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Phytosociological features of *Adonis distorta* and *Trifolium noricum* subsp. *praetutianum*, two endemics of the Apennines (peninsular Italy)

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We present plant communities in which two endemic taxa of the Apennine mountain chain, *Adonis distorta* Ten. and *Trifolium noricum* Wulfen subsp. *praetutianum* (Savi) Arcang are distributed. Although these taxa occur sporadically in some other Apennine massifs, it is only in the Majella mountain range where these species are physiognomically dominant. *Trifolium noricum* subsp *praetutianum* behaves as a differential element in *Helianthemo-Festucetum italicae*, where it characterizes a new edapho-mesophilous subassociation named *Helianthemo alpestris-Festucetum italicae trifolietosum praetutiani*. *Adonis distorta* is linked to specific geo-morphotypes characterised by an alternation of strips of detritus and fine soil particles as well as to distinguishable communities described in this paper as a new association named *Ranunculo seguierii-Adonidetum distortae*.

Keywords: *Adonis*, *Trifolium*, alpine, vegetation, synecology, syntaxonomy, Italy

Introduction

The basic features of the vegetation found on the Majella massif above the timberline have been partially described in previous studies (MIGLIACCIO 1966, 1970; FEOLI-CHIAPELLA and FEOLI 1977; FEOLI-CHIAPELLA 1983; BIONDI et al. 1988; PETRICCIONE 1988; STANISCI 1994, PETRICCIONE and PERSIA 1995; STANISCI 1997; BLASI et al. 2003, 2005). Nonetheless, the extension of the alpine and subalpine belts, which cover relatively wide areas of the Majella massif, and the difficulty of reaching the high altitude zones have precluded the carrying out of thorough studies of these environments. This is especially the case as regards the central and eastern sectors of the massif, which are characterized by extensive plateaus, such as Piano Amaro and Sella di Grotta Canosa.

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Fig. 1. *Adonis distorta* Ten (A), and typical stand of *Helianthemo-Festucetum trifolietosum* with *Trifolium noricum* subsp. *Praetutianum* (B).

This paper reports two new plant communities that have been found in these areas, growing in the alpine bioclimatic belt, at altitudes ranging between 2500 and 2600 m a.s.l. These communities are dominated by *Adonis distorta* Ten. and *Trifolium noricum* Wulfen subsp. *praetutianum* (Savi) Arcang respectively, two taxa of high biogeographical importance for the Italian flora but extremely sporadic in the rest of the Apennines. Although well known to botanists because of their biogeographical significance, the role of *Adonis distorta* and *Trifolium noricum* subsp. *praetutianum* has never previously been studied from a phytosociological and syntaxonomical point of view. There was a tendency to classify them as »companions« (less often as differentials) within communities dominated by other species, rather than as dominant taxa of specific plant communities at the coenological, phytosociological and nomenclatural level.

Study Area

The limestone massif of Majella (2974 m.) is one of the most imposing mountain massifs in the Apennine chain. It consists of a mountain ridge about 30 km in length, running in a north-south direction between 42°12'00'' north and the 42nd parallel south, 32.5 km W of the Adriatic Sea coast (Fig. 2). A morphological peculiarity of the Majella is its shape, which is that of a dome flattened at the top; its very steep sides are cut by deep gorges of glacial origin (DEMANGEOT 1965; JAURAND 1994; GIRAUDI 1998). Our study area was located on the flattish areas occurring between 2450 and 2650 m a.s.l. (Piano Amaro, Sella Grotta Canosa, Cima dell'Altare and M. Macellaro). The climate of this area is extremely cold, with a mean minimum temperature in the coldest month lower than –5° and with

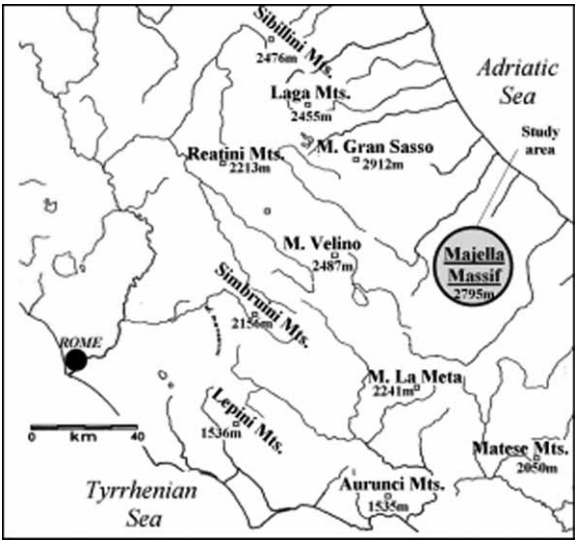

Fig. 2. Schematic map of the geographical position of the study area.

snow cover for 7–8 months a year. From a bioclimatic point of view the area belongs to the cold axeric subregion of the temperate region (RIVAS-MARTINEZ 1995) and to the cryo-oro-temperate thermotype (BLASI et al. 2003).

The Majella massif is one of the most interesting floristic and vegetational areas in the whole Italian peninsula. As in the rest of the Apennines, beech woods dominate the entire montane belt up to 1800 m, while in the subalpine belt well-developed *Pinus mugo* woodlands extend up to 2300–2400 m. This is the only area where *Pinus mugo* stands are to be found in the entire Apennine range, where *Juniperus alpina* and *Arctostaphylos uva-ursi* tend to dominate on limestone and *Vaccinium myrtillus* on sandstones.

The karst plateaus of the alpine belt in the Majella massif are covered by an almost continuous layer of calcareous debris due to periglacial phenomena that have caused the breaking up of the rocky substrate into flattish clasts, small (3–6 cm) and sharp-edged (DRAMIS and KOTARBA 1992). On these plateaus, in the absence of steep slopes, sliding movements in the upper part of the substrate are practically non-existent. However, the prolonged winter cold causes the formation of ice needles (pipkrakes) perpendicular to the surface, which lift small stones, topsoil and plant remains from the ground. The soil is moreover subject to the selective action of the wind, which blows away finer particles. The heavier material which is left is then subjected to the weight of the snow cover and the action of flowing water (both rainwater and melting snow water), which lines stones up with their longer sides parallel and smaller end surface pointing upwards (GENTILESCHI 1967; JAURAND 1994). Under these edaphic conditions, only a specialized flora, such as that characterizing the xerophilous component of *Thlaspietea rotundifolii* (*Saxifrago-Papaveretum julici, Crepido-Leontodontetum montani*) can survive.

In sheltered spots on the windy ridges, where small accumulations of finer material can build up, it is possible to find *Elyno-Seslerietea* communities: *Leontopodio-Elynetum* and *Leontopodio-Seslerietum*, at higher and lower altitudes, respectively. Instead, on the slight-

Tab. 1. Life form spectra calculated: on the percentage of species belonging to the different life forms in the phytosociological tables 3 and 4 (n); weighted, based on the frequency of the different life forms (f); weighted, based on the specific cover index (i.r.s.) of the different life forms (c).

Life forms	*Ranunculo-Adonitetum*			*Helianthemo-Festucetum trifolietosum*		
	n %	f %	c %	n %	f %	c %
Tot. Hemicryptophytes	65,0	63,9	71,4	63,0	66,5	75,0
Tot. Chamaephytes	27,5	30,1	22,0	30,4	31,2	23,3
Tot. Geophytes	5,0	5,3	6,5	4,3	1,2	1,6
Tot. Therophytes	2,5	0,8	0,1	2,2	1,2	0,1
H scapose	35,0	36,1	45,5	30,4	31,2	18,8
H rosulate	22,5	19,5	19,4	15,2	15,3	9,8
H caespitose	7,5	8,3	6,5	15,2	19,4	46,3
H biennis	0,0	0,0	0,0	2,2	0,6	0,1
Ch suffruticose	22,5	25,6	20,4	17,4	18,2	15,4
Ch succulent	0,0	0,0	0,0	4,3	2,4	0,6
Ch reptant	2,5	3,8	1,5	4,3	5,3	4,1
Ch pulvinate	2,5	0,8	0,1	4,3	5,3	3,2
T scapose	2,5	0,8	0,1	2,2	1,2	0,1
G rhizomatose	5,0	5,3	6,5	4,3	1,2	1,6

ly sloping stretch connecting the lower part of the slope to the bottom of the karst basins *Helianthemo-Festucetum italicae* can be found. In similar environmental conditions to these, communities belonging to the meso-hygrophilous fringe of *Thlaspietea rotundifolii* (e.g. *Carici-Salicetum retusae*), floristically richer and less fragmented in structure, also occur. *Nardetea strictae* communities (*Gnaphalio-Plantaginetum atratae*, *Taraxaco-Trifolietum thalii*) are rare and only found in dolinas.

Investigated taxa

Adonis distorta is a steno-endemic species defined as »italic tertiary relic« (MONTELLUCCI 1971). Its distribution area, restricted to the limestone massifs of the Central Apennines such as Majella, Gran Sasso, Sirente, Vettore (Sibillini mountains), Velino and Monti della Duchessa, has its southern limit at Mount Morrone in the southern Abruzzo administrative region (TENORE and GUSSONE 1842, DEL GROSSO and POGLIANI 1971, TAMMARO 1971, FRATTAROLI and FRIZZI 1988, TAMMARO 2000) (Fig. 3A).

