Acta Bot. Croat. 67 (2), 147–174, 2008

CODEN: ABCRA 25
ISSN 0365–0588

Chasmophytic vegetation of the class *Asplenietea trichomanis* in south-eastern Italy

MASSIMO TERZI[1]*, FRANCESCO S. D' AMICO[2]

[1] Institute of Plant Genetics, CNR, Via Amendola 165/A, 70126 Bari, Italy

[2] University of Bari, Department of Plant Production Science, Botanical Garden, Via Orabona 4, Bari, Italy

The southeast of Italy is characterized by the presence of some highly phytogeographically relevant taxa with a Balkan-Aegean distribution. Three of these taxa, *Campanula versicolor*, *Carum multiflorum* and *Scrophularia lucida*, characterize the chasmophytic vegetation in central-southern Apulia (Serre Salentine and Bassa Murgia). Chasmophytic vegetation has already been referred to the *Onosmetalia frutescentis* order and to its only alliance *Campanulion versicoloris*, which are syntaxa with mainly a south-western Balkan distribution. This paper reports a phytosociological study of chasmophytic vegetation throughout the entire distributional range of these three species in south-eastern Italy and describes two new associations: *Piptathero holciformis-Campanuletum versicoloris* and *Iberido carnosae-Athamantetum siculi*. We analyse their floristic relationships with other communities described for southern Italy, the Adriatic area and the southern Balkans. As distinct from reports in the literature, the results show that south-eastern Italian rupicolous communities, now grouped under the new alliance *Caro multiflori-Aurinion megalocarpae*, have higher floristic similarity with the order *Asplenietalia glandulosi*, where they have been placed. In other words, the presence of different species gravitating in the East discriminates the chasmophytic vegetation of south-eastern Italy within a central Mediterranean order, rather than justifying its assignment to *Onosmetalia frutescentis,* whose distributional area is limited to the Balkan Peninsula.

Keywords: Chasmophytes, vegetation, phytosociology, Italy, Balkan.

Introduction

South-eastern Italy shows great floristic affinities with the Balkan and Aegean territories, which witness to the ancient connections between the opposite sides of two emerged lands (FRANCINI CORTI 1966, 1967; DI PIETRO 2001; MEDAGLI and GAMBETTA 2003). These affinities are mirrored at the vegetation level and affect formations of different environments and physiognomies (BIANCO et al. 1988, FANELLI et al. 2001, BIONDI et al. 2004, FORTE et al. 2005, TERZI and D' AMICO 2006). For instance, the inland chasmophytic communities of »Serre Salentine« and »Bassa Murgia« uplands in southern Apulia (Fig. 1) are

* Corresponding author, e-mail: massimo.terzi@igv.cnr.it

assigned to the order *Onosmetalia frutescentis* (class *Asplenietea trichomanis*) and to its only alliance *Campanulion versicoloris* (BIANCO et al. 1988), which are syntaxa having a typically south-western Balkan distribution (cfr. QUÉZEL 1964, HORVAT et al. 1974, GEORGIADIS and DIMOPOULOS 1993, DIMOPOULOS et al. 1997, DRING et al. 2002). Moving west from south-eastern Apulia, the order is replaced by *Asplenietalia glandulosi* (BRULLO et al. 1998, MAIORCA and SPAMPINATO 1999, CORBETTA et al. 2000, BRULLO et al. 2001) and further north on the Gargano promontory by *Centaureo-Campanuletalia* (TRINAJSTIĆ 1980, BIANCO et al. 1988). In the higher vegetation belts, the rupicolous communities of southern Italy refer to *Potentilletalia caulescentis* (CORBETTA and PIRONE 1981, CORBETTA et al. 1988, BIONDI et al. 1997, BRULLO et al. 1998, MAIORCA and SPAMPINATO 1999, BRULLO et al. 2001, GIANCOLA and STANISCI 2006).

