Tammaro 1997; Allegrezza et al. 1997; Biondi et al. 2005). The choice of these species has been made on the basis of their dominance and frequency, and because

they (more than others) reveal a peculiar vegetation in the frame of the *Thlaspietea rotundifolii* class.

Syntaxonomy. For the reasons explained in the discussion, the new association *Linario purpureae-Petrosedetum rupestris* ass. nova is framed in the *Linarion purpureae* alliance (order *Scrophulario bicoloris-Helichrysetalia italici*, class *Thlaspietea rotundifolii*).

Syndynamics. The association is framed in the vegetation series of both mixed thermophilous and semi-mesophilous oak forests of the order *Quercetalia pubescenti-petraeae* Klika 1933 and mesophilous forests of the order *Fagetalia sylvaticae* Pawłowski in Pawłowski, Sokołowski and Wallisch 1928 (Pirone et al. 2010). The subassociation *petrosedetosum rupestris* is mainly linked to the series of semi-mesophilous and mesophilous woods.

Synecology. The association develops on carbonatic incoherent sediments (gravel, debris, etc..), at altitudes between 400 and 1300 m a.s.l. The bioclimatic context ranges from Upper Mesotemperate to Lower Supratemperate, with ombrotypes from Upper Subhumid to Lower Humid. The typical subassociation is linked to an altitudinal range between 700 and 1,300 m a.s.l. with a Supratemperate thermotype.

Synchorology. The association is known at the moment only for the hilly and lower mountain belts of the Gran Sasso, Sirente-Velino and Marsica Mts. groups and their surroundings; its potential distribution might include also other areas of the Carbonatic Apennines.

Linario purpureae-Petrosedetum rupestris ass. nova, *teucrietosum flavi* subass. nova (Table 1, rels. n. 9-14; *holotypus*: rel. n. 15)

Physiognomy and structure. Comparable to the typical subassociation, with a more abundant presence of chamaephytes.

Differential species. *Teucrium flavum* subsp. *flavum* and *Euphorbia spinosa*. These species have been chosen since they well highlight the more thermophilous character of this subassociation.

Syndynamics. The subassociation is framed in the vegetation series of mixed thermophilous and semi-mesophilic oak woods of the order *Quercetalia pubescenti-petraeae* Klika 1933 (Pirone et al. 2010).

Synecology. The subassociation settles on carbonatic incoherent sediments (gravel, escarpments with clastic debris, etc..), at an altitudinal range between 400 and 700 m a.s.l. The bioclimatic context can be referred to Upper Mesotemperate thermotype and Upper Subhumid ombrotype. It describes the most thermophilous aspects of the association, characterized by a greater presence of species of the *Cisto-Micromerietea* class.

Synchorology. The subassociation is known at the moment only for the Gran Sasso and Sirente-Velino mountain groups and their surroundings; its potential distribution might include also other areas of the Carbonatic Apennines.

Conclusions

The performed syntaxonomic, structural, chorological and ecological analyses clearly showed the autonomy and the peculiarity of the studied vegetation that is formalized in the new association *Linario purpureae-Petrosedetum rupestris* ass. nova. The two subassociations *petrosedetosum rupestris*, *typicum*, and *teucrietosum flavi*, have been identified inside the association, the latter with reference to the most thermophilous aspects linked to the lower altitudes and differentiated by chamaephytes that are typical of the garrigue vegetation.

On the basis of the floristic, ecological and chorological features of the new association, we think that its best classification is in the *Linarion purpureae* alliance (order *Scrophulario bicoloris-Helichrysetalia italici*). At the moment we agree with the interpretation by Biondi et al. (2014) who put the order in the *Thlaspietea rotundifolii* class even if Mucina et al. (2016) includes it in the *Drypidetea spinosae*. A complete revision of the scree plant communities spread in the whole Center and Southern Italy and the Balkans should be performed in order to better understand the relationships between the two classes, but this goes beyond the aim of this work.

This is the third report from Central Italy of communities referable to the *Scrophulario-Helichrysetalia italici* order after the ones by Pirone et al. (2009) and Di Pietro et al. (2017). However, Di Pietro et al. (2017) cast doubt on the possibility that typical classes of high-altitude screes and talus slopes such as *Drypidetea* and *Thlaspietea* may could represent strictly Mediterranean vegetation units like the ones surveyed on Cornicolani Mts. As to the *Linarion purpureae* alliance, this may be considered its first record from Central Italy, since the inclusion of the *Helichryso italici-Dittrichietum viscosae* in this alliance was provisional (Di Pietro et al. 2017).