The relatively more widespread *Trifolium noricum* subsp. p*raetutianum* is found in an area ranging from the Sibillini Mountains (Umbria administrative region) to the Matese massif (Campania administrative region) (Fig. 3B). Compared to *Adonis distorta*, which is a strictly basiphilous species, *Trifolium noricum* subsp. *praetutianum* is edaphically less demanding, and can also grow on acid and subacid soils (MAURI et al. 1830, FALQUI 1898, LUCCHESE and DE SIMONE 2000, TAMMARO 2000).

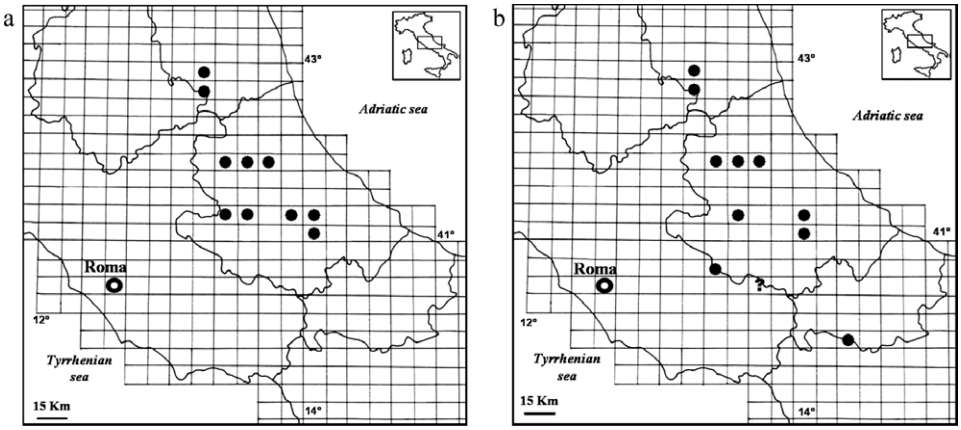

Fig. 3. Updated distribution map of *Adonis distorta* (A) and *Trifolium noricum* subsp. *praetutianum* (B). The distribution maps were drawn up using the topographic map of Italy (UTM system) of the Italian Geographic and Military Institute, superimposed by a grid of square elements at the scale of 1:50.000 with dimensions of 20' in longitude and 12' in latitude.

Materials and methods

The field work was carried out during 2002–2003, with the establishment of 15 vegetation relevés using the Braun-Blanquet phytosociological approach (BRAUN-BLANQUET 1964). Synoptic tables were also compiled in order to verify the coenological and syntaxonomical autonomy of the plant communities identified in this paper.

Nomenclature of the species follows CONTI et al. (2005), while phytosociological nomenclature follows the rules of ICPN (WEBER et al. 2000). Chorological elements and life forms were drawn from PIGNATTI (1982). In order to obtain more complete information

Tab. 2. Chorotypes spectrum calculated: on the percentage of species belonging to the different chorotypes in the phytosociological tables 3 and 4 (n); weighted, based on the frequency of the different chorotypes (f); weighted, based on the specific cover index (i.r.s.) of the different chorotypes (c).

chorotypes	*Ranunculo-Adonitetum*			*Helianthemo-Festuc. trifolietosum*		
	n %	f %	c %	n %	f %	c %
Endem. Central Apennines	17,5	21,1	38,1	8,7	7,6	2,8
Endem. Centr.-South. Apennines	7,5	7,5	3,5	10,9	15,9	36,5
Endemic Italian	10	6,0	1,1	10,9	11,2	5,2
SE-European Orophytes s.l.	17,5	23,3	25,0	17,4	17,6	16,6
European Orophytes	22,5	20,3	17,2	30,4	22,9	13,3
Mediterranean-Montane	7,5	7,5	6,5	2,2	2,9	0,9
Euroasiatic	7,5	6,8	4,8	10,9	12,9	15,2
Circumboreal and Artic-Alpine	7,5	6,8	3,7	8,7	8,8	9,5
Cosmopolite	2,5	0,8	0,1	0,0	0,0	0,0

about the structure and chorology of the plant communities we analysed the percentages of the different life forms and chorotypes in the phytosociological tables (normal spectrum »n«), the frequency of occurrence in the phytosociological tables (frequency spectrum, »f«), and the specific cover index of each chorotype in the phytosociological tables (I.R.S. spectrum). The specific cover index (I.R.S.) for each species makes reference to BRAUN-BLANQUET (1964); it is the ratio (multiplied by 100) between the sum of the medium value of the Braun-Blanquet dominance-abundance index (e.g. 5 = 87,5, 4 = 62,5...) and the number of relevés in the phytosociological table. In the synoptic tables the frequency percentages of the species in the original phytosociological tables (see caption of Tab. 5 and 6) are reported. The synoptic tables report the syntaxonomical scheme according to BLASI et al. (2003, 2005) (Tabs. 8, 9).

Results

Ranunculo seguierii-Adonidetum distortae ass. nov. hoc loco
(Holotypus Tab. 3, rel. 3)

The plant community dominated by *Adonis distorta* and *Ranunculus segueri* subsp. *seguieri* grows in the form of scattered stands of limited extent (about 50 m^2), usually located on very gentle slopes (from 0° to 7°), where the substrate consists of a continuous layer of calcareous detritus made up of small-sized (2–5 cm) pebbles (Fig. 4A). The slight slope of the ground causes rain and snow melt-water to flow slowly towards the nearest

Fig. 4. Physiognomical expression of *Ranunculo-Adonidetum distortae* in the alpine belt of Majella (A), and *Helianthemo-Festucetum italicae typicum* (Ba) with *Helianthemo-Festucetum trifolietosum* (Bb).

karstic swallow-hole, in the process creating alternating strips of detritus (white colored) and fine soil particles (dark colored). These are the so-called »striped soils« which are fairly common in the flattish areas of the eastern part of the Majella massif (SACCO 1908, SEGRE 1947).

The main physiognomic role in the community is played by *Adonis distorta* (specific cover index = 3300), but *Leontodon montanus* subsp. *montanus*, *Ranunculus seguieri* subsp. *seguieri* and *Cerastium thomasii* are found frequently and in abundance as well (Fig. 4A).

In the present paper we propose a new association which belongs to the endemic Apennine alliance *Linario-Festucion dimorphae* (*Thlaspietea rotundifolii*), to be named *Ranunculo seguierii-Adonidetum distortae*. Character species of this community are *Adonis distorta*, *Ranunculus seguieri* and *Crepis bithynica*. The choice of this specific character component follows a biogeographical criterion. In fact, these species are not exclusive to the Majella massif (the species occurs also in Gran Sasso massif). However *Crepis bithynica* exhibits the highest frequency and abundance in the Majella massif, in the association *Ranunculo-Adonidetum*. From the spatial-pattern point of view, *Ranunculo-Adonidetum* comes into contact with pioneer vegetation types such as *Crepidi-Leontodontetum* (unstable screes), and *Galio-Silenetum acaulis* (dwarf cushions of alpine tundra). Where the clayey component of the soil is higher, *Ranunculo-Adonidetum* comes into spatial contact with *Helianthemo-Festucetum italicae* (*Elyno-Seslerietea*).

Helianthemo alpestris-Festucetum italicae trifolietosum praetutiani
subass. *nova hoc loco* (Holotypus Tab. 4, rel. 12)

The communities of *Trifolium noricum* subsp. *praetutianum* form thick, dark-green patches of limited extent (about 50 square metres) within the wider areas occupied by *Helianthemo alpestris-Festucetum italicae* (Fig. 4B), which is an association described for the karst-tectonic basins of lower altitude of the Majella massif but which can also be found at higher altitudes. The occurrence and the dominance of *Trifolium noricum* subsp. *praetutianum* in the range of the *Helianthemo-Festucetum alpestris* communities appear to be linked to slight variations in the edaphic and micro-geomorphological features of the substrates. It is found where the slope of the ground is less steep (about 5–10° C) and the upper soil layer is deeper and richer in fine material, with a consequent reduction in its basicity. In an environment such as this, *Trifolium noricum* subsp. *praetutianum* is very competitive, forming its typical continuous carpets among surrounding vegetation types having a lower degree of cover, and thus reducing the possibilities of growth for other plants (Fig. 4B). Thermal factors would appear to play a role, too, since *Trifolium noricum* subsp. *praetutianum* communties are much more widespread on the warmer slopes of the massif, being found more frequently in those areas subject to the mitigating influence of the Adriatic Sea breezes, on the eastern slopes, and the mostly south-facing plateaus of Majella higher zones (STANISCI et al. 2005). On the other hand, on the north facing slopes or where the microclimatic conditions are too cold, *Trifolium noricum* subsp. *praetutianum* stands are never found. In fact, the ecological optimum of *Trifolium noricum* subsp. *praetutianum* occurs at altitudes lower than those recorded in the present study. For this reason the *Trifolium noricum* subsp. *praetutianum* grassland type we found on the Majella alpine belt is considered to be a sub-association (edapho-mesophilous) of the association *Helian-*