Rupicolous vegetation in south-eastern Italy is typified by two associations, *Campanulo-Aurinietum leucadeae* and *Aurinio-Centaureetum apulae*, assigned to *Onosmetalia frutescentis* and *Campanulion versicoloris* due to the presence of three character-species of the order and alliance: *Campanula versicolor*, *Carum multiflorum* and *Scrophularia lucida* (BIANCO and SARFATTI 1961, BIANCO et al. 1988). These are three east-Mediterranean species with Balkan and Aegean distribution, whose range overlaps with the far south-eastern Italian peninsula and also covers, beside the Serre and Bassa Murgia, the territory of »Murgia of Matera« and, for *Carum multiflorum* only, the territory of »Alta Murgia« (BIANCO and SARFATTI 1961, BIANCO et al. 1982, PIGNATTI 1982). This paper carries out a vegetation study of the Murgia of Matera and Alta Murgia territories with the aim of gaining an insight into the chasmophytic vegetation of south-eastern Italy along the whole regional distribution range of the three previously mentioned reference species.

Moreover, because the distributional areas of the *Onosmetalia frutescentis*, *Asplenietalia glandulosi* and *Centaureo-Campanuletalia* orders converge in the south-east of Italy, chasmophytic communities of this area have been compared with other syntaxa, associations and sub-associations already assigned to these three orders and described for southern Italy, the Adriatic area and the southern Balkans, in order to verify the present syntaxonomical assignment and the relevant synchorological issues.

The areas under study, Murgia of Matera and Alta Murgia, are of great naturalistic importance as they are both Natural Parks and are listed among the Sites of Community Importance in Italy, established according to the Directive EEC/43/92 (MINISTRY FOR THE ENVIRONMENT, LAND AND SEA 2007). Because »rocky habitats with chasmophytic vegetation« are listed in Annex 1 of the mentioned Directive, a proper knowledge of these environments and the classification of their communities are a contribution to European policies for biodiversity conservation (cfr. EUROPEAN COMMISSION 2003).

Study Area

The physiographic features of Apulia, with little more than half of the territory being flat, are characterized by the presence of two large ranges, the Murge and Serre Salentine, whereas highlands (Gargano and Daunia Subappenine) account for less than 2% of its territory. The Murge is an oblong plateau in the centre of Apulia that stretches NW-SE towards nearby Basilicata. The composite geographic environment where this range develops allows its division into three well-differentiated parts: Alta Murgia, Murgia of Matera and Bassa Murgia (Fig. 1).

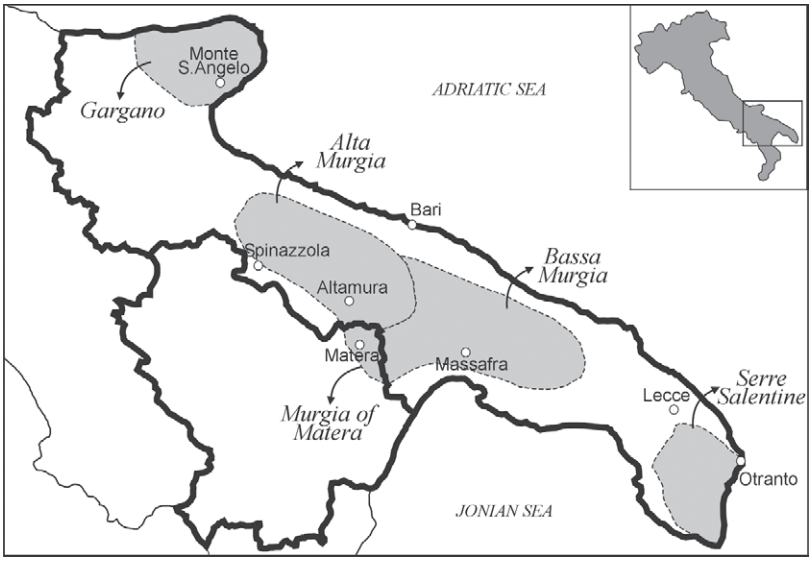

Fig. 1. Study area

The Serre, Murge and Gargano share the same geological basement, made up of a thick layer of Jurassic-Cretaceous carbonate sedimentary rocks that originated after the first common phase of tectonic evolution. Later a fault system formed that divided the original carbonate platform into the three blocks that presently make up the Serre, Murge and Gargano (BOENZI et al. 1971, RICCHETTI et al. 1988).