Our results confirm the presence of the *Linarion purpureae* alliance and the *Scrophulario bicoloris-Helichrysetalia italici* order in Central Italy.

Syntaxonomic scheme

THLASPIETEA ROTUNDIFOLII Br.-Bl. 1948
SCROPHULARIO BICOLORIS-HELICHRYSETALIA ITALICI Brullo 1984
Linarion purpureae Brullo 1984
Linario purpureae-Petrosedetum rupestris ass. nova
petrosedetosum rupestris subass. nova
teucrietosum flavi subass. nova

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Appendixes

Appendix I - Localities, dates and sporadic species of the relevès in Table 1

Rel. 1: Between Passo delle Capannelle and Acqua di Pizzoli (AQ), 06/07/2017, *Digitalis micrantha* (1.1), *Asperula purpurea* (+.2), *Pimpinella tragium* (1.1), *Hypericum perforatum* s.l. (+), *Melica ciliata* ssp. *ciliata* (+.2), *Silene vulgaris* s.l. (+.2), *Aethionema saxatile* (+).

Rel. 2: S. Stefano di Sessanio (AQ), 5/07/2012.

Rel. 3: Brittoli (PE), 30/07/2012.

Rel. 4: Carpineto della Nora (PE), 30/07/2012, *Crepis lacera* ssp. *lacera* (+).

Rel. 5: Venere di Pescina (AQ), 15/07/2011, *Nigella damascena* (+).

Rel. 6: Between Capestrano and Navelli (AQ), 10/08/2012, *Reichardia picroides* (+), *Stachys recta* s.l. (+), *Crupina vulgaris* (+), *Ruta graveolens* (+.2).

Rel. 7: Between Ofena and Calascio (AQ), 25/09/2012, *Artemisia alba* (+.2).

Rel. 8: Calascio (AQ), 25/09/2012, Sabulina sp. (1.2), *Matthiola fruticulosa* ssp. *fruticulosa* (+).
Rel. 9: Goriano Sicoli (AQ), 02/08/2013, *Plantago sempervirens* (+).
Rel. 10: Colle S. Angelo (PE), 16/07/2011, *Fraxinus ornus* ssp. *ornus* (+).
Rel. 11: Colle S. Angelo (PE), 16/07/2011, *Spartium junceum* (+).
Rel. 12: Gole di S. Venanzio (AQ), 26/07/2012, *Linum tenuifolium* (+), *Silene italica* ssp. *italica* (+.2), *Petrorhagia saxifraga* ssp. *saxifraga* (+.2).
Rel. 13: Colle S. Angelo (PE), 16/07/2011, *Silene otites* (+).
Rel. 14: Monte di Roccatagliata (PE), 15/07/2011.

Appendix II - Syntaxonomical spectra

	NORMAL			
	Thl	**S-S**	**C-M**	**F-B**
Linario-Petrosedetum petrosedetosum	27.3	9.1	18.2	45.5
Linario-Petrosedetum teucrietosum	29.6	7.4	25.9	37.0
	FREQUENCY			
	Thl	**S-S**	**C-M**	**F-B**
Linario-Petrosedetum petrosedetosum	38.3	11.1	17.3	33.3
Linario-Petrosedetum teucrietosum	34.2	11.0	24.7	30.1
	COVERAGE			
	Thl	**S-S**	**C-M**	**F-B**
Linario-Petrosedetum petrosedetosum	24.0	42.9	29.3	3.8
Linario-Petrosedetum teucrietosum	19.4	36.1	38.7	5.8

Syntaxonomical spectra (Thl = *Thlaspietea rotundifolii*, S-S = *Sedo-Scleranthetea*, C-M = *Cisto-Micromerietea*, F-B = *Festuco-Brometea*).

Appendix III - Ellenberg's indicator values (Pignatti 2005) for the two groups of relevès

	Linario purpureae-Petrosedetum rupestris petrosedetosum						*Linario purpureae-Petrosedetum rupestris teucrietosum*					
	L	**T**	**C**	**U**	**R**	**N**	**L**	**T**	**C**	**U**	**R**	**N**
NORMAL	7.9	6.6	4.9	3.0	6.4	2.5	8.2	7.1	4.9	2.9	6.1	2.5
FREQUENCY	8.4	7.3	5.4	3.3	7.0	2.9	9.5	8.1	5.7	3.2	7.4	2.8
COVER	10.0	8.1	7.2	3.7	7.8	2.5	10.8	8.7	7.3	3.7	8.2	2.7

Ellenberg's indicator values for the two groups of relevès (L = light, T = temperature, C = continentality, U = humidity, N = nutrients).