Tab. 3. New association of *Ranunculo seguierii-Adonidetum distortae.* Place and date of the relevés: Rel. 1: Taranta Peligna valley, 5/8/2003, 42° 3' 49,8''N 14° 6' 40'' E; Rel. 2-3-6-7-8 : Piano Amaro, 9/8/2003, 42°4'23,1''N 14°6'40,4''E (rel.2), 42°4'22,8''N 14°6'48,7''E (rel.3), 42°4'30,5''N 14°6'29,3''E (rel.6), 42°4'52''N 14°7'4,4''E (rel.7), 42°4'35,3''N 14°6'45,1''E (rel.8); Rel. 4 : Piano Amaro-Sella Grotta Canosa, 6/8/2003, 42° 4' 29,7''N 14° 6' 34,3''E; Rel. 5 : Sella Grotta Canosa, 9/8/2003, 42°4'30,5''N 14°6'29,3''E.

	relevée no.	1	2	3	4	5	6	7	8		
	altitude m a. s. l. (x10)	243	255	256	255	255	255	252	254		
	aspect	W	W	N	W	SW	0	0	W		
	slope°	7	2	2	3,5	4	0	0	1		
	rochyness (% of stable rocks occurring in the relevé area)	0	0	0	0	0	0	0	0		
	detritus% (% of mobile detritus occurring in the relevé area)	100	95	100	100	100	100	100	100		
	area m2	60	50	50	70	100	16	20	20		
	cover %	55	55	45	60	60	45	45	45		
	number of species per relevée	19	27	23	14	16	14	9	11		
					Typ.						
	Char.species of *Ranunculo seguierii-Adonitetum distortae*									**freq.%**	**i.r.s.**
	Adonis distorta	3	3	3	3	3	2	3	2	100	3300
	Ranunculus seguieri subsp. *seguieri*	2	3	2	.	.	2	2	2	75	1600
	Crepis bithynica	.	+	+	+	.	.	.	.	38	38
	Char. species of *Thlaspienion stylosi*										
	Cerastium thomasii	1	2	2	3	2	1	2	+	100	1413
	Linaria alpina	.	.	.	+	.	+	1	1	50	50
	Thlaspi stylosum	.	.	1	1	1	.	.	.	38	38
	Viola magellensis	.	.	1	.	.	.	.	+	25	25
	Alyssum cuneifolium subsp. *cuneifolium*	.	+	.	.	.	.	.	+	25	25
	***Char. species of Linario-Festucion* (Al), *Thlaspietalia rotundifolii* (Or), *Thlaspietea rotundifolii* (Cl)**										
Cl	*Leontodon montanus* subsp. *montanus*	1	3	2	3	3	1	1	1	100	1700
Al	*Ranunculus brevifolius*	+	1	1	2	3	1	.	.	75	750
Or	*Arenaria grandiflora* subsp. *grandiflora*	2	1	1	.	+	2	.	2	75	713
Al	*Achillea barrelieri* subsp. *barrelieri*	+	1	1	1	2	+	.	.	75	288

Tab. 3. – continued

	relevée no.	1	2	3	4	5	6	7	8		
Al	*Galium magellense*	.	1	1	.	.	.	1	1	50	50
Or	*Iberis saxatilis* subsp. *saxatilis*	+	.	.	.	.	1	.	.	25	25
Al	*Valeriana saliunca*	.	+	+	.	.	.	.	.	25	25
Al	*Androsace vitaliana* subsp. *praetutiana*	.	.	+	.	.	.	+	.	25	25
Al	*Myosotis ambigens*	.	+	.	.	.	.	.	.	13	13
	***Seslerion apenninae* (Al), *Seslerietalia tenuifoliae* (Or), *Elyno-Seslerietea* (Cl)**										
Or	*Anthyllis vulneraria* subsp. *pulchella*	1	+	+	1	1	+	.	+	88	88
Cl	*Minuartia verna* subsp. v*erna*	+	+	1	+	1	+	.	.	75	75
Or	*Androsace villosa* subsp. *villosa*	+	+	1	.	.	1	.	1	63	63
Cl	*Potentilla crantzii* subsp. *crantzii*	.	+	+	.	.	.	+	.	38	38
Cl	*Draba aizoides* subsp. *aizoides*	+	1	1	.	.	.	.	.	38	38
Or	*Acinos alpinus* subsp. *alpinus*	.	+	+	.	+	.	.	.	38	38
Al	*Pedicularis elegans*	.	+	+	.	.	+	.	.	38	38
Cl	*Campanula scheuchzeri*	+	2	.	.	.	.	.	.	25	238
Or	*Edrajanthus graminifolius* subsp. *graminifolius*	+	.	+	.	.	.	.	.	25	25
Cl	*Silene acaulis* s.l.	+	.	.	.	.	.	.	.	13	13
Al	*Avenula praetutiana*	+	.	.	.	.	.	.	.	13	13
Al	*Gnaphalium hoppeanum* subsp. *magellense*	.	+	.	.	.	.	.	.	13	13
Or	*Armeria majellensis* s.l.	.	+	.	.	.	.	.	.	13	13
Cl	*Erigeron epiroticus*	.	+	.	.	.	.	.	.	13	13
Cl	*Sedum atratum* subsp. *atratum*	.	.	.	.	+	.	.	.	13	13
	Other species										
	Poa molinerii	1	.	1	1	2	.	+	.	63	275
	Poa alpina subsp. *alpina*	1	1	1	1	2	.	.	.	63	275
	Taraxacum apenninum (group)	.	+	.	+	1	.	.	.	38	38
	Leontodon hispidus	3	.	.	.	+	.	.	.	25	488
	Plantago atrata subsp. *atrata*	.	+	.	.	+	.	.	.	25	25
	Viola eugeniae subsp. *eugeniae*	.	+	.	.	.	.	.	.	13	13
	Botrychium lunaria	.	.	.	+	.	.	.	.	13	13
	Leontodon crispus subsp. *crispus*	.	.	.	.	.	+	.	.	13	13

Tab. 4. New subassociation of *Helianthemo alpestris-Festucetum italicae trifolietosum praetutiani*. Place and date of the relevés: Rel. 9-10-11-12 : Piano Amaro, 9/8/2003, 42°4'48'' N 14°5'56,6'' E (rel.9), 42°4'29,7'' N 14°6'55,2'' E (rel.10), 42°4'21,7'' N 14°7'1'' E (rel.11), 42°4'20,4'' N 14°6'52,2'' E (rel.12); Rel.13 slope S-E of the Macellaro Mt., 5/8/2003, 42°3'9'' N 14°6'29,4'' E; Rel. 14: Piano Amaro, 29/7/2003, 42°4'37,5'' N 14°7'4,7'' E; Rel. 15: Piano Amaro-Cima dell'Altare, 29/7/2003, 42°4'42,3'' N 14°7'4,4'' E.

	relevée no.	9	10	11	12	13	14	15		
	altitude m a.s.l. (x10)	260	255	253	256	253	255	254		
	aspect	ENE	E	ESE	E	E	N	NNE		
	slope°	9,5	3	5	6	17	7,5	8		
	rochyness (% of stable rocks occurring in the relevé area)	5	0	0	0	0	1	5		
	detritus% (% of mobile detritus occurring in the relevé area)	45	30	30	40	40	50	20		
	area sq. mt.	25	100	70	36	20	20	20		
	cover %	85	90	75	80	85	85	80		
	number of species per relevée	24	19	24	21	31	26	22		
	Char. species of *Helianthemo alpestris-Festucetum italicae*				**Typ.**				**freq.%**	**i.r.s**
	Helianthemum oelandicum subsp. *alpestre*	3	.	3	3	1	1	1	86	1843
	Festuca violacea subsp. *italica*	2	2	2	2	2	2	2	100	1800
	Poa molinerii	+	2	2	2	1	1	1	100	1000
	Leontopodium nivale	.	1	1	1	1	1	.	71	357
	Sempervivum arachnoideum	.	.	.	+	.	+	1	43	100
	trifolietosum praetutianii subass. nova									
	Trifolium noricum subsp. *praetutianum*	3	4	4	4	4	3	3	100	5229
	Char. species of *Leontopodio-Elynenion*									
	Potentilla crantzii subsp. c*rantzii*	2	1	2	2	1	1	1	100	1057
	Silene acaulis s.l.	+	1	1	2	1	.	1	86	557
	Oxytropis campestris	1	1	1	1	1	1	+	100	443
	Sedum atratum subsp. *atratum*	.	.	+	+	.	.	.	29	29
	Char. species of *Seslerion apenninae* (Al), *Seslerietalia tenuifoliae* (Or), *Elyno-Seslerietea* (Cl)									
Or	*Carex kitaibeliana* subsp. *kitaibeliana*	2	2	1	1	2	2	1	100	1243
Or	*Armeria majellensis* s.l.	2	2	1	1	2	1	1	100	1057
Cl	*Thymus praecox* subsp. *polytrichus*	2	1	1	.	2	1	1	86	800
Cl	*Minuartia verna* subsp. v*erna*	1	+	1	1	1	1	.	86	371
Or	*Anthyllis vulneraria* subsp. *pulchella*	2	.	.	+	2	1	.	57	600
Al	*Trinia dalechampii*	1	1	1	1	1	1	+	100	443