In some places, on alternate tracts, the blocks are covered by thin and discontinuous Plio-Pleistocene deposits. The widespread presence of carbonate rocks allowed the formation of karst and slightly corrugated landscapes, which were disrupted by tectonic events or cut with shallow or deep karst valleys, locally known as lame and gravine (PARISE et al. 2003). Along these discontinuous topographical elements, large cliffs crop out, suitable for the development of chasmophytic communities. On Gargano and Serre Salentine, these communities are mainly concentrated on the large fault planes, whereas in Bassa Murgia and Murgia of Matera they are typically associated with the deep karst canyons. In Alta Murgia, rocky crags are less extended and frequent in the landscape.

The bioclimatic conditions of Gargano, Serre and Murge are rather differentiated; the bioclimatic classification according to RIVAS-MARTINEZ (2004) of some meteorological stations representative of these territorial units is reported in table 1. Bioclimatic indices were calculated based on the thermo-pluviometric data reported in the database of Apulia Region, project »Acla 2« (CALIANDRO et al. 2002), concerning the period 1952 to1992.

Materials and methods

From 2005–2006, 36 relevés were analyzed according to the procedures of the Zurich-Montpellier School of Phytosociology (BRAUN-BLANQUET 1932): 21 relevés in Alta Murgia and 15 in Murgia of Matera (Tab. 5). Bryophytes and lichens were not recorded in

Tab. 1. Bioclimatic classification according to RIVAS-MARTINEZ (2004) of the meteorological stations of Otranto, Massafra, Matera, Altamura, Spinazzola and Monte S. Angelo. Ic – continentality index; It – thermicity index; Itc – compensated thermicity index; Io – ombrothermic index; Ios2/3/4 – summer compensated ombrothermic indexes for 2, 3 or 4 mounths.

Territorial units	Meteorological stations	Altitude (a.s.l.)	Ic	It (Itc)	Io	Ios2	Ios3	Ios4	Macro bioclimates	Bioclimates	Continentality subtypes	Ombro-types	Thermo-types
Gargano	Monte S. Angelo	838 m	17.1	202.1	5.4	1.9	2.0	2.3	Temperate	Submediterranean (variant)	Semi-continental	Upper Subhumid	Upper Meso-temperate
Alta Murgia	Spinazzola	445 m	18.8	273.2	3.7	1.2	1.3	1.7	Mediterranean	Pluviseasonal-Oceanic	Semi-continental	Lower Subhumid	Upper Meso-mediterranean
Alta Murgia	Altamura	475 m	18.0	261.5	3.2	1.2	1.3	1.6	Mediterranean	Pluviseasonal-Oceanic	Semi-continental	Upper Dry	Upper Meso-mediterranean
Murgia of Matera	Matera	455 m	18.2	277.8	3.2	1.2	1.3	1.5	Mediterranean	Pluviseasonal-Oceanic	Semi-continental	Upper Dry	Upper Meso-mediterranean
Bassa Murgia	Massafra	116 m	17.0	343.5	2.6	0.8	0.9	1.1	Mediterranean	Pluviseasonal-Oceanic	Euoceanic	Lower Dry	Lower Meso-mediterranean
Serre Salentine	Otranto	52 m	15.1	357.0	4.0	0.7	0.8	1.0	Mediterranean	Pluviseasonal-Oceanic	Euoceanic	Lower Subhumid	Upper Thermo-mediterranean

the relevès. The floristic analysis was based on the floras by PIGNATTI (1982), FIORI (1923/29) and TUTIN et al. (1968–1993) and on the papers by MORALDO (1986) and BRULLO (1988); nomenclature was standardized using the checklist of the Italian Flora by CONTI et al. (2005).

These relevés, together with those carried out by BIANCO et al. (1988: relevés no. 1–48 in tables 1 and 2) formed a data set that represents the major chasmophytic communities throughout the regional distributional area of *Campanula versicolor*, *Carum multiflorum* and *Scrophularia lucida.* After excluding taxa with a frequency lower than 5%, the resulting data set (a matrix of 84 relevés x 66 species) was hierarchically clustered using the ordinal clustering algorithm and measure of discordance (PODANI 1997, 2001). Indeed, according to PODANI (2005, 2006), the data collected based on the cover-abundance scale (BRAUN-BLANQUET 1932) should be treated as ordinal data. The analysis was carried out with Syn-Tax 2000, ver. 5.1 (PODANI, 2001). Results of the clustering procedure, together with other observations detailed later, allowed us to describe two new associations in addition to those two already defined by BIANCO et al. (1988). The chorological spectra of these 4 associations were calculated according to species frequency; the chorological types were identified using information from Flora d'Italia by PIGNATTI (1982).