Tab. 4. – continued

	relevée no.	9	10	11	12	13	14	15		
Or	*Edrajanthus graminifolius* subsp. *graminifolius*	1	1	1	1	+	1	1	100	443
Cl	*Draba aizoides* subsp. *aizoides*	1	1	1	1	+	1	1	100	443
Al	*Pedicularis elegans*	+	.	1	1	.	.	1	57	229
Al	*Achillea barrelieri* subsp. *barrelieri*	+	.	.	+	+	+	.	57	57
Al	*Avenula praetutiana*	+	.	.	.	1	1	.	43	157
Or	*Androsace villosa* subsp. *villosa*	.	.	.	+	+	+	.	43	43
Cl	*Erigeron epiroticus*	+	.	.	.	+	.	.	29	29
Cl	*Gentiana verna* subsp. *verna*	.	+	.	.	+	.	.	29	29
Cl	*Campanula scheuchzeri*	1	.	.	.	.	.	.	14	71
Cl	*Bistorta vivipara*	2	.	.	.	.	.	.	14	257
Cl	*Phyteuma orbiculare*	.	.	.	.	2	.	.	14	257
Cl	*Astragalus depressus* subsp. *depressus*	.	.	.	.	.	+	.	14	14
Cl	*Acinos alpinus* subsp. *alpinus*	.	.	.	.	.	.	+	14	14
	Char. species of *Ranuncolo-Nardion* (Al), *Nardetalia* (Or), *Nardetea* (Cl)									
Al	*Viola eugeniae* subsp. *eugeniae*	1	+	.	.	1	+	.	57	171
Cl	*Hieracium pilosella*	1	.	+	.	+	.	.	43	100
Cl	*Plantago atrata* subsp. *atrata*	.	.	.	.	1	.	1	29	143
Cl	*Phleum alpinum* subsp. *rhaeticum*	.	.	+	.	.	.	.	14	14
	Char.species of *Linario-Festucion* (Al), *Thlaspietalia rotundifolii* (Or), *Thlaspietea rotundifolii* (Cl)									
Or	*Arenaria grandiflora* subsp. *grandiflora*	.	1	+	+	+	.	1	71	186
Al	*Myosotis ambigens*	.	+	1	.	+	1	+	71	186
Al	*Androsace vitaliana* subsp. *praetutiana*	.	.	1	.	.	1	+	43	157
Cl	*Saxifraga oppositifolia* subsp. *oppositifolia*	.	+	.	.	+	1	.	43	100
Al	*Cerastium thomasii*	.	.	.	.	.	+	1	29	86
Cl	*Salix retusa*	1	.	.	.	.	.	.	14	71
Al	*Artemisia umbelliformis* subsp. *eriantha*	.	.	+	.	.	.	.	14	14
Al	*Ranunculus brevifolius*	.	.	.	.	1	.	.	14	71
	Other species									
	Thesium parnassi	.	.	+	.	.	.	.	14	14
	Poa alpina subsp. *alpina*	.	.	.	.	1	.	.	14	71
	Cerastium arvense subsp. *strictum*	.	.	.	.	+	.	.	14	14
	Sedum acre	.	.	.	.	.	+	.	14	14
	Saxifraga adscendens subsp. *adscendens*	.	.	.	.	.	.	+	14	14

themo-Festucetum italicae, and it is codified here with the epithet »*trifolietosum praetutiani*« (subass. nova). This sub-association is included in the *Leontopodio-Elynenion* sub-alliance and the *Seslerion apenninae* alliance.

Structural and chorological analysis of the communities

The life form spectrum shows a marked dominance of Hemicryptophytes and, to a lesser degree, of Chamaephytes. The presence of Geophytes, on the other hand, is negligible, and Therophytes are only represented by *Sedum atratum* subsp. *atratum.* Phanerophytes are absent, and, in any case, at these altitudes could only be represented by isolated stations of *Pinus mugo* or *Juniperus communis* subsp. *nana* (Tab. 1). Among the hemicryptophytes the »scapose« growth form is dominant but also »rosulate« forms are also well represented. The chamaephyte life form is almost exclusively composed of suffruticose species (Ch suffr.). The Hemicryptophytes/Chamaephytes ratio is similar in the two communities identified, ranging between 2.1 and 3.2.

From a chorological point of view, the communities investigated present a strong endemic component, especially those restricted to the central Apennines and to the central-southern Apennines (Tab. 2). The high percentage of endemics is strictly connected to the highly fragmentary character of the alpine bioclimatic belt in the Apennines, which has led to species isolation and consequent interruption of genic flow.

The central Apennines endemic component is higher in *Ranunculo-Adonidetum* than in *Helianthemo-Festucetum trifolietosum*. This is due to the frequent and abundant presence, apart from *Adonis distorta*, of species such as *Cerastium thomasii, Galium magellense* and *Thlaspi stylosum,* whose development is favoured by the higher percentages of detritus in the substrate.

Helianthemo-Festucetum trifolietosum praetutiani shows a high percentage of the endemic central-south Apennines chorotype, whose values increase sharply when passing from the normal spectrum (11%) to the cover spectrum (36.5%) as a consequence of the coenological dominance of *Trifolium noricum* subsp. *Praetutianum* in the community.

Also important is the role of the south-European Orophytes species, which attain percentages of 16.6% for *Helianthemo-Festucetum trifolietosum* and 25% for *Ranunculo--Adonidetum.* Circumboreal and Arctic-Alpine species exhibit relatively low values, compared, that is, to what might be expected for the average altitude of the study area, ranging from just 3.7% to 9.5% of the cover spectrum.

Discussion

The presence of *Adonis distorta* has been recorded on various massifs (ANZALONE 1947, STEINBERG 1952, TAMMARO 1971), but it is only on the Majella and, to a lesser degree, on the Velino massif that its cover percentages are such as to make it a characteristic feature of the high altitude landscape. Indeed, its presence is only sporadic on the Gran Sasso, Vettore, and in the Abruzzo, Lazio and Molise National Park (TAMMARO 1971, BALLELLI 1999).

On the Majella massif *Adonis distorta* has been considered a differential species in a variant of *Crepidi-Leontodontetum montani* (FEOLI-CHIAPELLA and FEOLI 1977, FEOLI-CHIA-

PELLA 1983). On the Velino, on the other hand, AVENA and BLASI (1980) consider it a characteristic species of *Crepido-Isatidetum allionii* (nom. inv. Art. 2). On the basis of our observations, *Adonis distorta* tends to form its own communities, which have a precisely defined location within the micro-geosigmetum of the alpine belt of the Majella. These communities, in fact, grow only on those special forms of the detritus component which give rise to alternating strips of broad detritus and fine soil particles.

A preference for this kind of environment, however, does not prevent *Adonis distorta* from also playing a role of »differential species« within *Crepidi-Leontodontetum*, whose substrate scree-layer is steeper and less stable. Because of the heterogeneity of the original table of *Crepidi-Leontodontetum*, we indicate here the lectotypification of the association: Lectotypus hoc loco design. rel. 44 in Tab. 4 from FEOLI-CHIAPELLA and FEOLI (1977, page 34). The community *Crepidi-leontodontetum*, more than any other community of the high-altitude scree communities of the central Apennines, is most floristically similar to *Ranunculo-Adonidetum* (Tab. 5). This similarity is essentially due to the common presence of *Adonis distorta* (25% in *Crepidi-leontodontetum*) and to the high frequency and abundance of *Leontodon montanus*. Nevertheless, the ecological features of these two communities remain very different, and these differences are reflected, floristically, in the absence in *Crepidi-Leontodontetum* of the other two character species of *Ranunculo-Adonidetum* (*Crepis bithynica* and *Ranunculus seguieri*), as well as that of several other species which are frequent in *Ranunculo-Adonidetum,* such as *Arenaria grandiflora, Androsace villosa, Anthyllis vulneraria* subsp. *pulchella, Minuartia verna, Poa molinerii*). At the same time in *Crepido-Leontodontetum* there is a higher number of species such as *Crepis pygmaea, Arabis alpina, Cymbalaria pallida, Isatis apennina, Festuca dimorpha, Arenaria bertolonii* (etc.) which are more strictly linked to scree environments and which do not occur in *Ranunculo-Adonidetum*.

Concerning the phytosociological literature references on this argument, it is likely that the diagnosis of the *Isatis apennina* and *Adonis distorta* variant of *Crepidi-Leontodontetum* proposed in FEOLI-CHIAPELLA and FEOLI (1977) would also be suitable for representing the communities with *Adonis distorta* found on some scree environments of Mount Velino (AVENA and BLASI 1980) and described as *Crepidi-Isatidetum allionii*. At present, however, such a comparison cannot be performed, because in the paper of AVENA and BLASI (1980) there is no phytosociological table for *Crepidi-Isatidetum* stands. Moreover, *Crepidi--Isatidetum* is not mentioned at all in a further paper giving an overview of the entire flora and vegetation of Mount Velino (PETRICCIONE 1993).