The 4 associations were then compared to other syntaxa, associations and sub-associations described for southern Italy, Greece and the northern Adriatic area and already assigned to *Onosmetalia frutescentis*, *Asplenietalia glandulosi* and *Centaureo-Campanuletalia* (Tab. 6). Based on the association tables and the frequency value within the different syntaxonomical units for each species, the matrix expressed as syntaxonomical units x species (41 x 569) was obtained and then submitted to hierarchical clustering and ordination. Clustering was performed using the UPGMA linkage method (SOKAL and MICHENER 1958); ordination was carried out with non-metric multidimensional scaling (NMS) (KRUSKAL 1964, MATHER 1976), which is highly recommended for high beta-diversity gradients (MCCUNE and GRACE 2002), as is the case with Mediterranean chasmophytic vegetation, where several environmental factors at different levels bring about sharp phytocoenotic differentiation (DAVIS 1951, KUNTZ and LARSON 2006). In both cases the Sørensen similarity coefficient was used. Data were processed with PC-Ord, ver. 4 (MCCUNE and MEFFORD 1999). For NMS, the »slow and thorough« autopilot mode was selected, which uses an instability criterion of 0.00001 (up to 400 iterations to reach that stability) and performs 40 runs with real data and 50 runs with randomized data to identify the number of axes (Monte Carlo test).

Syntaxonomical nomenclature follows the references mentioned in the text; for characteristic species of high-ranking phytosociological units, reference was made to works by QUÉZEL (1964), TRINAJSTIĆ (1980), MUCINA (1997), DIMOPOULOS et al. (1997) and BRULLO et al. (1998), unless otherwise indicated.

Results

Clustering the relevés of chasmophytic communities from Murge and Serre Salentine allows us to single out 5 rather differentiated groups (Fig. 2). The relevés by BIANCO et al. (1988) were divided into three groups. Group D contains the relevés assigned to *Campanulo-Aurinietum leucadeae*, whereas groups B and E contain those referred to *Aurinio-*

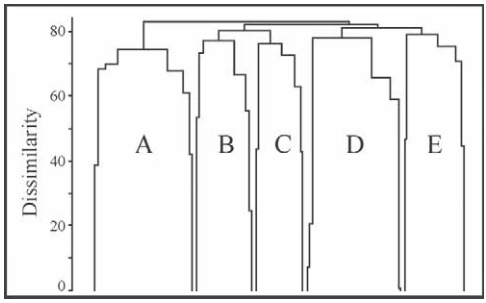

Fig. 2. Dendrogram of the ordinal clustering (Podani measure of discordance) of reléves sampled in the Murge and Serre Salentine districts. Group A corresponds to the *Iberido carnosae--Athamantetum siculi* association, group B to *Aurinio-Centaureetum apulae*, group C to *Piptathero holciformis-Campanuletum versicoloris* and group D to *Campanulo-Aurinietum leucadeae*. Group E, instead, covers the relevés lacking association character-species, here considered as association fragments.

-*Centaureetum apulae*. In this paper, relevés grouped under E (relevés no. 34–48 in BIANCO et al. 1988) are considered to be association fragments and are excluded from the following discussion because they lack association-character species (i.e. *Centaurea brulla*) and harbour few real rupicolous chasmophytes but several species typical of other environments. Group B is made up of the remaining relevés carried out in Bassa Murgia and is representative of *Aurinio-Centaureetum apulae.* The relevés from Murgia of Matera and Alta Murgia are classified under groups C and A, respectively; these groups, which are floristically well-differentiated from the others, allow us to describe two new associations: *Piptathero holciformis-Campanuletum versicoloris* and *Iberido carnosae-Athamantetum siculi*.

Piptathero holciformis-Campanuletum versicoloris ass. nov. hoc loco (holotypus rel. 9, Tab. 2, 4).