In the past *Trifolium noricum* subsp. *praetutianum* was considered a characteristic species of the association *Carici-Salicetum retusae* found on the Gran Sasso (BIONDI et al. 1999) and a subassociation differential (PETRICCIONE and PERSIA 1995) of *Pedicularido--Seslerietum apenninae caricetosum ericetori*. Such attributions are in line with the ecology of this taxon which, although broadly linked to the dry grasslands of the subalpine belt, abounds only where the layer of soil is relatively deep and the degree of plant cover in the relevés ranges between 80 and 100%. From a syntaxonomical point of view neither *Carici-Salicetum* or *Pedicularido-Seslerietum* are suitable for use as references for the Majella *Trifolium noricum* subsp. *praetutianum* stands described in this paper, due, on the one hand, to the extremely sporadic presence of *Salix retusa* and, on the other hand, to the complete lack of *Sesleria juncifolia*. Instead, the similarities between the *Helianthemo-*

Tab. 5. Synoptic table including all the scree associations described at present for the alpine belt of the central Apennines. 1 – *Ranunculo seguirii-Adonidetum distortae* ass. nova; 2 – *Saxifrago--Papaveretum julici* from Feoli-Chiapella and Feoli, 1977; 3 – *Saxifrago-Papaveretum julici* from BLASI et al. (2005)*;* 4 – *Saxifrago-Papaveretum julici androsacetosum villosae* from BLASI et al. (2005); 5 – *Saxifrago speciosae-Silenetum cenisiae* from PETRICCIONE (1993); 6 – *Arabido alpinae-Cerastietum thomasii* from (BIONDI et al. 2000); 7 – *Crepido-Leontodontetum montanii* from FEOLI-CHIAPELLA and FEOLI (1983); 8 – *Isatido -Thlaspietum stylosi* from BIONDI et al. (2000); 9 – *Achilleo-Saxifragetum azoidis* from DI PIETRO et al. (2001).

column no.	1	7	2	3	4	5	6	8	9
average altitude m a.s.l. (x 10)	253	254	267	270	265	255	280	225	242
total number of relevés	8	16	14	6	8	8	9	10	10
Ranunculo-Adonidetum distortae									
Adonis distorta	100	25	.	.	.	.	.	.	.
Crepis bythinica	38	.	.	.	.	.	.	.	.
Ranunculus seguieri subsp. *seguieri*	75	.	7	.	13	.	.	.	.
char. spesies of *Crepido-Leontodontetum montani*									
Leontodon montanus subsp. *montanus*	100	81	43	17	63	75	.	30	10
Crepis pygmaea subsp. *pygmaea*	.	62	14	.	25	.	.	80	.
Senecio squalidus	.	50	.	.	.	.	.	60	10
char. spesies of *Saxifrago-Papaveretum julici*									
Papaver alpinum subsp. *ernersti-mayeri*	.	31	93	100	88	.	33	40	.
Arenaria grandiflora subsp. *grandiflora*	75	.	93	83	100	.	.	.	.
Androsace vitaliana subsp. *praetutiana*	25	12	79	67	88	50	.	.	.
Saxifraga exarata subsp. *ampullacea*	.	.	64	50	75	.	33	.	.
char. spesies of *Saxifrago speciosae-Silenetum cenisiae*									
Ranunculus brevifolius	75	6	.	.	.	87	.	20	.
Valeriana saliunca	25	.	50	.	88	50	.	.	.
Festuca alfrediana	.	.	.	.	.	87	33	.	80
Achillea barrelieri subsp. *barrelieri*	75	75	50	17	75	75	33	30	.
Potentilla crantzii subsp. *crantzii*	38	12	14	.	25	75	.	.	.
Veronica aphylla	.	.	.	.	.	50	.	10	.
char. spesies of *Arabido alpinae-Cerastietum thomasii*									
Cerastium thomasii	100	75	93	100	88	.	100	.	.
Hornungia alpina	.	.	.	.	.	.	77	10	.
Arabis alpina	.	50	14	33	.	.	100	20	.
Draba aspera	.	25	.	.	.	.	55	.	.
char. spesies of *Isatido-Thlaspietum stylosi*									
Isatis apennina	.	44	.	.	.	.	.	90	.
Thlaspi stylosum	38	37	.	.	.	.	.	10	.
char. spesies of *Achilleo-Saxifragetum azoidis*									
Acinos alpinus subsp. *alpinus*	38	13	.	.	.	.	.	.	100
Saxifraga aizoides	.	.	.	.	.	.	.	.	100
Achillea barrelieri subsp. *mucronulata*	.	.	.	.	.	.	.	.	100
Senecio scopolii	.	.	.	.	.	.	.	.	80

Tab. 5. – continued

column no.	1	7	2	3	4	5	6	8	9
average altitude m a.s.l. (x 10)	253	254	267	270	265	255	280	225	242
total number of relevés	8	16	14	6	8	8	9	10	10
char. spesies of *Linario-Festucion dimorphae*									
Galium magellense	50	37	86	83	88	.	44	50	100
Viola magellensis	25	37	71	83	63	.	11	.	.
Myosotis ambigens	13	75	79	100	63	.	.	.	.
Alyssum cuneifolium subsp. *cuneifolium*	25	37	71	100	50	.	.	.	.
Arenaria bertolonii	.	6	7	17	.	.	.	.	40
Artemisia umbelliformis subsp. *eriantha*	.	.	14	17	13	.	.	.	.
Festuca dimorpha	.	6	.	.	.	.	.	40	20
Doronicum columnae	.	18	.	.	.	.	.	30	.
Carduus chrysacanthus subsp. *chrysacanthus*	.	6	.	.	.	.	.	.	80
Robertia taraxacoides	.	.	.	.	.	.	.	20	80
Leucanthemum coronopifolium subsp. *tenuifolium*	.	6	.	.	.	.	.	.	.
Erysimum majellense	.	6	.	.	.	.	.	.	.
Cymbalaria pallida	.	6	.	.	.	.	.	.	.
Heracleum sphondylium subsp. *orsinii*	.	.	.	.	.	.	.	50	.
char. spesies *of Thlaspietalia rotundifolii* and *Thlaspietea rotundifolii*									
Saxifraga oppositifolia subsp. *oppositifolia*	.	31	86	67	100	87	44	10	80
Linaria alpina	50	62	64	67	63	.	.	30	.
Salix retusa	.	13	29	17	38	.	.	.	.
Iberis saxatilis subsp. *saxatilis*	25	.	29	.	50	.	.	.	.
Saxifraga paniculata	.	.	14	.	25	.	.	.	.
Scrophularia hoppii	.	6	.	.	.	.	.	20	.
Campanula cochlearifolia	.	.	.	.	.	.	11	.	.
Saxifraga caesia	.	.	.	.	.	.	11	.	.
Saxifraga sedoides subsp. *sedoides*	.	6	.	.	.	.	.	.	.
Bellidiastrum michelii	.	.	.	.	.	.	.	10	.
Rumex scutatus	.	.	.	.	.	.	.	20	.
char. spesies of *Seslerion apenninae* and *Seslerietalia tenuifoliae*									
Armeria majellensis	13	13	29	17	38	.	22	.	30
Edrajanthus graminifolius subsp. *graminifolius*	25	.	36	17	50	.	.	10	.
Carex kitaibeliana subsp. *kitaibeliana*	.	.	43	17	63	62	.	.	.
Andosace villosa subsp. *villosa*	63	.	71	33	100	.	.	.	.
Anthyllis vulneraria subsp. *pulchella*	88	.	36	.	63	.	.	.	10
Avenula praetutiana	13	6	7	.	13	.	.	.	.
Sesleria juncifolia subsp. *juncifolia*	.	.	14	.	25	.	.	.	20
Pedicularis elegans	38	.	7	.	13	.	.	.	.
Poa molinerii	63	.	7	.	13	.	.	.	.
Cerastium tomentosum	.	6	7	17	.	.	.	.	.
Leontopodium nivale	.	.	21	.	38	.	.	.	.
Festuca violacea subsp. *italica*	.	.	57	.	100	.	.	.	.
Trinia dalechampii	.	6	.	.	.	.	.	.	.