This association describes rupicolous communities settled in the calcareous substrate in south-western Murgia, with a dominance of *Campanula versicolor, Satureja montana* and *Athamanta sicula*; these entities are also the most frequent together with *Leontodon intermedius* and *Dianthus garganicus*. The association character-species are *Leontodon intermedius,* endemic to south east Italy, and *Piptatherum holciforme,* a south-eastern European species with a range centred in the Balkan Peninsula and Romania, which is present in Italy only in the gravine of Matera and Laterza (D' AMICO and TERZI 2007). The results of multivariate analysis (Fig. 2) highlight the floristic similarities between *Piptathero holciformis-Campanuletum versicoloris* and *Aurinio-Centaureetum apulae*, with several important species in common, such as *Campanula versicolor* and *Aurinia saxatilis* subsp. *megalocarpa*, that have high frequency and good cover. Conversely, many other species appear to prefer the environmental conditions of one or the other community, as is the case for *Centaurea brulla*, which is very rare in Murgia of Matera or, vice versa, for *Piptatherum holciforme, Leontodon intermedius* and *Athamanta sicula,* which are less frequent in Bassa Murgia. The different bioclimatic conditions of the two areas are mirrored in the chorological spectra of the relevant communities (Tab. 1, Fig. 3). Although Mediterranean species are dominant in both cases, *Piptathero holciformis-Campanuletum versicoloris*, whose habitat is characterized by a greater thermic continentality, shows a higher proportion of European, particularly eastern European, species.

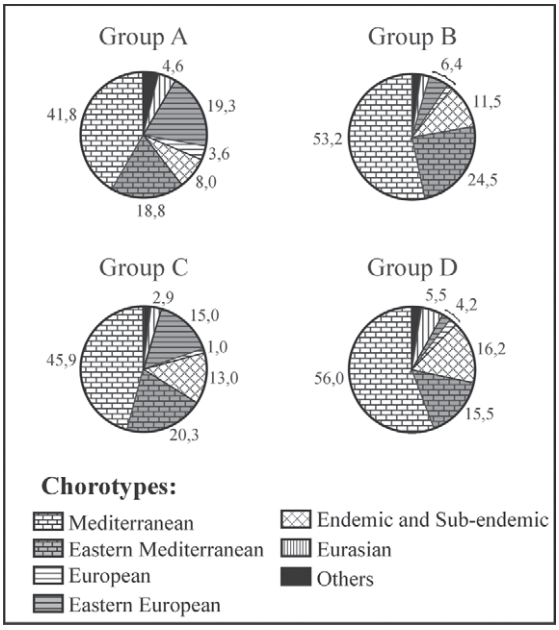

Fig. 3. Chorological spectra of the groups in Fig. 2, weighted against frequency values.

Iberido carnosae-Athamantetum siculi ass. nov. hoc loco (holotypus rel. 26, Tab. 3, 4)

This association is typical of rupicolous communities in northern Murgia, is marked by the absolute dominance of *Aurinia saxatilis* subsp. *megalocarpa* and *Athamanta sicula*, also is frequently associated with the presence of *Rhamnus saxatilis* subsp. *infectorius*, *Micromeria graeca* and *Convolvulus elegantissimus. Campanula versicolor* and *Scrophularia lucida* are absent and, of the three diagnostic species of *Onosmetalia frutescentis*, only *Carum multiflorum* was detected at a low frequency. Clustering results sharply separate relevés of Alta Murgia from the others (Fig. 2), but despite this clear-cut floristic differentiation, it is not possible to single out the association character-species; rather it can only be identified by the differential role played in the regional context by *Iberis carnosa* subsp. *carnosa*, *Sedum hispanicum* and *Acinos suaveolens.* The former is distributed in Mediterranean mountains, and its range is very fragmented and interrupted by wide gaps in Italy; these are conditions that do not exclude the possibility of local ecotype segregation (LANDOLT 1977, PIGNATTI 1982). Its frequency in *Iberido carnosae-Athamantetum siculi* does not compare to that in other communities studied in south-eastern Italy or on a larger scale. Similar cases include *Sedum hispanicum*, a widely distributed south-eastern European species that is already listed among the diagnostic species of *Asplenietea trichomanis* (MUCINA 1997), and *Acinos suaveolens*, which is also located in the east. This latter, very frequently recorded in chasmophytic vegetation as a differential species, is quite widespread in the Alta Murgia district; in the trans-Adriatic part of its range, *Acinos suaveolens* inhabits the chamaephytic and nanophanerophytic garrigue of *Cisto-Micromerietalia* Oberdorfer 1954 (cfr. OBERDORFER 1954, HORVAT et al. 1974, BRULLO et al. 1997). Although Alta Murgia is classified in the same bioclimate as Murgia of Matera, it features

Tab. 2. Association table of *Piptathero holciformis-Campanuletum versicoloris* ass. nova. d – differential species; T – Therophytes; Ch – Chamaephytes; H – Hemicryptophytes; G – Geophytes; P – Phanerophytes.

	relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
	altitude (m a.s.l.)	330	325	340	350	390	390	375	340	340	350	370	300	
	aspect	SW	SW	W	NE	NE	NE	S	N	W	W	W	W	presence
	slope (°)	90	85	90	90	90	85	80	90	90	90	85	85	
	cover (%)	30	10	20	15	15	25	15	15	10	30	15	20	
	area (m^2)	20	50	50	30	50	30	30	30	30	40	40	30	
	Piptathero holciformis – Campanuletum versicoloris													
H	*Leontodon intermedius*	+	+	+	1	1	1	+	+	+	+	1	1	V
H	*Piptatherum holciforme*	+	.	.	+	.	.	.	+	+	+	.	.	III
	Caro multiflori-Aurinion megalocarpae													
H	*Campanula versicolor*	+	1	2	1	1	2	1	1	2	1	2	1	V
H	*Melica transsilvanica* (d)	.	+	+	.	+	.	+	+	+	+	.	+	IV
Ch	*Aurinia saxatilis* subsp. *megalocarpa*	+	+	+	+	+	.	1	.	.	.	.	1	III
H	*Carum multiflorum* subsp. *multiflorum*	.	.	.	.	.	.	.	.	+	+	1	.	II
H	*Scrophularia lucida*	.	.	.	.	.	.	.	1	+	.	.	.	I
	Asplenietalia glandulosi/Asplenietea trichomanis													
H	*Athamanta sicula*	+	+	+	2	1	+	+	1	1	1	.	1	V
H	*Dianthus garganicus*	+	+	+	+	1	+	+	+	+	+	.	+	V
Ch	*Sedum dasyphyllum*	+	+	+	+	+	.	.	+	+	+	.	+	IV
H	*Parietaria judaica*	+	+	.	.	.	.	.	1	1	1	+	1	III
G	*Umbilicus horizontalis*	+	.	.	+	.	.	.	+	.	+	.	+	III
T	*Campanula erinus*	.	+	.	+	.	.	+	.	.	+	+	.	III
P	*Capparis spinosa*	.	+	+	.	.	+	+	.	.	.	+	.	III

Tab. 2. – continued

	relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
	altitude (m a.s.l.)	330	325	340	350	390	390	375	340	340	350	370	300	
	aspect	SW	SW	W	NE	NE	NE	S	N	W	W	W	W	presence
	slope (°)	90	85	90	90	90	85	80	90	90	90	85	85	
	cover (%)	30	10	20	15	15	25	15	15	10	30	15	20	
	area (m^2)	20	50	50	30	50	30	30	30	30	40	40	30	
Ch	*Teucrium flavum*	+	+	.	.	+	+	.	.	.	.	.	.	II
P	*Ficus carica*	.	+	.	.	+	.	+	.	.	.	.	.	II
Ch	*Centranthus ruber* subsp. *ruber*	.	.	.	.	+	+	.	+	.	.	.	.	II
H	*Leontodon apulus*	+	.	.	+	.	.	.	.	.	.	.	.	I
H	*Ceterach officinarum*	.	.	.	.	.	.	+	.	.	.	.	.	I
	Other taxa													
Ch	*Satureja montana*	2	1	1	+	2	2	1	.	+	1	1	+	V
P	*Rhamnus saxatilis* subsp. *infectorius*	+	+	+	.	.	+	+	.	+	+	1	+	IV
Ch	*Prasium majus*	1	+	+	.	.	+	+	+	.	.	1	+	IV
P	*Emerus majus* subsp. *emeroides*	1	+	+	.	+	+	.	.	+	.	+	+	IV
Ch	*Phagnalon rupestre* subsp. *annoticum*	+	+	.	+	+	.	+	+	.	+	+	.	IV
Ch	*Micromeria graeca*	.	.	+	+	+	.	.	.	.	+	+	+	III
H	*Linum austriacum* subsp. *tommasinii*	.	.	+	.	+	+	+	.	.	.	.	.	II
Ch	*Onosma angustifolia*	+	.	.	.	.	1	.	.	.	+	+	.	II
T	*Fumaria capreolata* subsp. *capreolata*	.	.	+	.	.	.	+	+	.	+	.	.	II
H	*Helictotrichon convolutum*	.	.	.	.	+	+	.	+	.	.	+	.	II
H	*Silene vulgaris* subsp. *tenoreana*	.	.	.	+	+	.	.	.	+	.	.	.	II
P	*Pistacia terebinthus*	.	.	.	.	+	+	.	.	.	.	+	.	II