Tab. 5. – continued

column no.	1	7	2	3	4	5	6	8	9
average altitude m a.s.l. (x 10)	253	254	267	270	265	255	280	225	242
total number of relevés	8	16	14	6	8	8	9	10	10
char. spesies of *Elyno myosuroidis-Seslerietea caeruleae*									
Thymus praecox subsp. *polytrichus*	.	6	7	.	13	62	.	.	50
Erigeron epiroticus	13	19	21	.	38	.	.	.	.
Draba aizoides subsp. *aizoides*	38	.	21	.	38	.	.	10	.
Pulsatilla alpina subsp. *alpina*	.	.	7	.	13	62	.	10	.
Campanula scheuchzeri s.l.	25	.	7	.	13	.	.	.	10
Minuartia verna subsp. *verna*	75	.	29	.	50	.	.	.	.
Helianthemum oelandicum subsp *alpestre*	.	.	7	.	13	.	.	.	.
Gentiana verna subsp. *verna*	.	.	7	.	13	.	.	.	.
Asperula cynanchica	.	.	.	.	.	12	.	.	.
Phyteuma orbiculare	.	6	.	.	.	.	.	.	.
Carum flexuosum	.	6	.	.	.	.	.	.	.
Myosotis alpestris	.	.	.	.	.	.	.	20	.
Ranunculus pollinensis	.	.	.	.	.	.	.	10	.
Char. species of *Carici-Kobresietea*									
Silene acaulis s.l.	13	19	64	17	100	87	11	.	.
Sedum atratum subsp. *atratum*	13	13	21	17	25	.	.	20	10
Bistorta vivipara	.	.	43	17	63	.	.	.	.
Oxytropis campestris	.	.	14	.	25	.	.	.	.
Dryas octopetala subsp. *octopetala*	.	.	7	.	13	.	.	.	.
Carex capillaris subsp. *capillaris*	.	.	7	17	.	.	.	.	.
Oxytropis neglecta	.	.	.	.	.	12	.	.	.
Kobresia myosuroides	.	6	.	.	.	.	.	.	.
Anemone narcissiflora subsp. *narcissiflora*	.	.	.	.	.	.	.	10	.
Other species									
Poa alpina subsp. *alpina*	63	87	57	67	50	.	100	20	90
Taraxacum apenninum (group)	38	13	7	.	13	.	.	.	10
Helianthemum nummularium subsp. *obscurum*	.	.	7	.	13	.	.	.	.
Euphrasia salisburgensis	.	.	7	.	13	25	.	.	.
Leontodon hispidus	25	.	7	.	13	.	.	.	.

Percentages of the sporadic species not included in the table. col. 1: *Botrychium* lunaria (13); *Plantago atrata* subsp. *atrata* (25); *Viola eugeniae* subsp. *eugeniae* (13); *Gnaphalium hoppeanum* subsp. *magellense* (13); *Leontodon crispus* subsp. *crispus* (13); **col. 2:** *Campanula tanfanii* (21); **col. 4:** *Campanula tanfanii* (38); **col. 7:** *Festuca* gr. a*lpina* (13); *Saxifraga glabella* (6); *Sedum magellense* subsp. *magellense,* (6; *Hypochaeris cretesi,s,* 12; *Alyssum montanum* subsp. *montanum,* 6; *Alchemilla alpina* (6); *Saxifraga adscendens* subsp. *parnassica* (6); *Cerastium arvense* subsp. *strictum* (19); **col. 8:** *Festuca circumediterranea* (10); *Valeriana montana* (10); *Rumex nebroides* (20); *Cerastium arvense* subsp. *strictum* (20); **col. 9:** *Trifolium thalii* (10); *Crepis aurea* subsp. g*labrescens* (40); *Valeriana montana* (10); *Cerastium arvense* subsp. s*uffruticosum* (?)

-Festucetum trifolietosum praetutiani (described in this paper) and the *Helianthemetum alpestris* described about forty years ago in this same area (MIGLIACCIO 1970) are quite evident. Both communities are physiognomically dominated by *Helianthemum oelandicum* subsp. *alpestre* and *Trifolium noricum* subsp. *praetutianum*. Nonetheless, the original description of *Helianthemetum alpestris* indicated that this association was the most widespread within the entire Majella alpine belt, whereas in reality *Trifolium noricum* subsp. *praetutianum* is not at all ubiquitous within this belt, its presence being rather sporadic (even if it tends to be accompanied by high cover indexes where it does occur). In ecological terms *Trifolium noricum* subsp. *praetutianum* is strongly linked to the microdepressions in the substrate on flattish slopes. It would therefore appear more consistent to consider *Trifolium noricum* subsp. *praetutianum* grasslands as a peculiar subassociation of the more widespread *Helianthemo-Festucetum*, rather than to generalize and describe *Trifolium noricum* subsp. *praetutianum* as dominant throughout the Majella alpine belt (as was done for *Helianthemetum alpestris*).

Doubts concerning the nomenclatural validity of *Helianthemetum alpestris* have already been expressed by BLASI et al. (2003, 2005). Indeed, strict observance of ICPN rules (Art. 7) leads us to regard this name as invalid. Thus we have chosen to keep *Helianthemo-Festucetum* as the reference association, and to consider only the subassociation *trifolietosum praetutianii* as a syntaxonomical synonym of the invalid *Helianthemetum alpestris* of MIGLIACCIO (1970). The original diagnosis of *Helianthemetum alpestris* contains only one synoptic column, which is incomplete because it lacks the entire component of companion species. Furthermore this name has not been validated by other authors in further publications.

Given the dominant physiognomical role of *Trifolium noricum* subsp. *praetutianum* in this new subassociation, and its almost complete absence from the *Helianthemo-Festucetum* typicum (Tab. 6), we have decided that *Trifolium noricum* subsp. *praetutianum* could be used as a differential at sub-association level only.

As for the higher rank syntaxa, *Adonis distorta* can be considered a good characteristic species of *Thlaspienion stylosi*, the microthermic high altitude sub-alliance of the Apennine endemic alliance *Linario-Festucion dimorphae*. Therefore we have included *Ranunculo-Adonidetum* in *Thlaspietea rotundifolii* class and *Thlaspietalia rotundifolii* order. Instead the best position for *Helianthemo-Festucetum trifolietosum praetutiani* is *Seslerion apenninae*, where it is representative of the edapho-mesophilous fringe of this alliance. *Trifolium noricum* subsp. *praetutianum* can nonetheless be present as »ingressive species« in communities belonging to *Arabidion caeruleae* or *Ranunculo-Nardion.*

In some cases the H/Ch ratio has been used as a discriminating criterion in distinguishing the scree communities of *Thlaspietea rotundifolii* (which show a notable presence of Chamaephytes) from the dry grasslands of *Elyno-Seslerietea* (where Hemicryptophytes are more clearly dominant) (BLASI et al. 2005). For the communities in issue, while the inclusion of *Trifolium noricum* subsp. *praetituanum* stands in *Elyno-Seslerietea* is implicit, the inclusion of *Ranunculo-Adonidetum* in *Thlaspietea* is not, because of the high percentages of Hemycryptophytes. It is likely, therefore, that the high H/Ch ratio of *Ranunculo-Adonidetum* is a consequence of the relative flatness of the ground, which has prevented the finer part of the stony substrate from being washed away and has therefore favoured the development of various Hemicryptophytes.

Tab. 6. Synoptic table including all the plant communities occurring in the alpine and subalpine belts of the central Apennines which exhibit floristic similarities with *Helianthemo-Festucetum trifolietosum praetutiani.* 1: *Helianthemo alpestris-Festucetum italicae* from BLASI et al. 2005; *Helianthemo alpestris -Festucetum italicae trifolietosum praetutiani* subass. nova (2); *Plantago atrata* and *Leontodon montanus* comm. from BLASI et al. 2005 (3); *Luzulo italicae-Festucetum macratherae,* from PETRICCIONE and PERSIA (1995)(4); *Caricetum kitaibelianae* from MIGLIACCO (1970) (in the original table of MIGLIACCIO (1970), only the frequency classes were given)(5); *Leontopodio nivalis-Seslerietum juncifoliae* from BLASI et al. (2005)(6); *Pedicularido-Seslerietum(caricetosum ericetorii)* from PETRICCIONE and PERSIA (1995) (7).

column no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
average altitude m a.s.l. (x 10)	238	255	248	221	200	240	234
total numbers of relevés	13	7	9	18	20	13	20
char. species of *Helianthemo alpestris-Festucetum italicae*							
Festuca violacea subsp. *italica*	100	100	67	94	V	77	25
Leontopodium nivale	100	71	11	.	.	100	.
Helianthemum oelandicum subsp *alpestre*	92	86	.	6	.	85	95
Sempervivum arachnoideum	85	43	.	.	.	85	.
Poa molinerii	62	100	11	.	.	62	.
char. species of *Helianthemo alpestris-Festucetum italicae trifolietosum praetutiani*							
Trifolium noricum subsp. *praetutianum*	.	100	.	.	.	.	8
char. species of *Plantago atrata and Leontodon montanus* comm.							
Leontodon montanus subsp. *montanus*	8	.	100	.	.	.	.
Achillea barrelieri subsp. *barrelieri*	15	57	89	.	.	.	5
Ranunculus brevifolius	23	14	78	.	.	.	.
char. species of *Luzulo italicae-Festucetum macratherae*							
Luzula spicata subsp. *italica*	8	.	.	89	IV	.	20
Plantago atrata subsp.*atrata*	15	29	89	94	V	8	15
char. species of *Caricetum kitaibelianae*							
Polygala alpestris	15	.	.	72	V	8	10
Potentilla crantzii subsp.*crantzii*	62	100	78	.	V	38	.
Phyteuma orbiculare	15	14	.	11	IV	.	45
Hypericum richeri subsp. *richeri*	.	.	.	.	IV	.	.
Trifolium montanum subsp. *montanum*	.	.	.	.	III	.	.
Erigeron epiroticus	62	29	11	72	III	46	35
Saxifraga adscendens subsp. *adscendens*	15	14	11	28	III	31	.
Alchemilla colorata	.	.	.	.	I	.	.
char. species of *Leontopodio-Seslerietum juncifoliae*							
Sesleria juncifolia subsp. *junicifolia*	54	.	.	6	.	100	95
Carex humilis	.	.	.	.	.	77	.
Aster alpinus subsp. *alpinus*	46	.	.	.	.	80	55
Ranunculus breyninus	46	.	.	.	.	85	65
char. species of *Pedicularido-Seslerietum caricetosum ericetori*							
Pedicularis elegans	54	57	44	6	.	92	75
Carex ericetorum	.	.	.	17	.	.	65
char. species of *Seslerion apenninae* and *Seslerietalia tenuifoliae*							
Carex kitaibeliana subsp. *kitaibeliana*	100	100	67	78	.	85	95
Anthyllis vulneraria subsp. *pulchella*	100	57	67	.	V	92	.
Trinia dalechampii	85	100	56	61	.	85	75

Tab. 6. – continued

column no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
average altitude m a.s.l. (x 10)	238	255	248	221	200	240	234
total numbers of relevés	13	7	9	18	20	13	20
Andosace villosa subsp. *villosa*	85	43	33	.	.	54	40
Edrajanthus graminifolius subsp. *graminifolius*	62	100	33	11	.	92	80
Armeria majellensis s.l.	69	100	89	83	.	46	80
Avenula praetutiana	85	43	11	44	.	69	.
Carduus carlinifolius subsp. *carlinifolius*	.	.	.	33	.	.	.
Cerastium tomentosum	.	.	.	47	.	.	.
Astrantia pauciflora subsp. *tenorei*	.	.	.	.	.	.	30
Cynoglossum magellense	.	.	.	.	.	.	5
char. species of *Elyno myosuroidis-Seslerietea caeruleae*							
Minuartia verna subsp. *verna*	85	86	89	61	V	69	85
Acinos alpinus subsp. *alpinus*	.	14	56	11	I	.	5
Campanula scheuchzeri	31	14	44	61	.	8	15
Thymus praecox subsp. *polytrichus*	85	86	44	83	.	46	90
Draba aizoides subsp.*aizoides*	85	100	44	.	V	85	.
Gentiana verna subsp.*verna*	46	29	33	61	II	31	55
Pulsatilla alpina subsp. *alpina*	85	.	22	22	.	31	30
Juncus trifidus subsp. *monanthos*	.	.	.	6	I	23	30
Thesium parnassi	.	14	.	6	.	8	.
Astragalus depressus subsp. *depressus*	.	14	11	.	.	.	.
Festuca laevigata subsp. *crassifolia*	.	.	.	6	.	8	.
Asperula cynanchica	.	.	.	6	.	.	15
Anthyllis vulneraria subsp. *nana*	.	.	.	33	.	.	75
Galium anisophyllon	.	.	.	28	.	.	45
Linum alpinum	.	.	.	.	.	.	5
char. species of *Carici-Kobresietea*							
Sedum atratum subsp. *atratum*	31	29	78	.	.	.	30
Silene acaulis s. l.	77	86	67	39	.	69	65
Oxytropis campestris	77	100	.	6	.	85	55
Bistorta vivipara	8	14	.	11	.	8	50
Kobresia myosuroides	.	.	.	17	.	15	45
Oxytropis neglecta	8	.	.	.	.	.	.
Gentiana nivalis	.	.	.	.	II	.	.
Dryas octopetala subsp. *octopetala*	.	.	.	.	.	15	.
Anemone narcissiflora subsp. *narcissiflora*	.	.	.	.	.	.	15
char. species of *Linario-Festucion dimorphae, Thlaspietalia rotundifolii, Thlaspietea rotundifolii*							
Myosotis ambigens	23	71	44	61	.	23	45
Saxifraga oppositifolia subsp. *oppositifolia*	8	43	22	6	.	23	15
Saxifraga paniculata	69	.	.	6	.	85	55
Salix retusa	15	14	.	.	.	3	15
Arenaria grandiflora subsp. *grandiflora*	8	71	.	.	.	31	5
Galium magellense	.	.	44	6	.	8	.
Thlaspi stylosum	8	.	33	.	.	.	.
Cerastium thomasii	.	29	78	.	.	.	.
Iberis saxatilis subsp. *saxatilis*	23	.	.	.	.	92	.
Valeriana saliunca	8	.	.	.	.	15	.
Androsace vitaliana subsp. *praetutiana*	.	43	.	.	.	.	5
Artemisia umbelliformis subsp. *eriantha*	.	14	.	.	.	.	5

Tab. 6. – continued

column no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
average altitude m a.s.l. (x 10)	238	255	248	221	200	240	234
total numbers of relevés	13	7	9	18	20	13	20
Ranunculus magellensis	.	.	22	.	.	.	.
Carduus chrysacanthus subsp. *chrysacanthus*	.	.	22	.	.	.	.
Stachys alopecuros	.	.	.	6	.	.	.
Bellidiastrum michelii	.	.	.	6	.	.	.
Alyssum diffusum	.	.	.	6	.	.	.
Erysimum majellense	.	.	.	.	.	.	5
Saxifraga caesia	.	.	.	.	.	.	10
char. species of *Ranunculo Nardion, Nardetalia strictae Nardetea strictae*							
Viola eugeniae subsp. *eugeniae*	31	57	67	72	.	15	20
Gentianella columnae	.	.	.	17	.	8	20
Hieracium pilosella	.	43	67	17	.	.	.
Ranunculus pollinensis	.	.	56	83	IV	.	.
Botrychium lunaria	.	.	.	61	III	.	25
Gentiana lutea subsp. *lutea*	.	.	.	6	.	.	5
Luzula multiflora	.	.	.	28	.	.	5
Rumex nebroides	.	.	.	22	.	.	15
Leucanthemum tridactylites	62	.	.	.	.	.	.
Crepis aurea subsp. *glabrescens*	.	.	11	.	.	.	.
Alchemilla glaucescens	.	.	.	87	.	.	.
Nardus stricta	.	.	.	22	.	.	.
Coeloglossum viride	.	.	.	.	.	.	25
Other species							
Poa alpina subsp. *alpina*	46	14	100	100	.	54	80
Hieracium lactucella	31	.	.	83	IV	8	25
Trifolium pratense subsp. *semipurpureum*	23	.	11	61	.	.	20
Cerastium arvense subsp. *strictum*	.	14	.	83	.	.	50
Gnaphalium hoppeanum subsp. *magellense*	62	.	100	44	.	.	5
Euphrasia salisburgensis	8	.	.	22	III	23	30
Trifolium thalii	23	.	11	.	II	.	.
Cerastium arvense subsp. *suffruticosum*	69	.	.	.	IV	62	.

Percentages of the sporadic species not included in the table. Col. 1: *Pinus mugo* subsp. *mugo*(8); **Col. 2:** *Phleum alpinum* subsp. *rhaeticum* (14); *Sedum acre* (14); **Col. 3:** *Taraxacum apenninum* (33); *Taraxacum glaciale* (11); *Leontodon crispus* subsp. *crispus* (11); **Col. 4:** *Dianthus sylvestris* s.l. (6); *Festuca circumeditteranea* (11); *Potentilla rigoana* (89); *Koeleria lobata* (11); *Rhinantus wettsteinii* (11); *Brachypodium genuense* (6); *Juniperus communis* (6); *Scabiosa holosericea* (6); *Silene ciliata* subsp. *graefferi* (44); **Col. 5:** *Phleum alpinum* subsp. *rhaeticum,* I; *Sagina saginoides* subsp. *saginoides*, I; *Carduus defloratus* subsp. *tridentinus*, III; *Crepis lucida*, I; *Helianthemum nummularium* subsp. *obscurum*, IV; **Col. 6:** *Helianthemum nummularium* subsp. *obscurum* (8); *Pinus mugo* subsp. *mugo* (8); *Potentilla apennina* subsp. *apennina* (8); *Anthyllis montana* subsp *atropurpurea* (15); **Col. 7:** *Anthyllis montana* subsp *atropurpurea* (35); *Scabiosa holosericea* (25); *Juniperus communis* (20); *Potentilla rigoana* (30); *Festuca circumeditteranea* (50); *Dianthus sylvestris* s.l. (55); *Sedum acre* (5); *Astragalus sempervirens* (10); *Biscutella levigata subsp. levigata* (5); *Cyanus triumfetti* (10); *Hieracium amplexicaule* (25); *Linum capitatum* subsp. *serrulatum* (10); *Senecio doronicum* (10); *Gentiana dinarica* (5); *Globularia meridionalis* (5); *Pedicularis comosa* subsp. *comosa* (15)

As is the case with the majority of dry grassland communities of the subalpine and alpine belts of the central Apennines (BRUNO and FURNARI 1966, LAKUŠIĆ 1969, PETRICCIONE and PERSIA 1995, BLASI et al. 2003), *Helianthemo-Festucetum italicae trifolietosum praetutiani* and *Ranunculo-Adonidetum distortae*, too, exhibit strong floristic similarities with the parallel communities occurring in the high-altitude zones of the Balkan peninsula (*Carex kitaibeliana, Edrajanthus graminifolius, Thesium parnassi, Anthyllis vulneraria* subsp. *pulchella*).