Tab. 3. Association table of *Iberido carnosae-Athamantetum siculi* ass. nova. d – differential species; T – Therophytes; Ch – Chamaephytes; H – Hemicryptophytes; G – Geophytes; P – Phanerophytes.

	relevé number	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	
	altitude (m a.s.l.)	625	580	600	620	630	630	625	610	590	600	620	540	530	630	620	620	630	625	620	620	630	530	540	610	
	aspect	W	S	S	E	E	N	W	NW	W	NW	SW	W	SW	SE	E	NW	NW	W	W	W	SW	NE	W	W	
	slope (°)	85	85	85	85	90	90	90	90	90	85	90	90	85	80	85	70	80	90	85	80	90	90	85	90	
	cover (%)	15	20	10	30	20	30	15	10	20	30	15	5	15	20	20	40	20	20	15	30	15	30	20	15	
	area (m^2)	40	50	50	10	20	10	10	15	20	6	60	30	30	20	20	30	30	30	30	30	20	18	60	40	
	Iberido carnosae-Athamantetum siculi																									
T	*Sedum hispanicum* (d)	+	.	+	+	+	.	+	.	+	+	+	+	+	+	+	+	.	.	.	+	+	+	+	+	IV
Ch	*Acinos suaveolens* (d)	+	.	.	+	1	+	+	+	+	.	+	.	.	+	+	+	+	.	+	.	.	1	.	+	III
H	*Iberis carnosa* subsp. *carnosa* (d)	+	+	.	.	+	.	.	.	.	.	.	.	.	+	+	.	1	+	.	.	.	.	.	.	II
	Caro multiflori-Aurinion megalocarpae																									
Ch	*Aurinia saxatilis* subsp. *megalocarpa*	1	+	2	1	1	.	.	.	+	1	3	.	+	2	1	1	+	1	+	+	+	1	1	+	V
H	*Melica transsilvanica* (d)	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+	+	+	+	.	+	1	V
H	*Carum multiflorum* subsp. *multiflorum*	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	+	2	.	.	+	.	.	.	.	II
	Asplenietalia glandulosi/Asplenietea trichomanis																									
H	*Athamanta sicula*	+	+	1	2	1	1	+	+	2	2	2	+	1	+	2	2	1	1	1	.	2	2	2	2	V
H	*Leontodon apulus*	+	1	.	.	.	.	1	+	+	.	.	.	+	+	.	1	+	1	1	1	+	.	+	+	VI
H	*Parietaria judaica*	+	+	.	.	.	1	1	.	+	+	+	.	+	+	.	+	.	1	1	.	.	+	1	.	III