The biogeographical links existing between the Central Apennines and the Balkans (RIVAS-MARTÍNEZ et al., 2001) are confirmed by the chorological spectra, which clearly show a higher number of Orophilous south-European species than Circumboreal and Arctic-Alpine species. This is probably a consequence of the last ice age (20.000–18.000 years ago) when the Majella, unlike the other massifs of large dimensions of the Apennines, was covered by an Icelandic-type glacier of about 30 square kilometres (GIRAUDI 1998). This thick ice cap, together with the gentle and regular shape of the massif, are likely to have prevented nunataks from emerging, or to have at least limited their presence. This, in turn, would have deprived microthermal species native to cold regions of their refuge, and in this way hindered their re-colonization of the area during the subsequent interglacial period (CATONICA and MANZI 2002).

A summary of the syntaxa identified so far in the alpine belt of the Majella can be found in table 7. Due to endemism of *Adonis distorta* and *Trifolium noricum* subsp. *Pratetutianum* in the Apennines, there are no associations physiognomically similar to those occurring in the Majella massif on the other side of the Adriatic sea. As far as the high-rank syntaxa are concerned, the Balkan communities that substitute *Helianthemo-Festucetum italicae trifolietosum preatutiani* are likely to be included in orders such as *Seslerietalia tenuifoliae* (*Seslerion juncifoliae*) or *Crepidetalia dinaricae* (*Oxitropidion dinaricae*). At association level *Helianthemo-Festucetum italicae* is most closely related to *Carici kitai-*

Tab. 7. Summary of the alpine belt vegetation of the Majella massif.

Crepidi pygmaeae-Leontodontetum montani	Vegetation of the unstable talus slopes
Galio – Silenetum acaulis alyssetosum cuneifolii *Carici kitaibelianae – Salicetum retusae* *Carici kitaibelianae – Salicetum retusae elynetosum*	Vegetation of the stable scree and relatively steep slopes
Saxifrago speciosae – Papaveretum julici *Saxifrago – Papaveretum julici androsacetosum villosae*	Vegetation of the stable scree on mild slopes of the very summit areas
Ranunculo seguierii-Adonidetum distortae	Vegetation of the unstable scree on mild slopes and »soil with stripes«
Plantago atrata and *Leontodon montanus* comm. *Helianthemo alpestris – Festucetum italicae* *Helianthemo– Festucetum italicae trifolietosum praetutiani*	Vegetation of the mild and stable gravelly substrates
Leontopodio nivalis – Elynetum myosuroidis *Saxifrago speciosae – Papaveretum julici typicum* *Leontopodio nivalis – Seslerietum juncifoliae*	Vegetation of the windy ridges and steeper slopes
Gnaphalio magellensis – Plantaginetum atratae *Taraxaco apennini – Trifolietum thalii gnaphalietosum* *Luzulo italicae – Nardetum strictae*	Vegetation of snowbeds and dolinas

Tab. 8. Syntaxonomical scheme.

ELYNO-SESLERIETEA Br.-Bl. 1948
Seslerietalia tenuifoliae Horvat 1930
Seslerion apenninae Furnari *in* Bruno et Furnari 1966
Leontopodio nivalis-Elynenion myosuroidis Blasi et Di Pietro *in* Blasi, Di Pietro, Fortini et Catonica 2003
Helianthemo alpestris-Festucetum italicae Blasi, Di Pietro et Pelino 2005
Helianthemo alpestris-Festucetum italicae trifolietosum praetutiani Di Pietro, Pelino, Stanisci & Blasi subass. nova hoc loco
THLASPIETEA ROTUNDIFOLII Br.-Bl. 1948
Thlaspietalia rotundifolii Br.-Bl. *in* Br.-Bl. et Jenny 1926
Linario-Festucion dimorphae Avena et Bruno 1975
Thlaspienion stylosi Avena et Bruno 1975
Ranunculo seguierii-Adonidetum distortae Di Pietro, Pelino, Stanisci et Blasi ass. nova hoc loco

Tab. 9. Complete list of the syntaxa quoted in the text and in the synoptic tables.

Achilleo mucronulatae-Saxifragetum aizoidis Di Pietro, Conti, Vannicelli-Casoni 2001;

Arabido alpinae-Cerastietum thomasii Biondi, Ballelli, Allegrezza et Taffetani 2000;

Arabidion caeruleae Br.-Bl. in Br.-Bl. et Jenny 1926;

Bunion alpini Lakušič (1968) 1970;

Caricetum kitaibelianae Migliaccio 1970;

Carici-Crepidetum dinaricae trifolietosum norici Lakušič 1964;

Carici kitaibelianae-Helianthemetum alpestris Horvat 1930 (= *Laevi-Helianthemetum alpestris*);

Carici rupestris-Kobresietea bellardii Ohba 1974;

Edrajantho-Helianthemetum alpestris Horvat 1935;

Carici kitaibelianae-Salicetum retusae Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian et Zuccarello 1999;

Carici kitaibelianae-Salicetum retusae elynetosum Blasi, Di Pietro, Fortini et Catonica 2003;

Crepidetalia dinaricae Lakušič 1966;

Crepidi-Leontodontetum montani Feoli-Chiapella et Feoli 1977;

Elyno myosuroidis-Seslerietea caeruleae Br.-Bl. 1948;

Galio magellensis-Silenetum acaulis Blasi, Di Pietro, Fortini et Catonica 2003;

Helianthemetum alpestris Migliaccio 1970;

Helianthemo alpestris-Festucetum italicae Blasi, Di Pietro et Pelino 2005;

Gnaphalio magellensis-Plantaginetum atratae Feoli-Chiapella et Feoli 1977;

Leontodontetum montani Feoli Chiapella et Feoli 1977;

Isatido-Thlaspietum stylosi Migliaccio 1970 corr. Feoli-Chiapella 1983;

Luzulo italicae-Festucetum macratherae (*violaceae*) Bonin 1978;

Luzulo italicae-Nardetum strictae Biondi, Ballelli, Allegrezza, Frattaroli et Taffetani 1992;

Leontopodio nivalis-Elynenion myosuroidis Blasi et Di Pietro *in* Blasi, Di Pietro, Fortini et Catonica 2003;

Leontopodio nivalis-Seslerietum juncifoliae Blasi, Di Pietro et Pelino 2005;

Tab. 9. – continued

Linario-Festucion dimorphae Avena et Bruno 1975;
Luzulo italicae-Festucetum macratherae Bonin 1978;
Nardetea strictae Riv. Goday et Borja C. 1961;
Nardetalia strictae Oberd. ex Preisg. 1949;
Oxytropidion dinaricae Lakušić 1966;
Pedicularido elegantis-Seslerietum apenninae caricetosum ericetori (Petriccione 1991) Petriccione et Persia 1995;
Ranunculo-Nardion Bonin 1972;
Saxifragion prenjae Lakušić 1966;
Saxifrago speciosae-Papaveretum julici Feoli-Chiapella et Feoli 1977;
Saxifrago speciosae-Papaveretum julici androsacetosum villosae Feoli-Chiapella et Feoli ex Blasi, Di Pietro et Pelino 2004;
Saxifrago speciosae-Silenetum cenisiae Petriccione 1993;
Seslerion apenninae Furnari *in* Bruno et Furnari 1966;
Seslerietalia tenuifoliae Horvat 1930;
Seslerion juncifoliae Horvat 1930;
Taraxaco apennini-Trifolietum thalii gnaphalietosum magellensis Blasi, Di Pietro et Pelino 2004;
Thlaspienion stylosi Avena et Bruno 1975;
Thlaspietalia rotundifolii Br.-Bl. *in* Br.-Bl. et Jenny 1926;
Thlaspietea rotundifolii Br.-Bl. 1948.

belianae-Helianthemetum alpestris of the northern Dinarides and to *Edrajantho-Helianthemetum alpestris* of the southern Dinarides, even if some floristic similarities to *Carici--Crepidetum dinaricae* are also apparent (HORVAT et al. 1974, REDZIC 2003, SURINA and DASKOBLER 2005). As far as *Ranunculo-Adonidetum distortae* is concerned, major similarities with the communities of the alliance *Bunion alpini* are identifiable, which in the Balkan peninsula behaves as vicariant alliance of the central Apennines *Thlaspienion stylosi*. Less evident is the relationship with *Saxifragion prenjae* communities.

Conclusions

Apart from providing new data on the ecological and coenological aspects of two Apennine endemisms, *Adonis distorta* and *Trifolium noricum* subsp. *praetutianum*, this paper also makes a significant contribution to the mapping of the intricate vegetational mosaic of the Apennine alpine belt, a mosaic whose most complete expression is to be found precisely on the Majella. In fact, the massif is a major node within the »European system of high mountains for the study of global change« (the G.L.O.R.I.A. project), and it has long been known as an important centre of plant speciation in the south of Europe (the epithets »magellense« or »majellensis« are very common among the central Apennines endemic floristic component). Recently, more detailed phytosociological studies have revealed that the high number of species is matched by a high coenological diversity, which becomes manifest in the complex mosaic of microgeosigmeta (BLASI et al. 2005). The identification of two new syntaxonomical types inside the alpine bioclimatic belt of the Apennines results

in an increase in the degree of »biodiversity«, at the level of both community and landscape. Table 7 provides a summary of the syntaxa identified so far in the alpine belt of the Majella.

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