presence

Tab. 3. – continued

	relevé number	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	altitude (m a.s.l.)	625	580	600	620	630	630	625	610	590	600	620	540	530	630	620	620	630	625	620	620	630	530	540	610	
	aspect	W	S	S	E	E	N	W	NW	W	NW	SW	W	SW	SE	E	NW	NW	W	W	W	SW	NE	W	W	presence
	slope (°)	85	85	85	85	90	90	90	90	90	85	90	90	85	80	85	70	80	90	85	80	90	90	85	90	
	cover (%)	15	20	10	30	20	30	15	10	20	30	15	5	15	20	20	40	20	20	15	30	15	30	20	15	
	area (m^2)	40	50	50	10	20	10	10	15	20	6	60	30	30	20	20	30	30	30	30	30	20	18	60	40	
G	*Umbilicus horizontalis*	+	.	.	+	+	.	.	+	.	+	.	+	.	+	+	.	.	+	+	.	.	+	+	+	III
H	*Ceterach officinarum*	.	.	.	.	+	+	.	+	.	.	+	.	.	+	+	+	.	+	.	.	.	+	+	+	III
H	*Dianthus garganicus*	.	.	.	.	+	.	+	+	.	.	.	.	+	+	.	.	1	.	.	+	.	+	+	.	II
T	*Campanula erinus*	+	+	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	.	+	.	.	.	II
T	*Geranium purpureum*	.	.	.	.	.	+	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	+	.	+	II
P	*Ficus carica*	.	1	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
	Other taxa																									
P	*Rhamnus saxatilis* subsp. *infectorius*	2	+	+	+	.	2	1	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1	V
Ch	*Micromeria graeca*	1	+	+	1	.	+	+	+	+	+	+	+	+	+	1	+	+	+	+	+	+	+	+	1	V
H	*Convolvulus elegantissimus*	+	+	+	+	+	.	+	+	1	+	+	+	+	+	.	.	+	+	+	+	+	+	+	+	V
H	*Festuca circummediterranea*	.	.	.	.	.	+	.	+	+	+	1	.	+	.	+	.	+	+	+	+	.	+	+	+	III
Ch	*Sedum rupestre*	.	+	.	.	.	.	.	+	.	+	+	+	+	+	+	+	.	+	.	+	+	.	.	+	III
Ch	*Sedum album*	+	+	1	.	.	.	.	.	.	.	.	.	+	1	+	1	+	+	+	+	+	.	.	.	III

Tab. 3. – continued

	relevé number	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	altitude (m a.s.l.)	625	580	600	620	630	630	625	610	590	600	620	540	530	630	620	620	630	625	620	620	630	530	540	610	
	aspect	W	S	S	E	E	N	W	NW	W	NW	SW	W	SW	SE	E	NW	NW	W	W	W	SW	NE	W	W	presence
	slope (°)	85	85	85	85	90	90	90	90	90	85	90	90	85	80	85	70	80	90	85	80	90	90	85	90	
	cover (%)	15	20	10	30	20	30	15	10	20	30	15	5	15	20	20	40	20	20	15	30	15	30	20	15	
	area (m^2)	40	50	50	10	20	10	10	15	20	6	60	30	30	20	20	30	30	30	30	30	20	18	60	40	
H	*Reichardia picroides*	.	+	+	+	+	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	+	+	.	III
G	*Scorzonera villosa* subsp. *columnae*	.	.	+	.	.	.	.	.	.	.	.	+	+	.	+	+	+	.	.	+	.	+	+	+	III
H	*Hyoseris radiata* subsp. *radiata*	.	.	.	.	.	+	.	.	+	+	2	.	.	.	+	.	.	1	.	.	.	1	+	+	II
H	*Linum austriacum* subsp. *tommasinii*	.	.	.	.	.	+	+	+	+	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	II
Ch	*Thymus spinulosus*	.	+	.	.	.	.	.	+	+	.	.	+	.	.	.	.	+	.	.	.	+	+	.	+	II
Ch	*Onosma angustifolia*	.	+	+	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	.	.	+	.	.	.	II
Ch	*Minuartia verna* subsp. *attica*	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	.	.	+	II
H	*Galium corrudifolium*	+	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	II
H	*Silene vulgaris* subsp. *tenoreana*	+	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	II

longer and colder winters (FORTE et al. 2005). These events affect the chorological composition of *Iberido carnosae-Athamantetum siculi*, where the weight of Mediterranean entities is reduced, though still dominant, and the weight of the European chorotype is increased (Fig. 3). As in *Piptathero holciformis-Campanuletum versicoloris*, eastern species here are also more or less equally divided into Mediterranean and European types and play an important role with a percentage higher than 35%. In the more thermophilic communities of Bassa Murgia and Salento, *Aurinio-Centaureetum apulae* and *Campanulo-Aurinietum leucadeae*, the presence of European species is sharply lower. Based on the above and despite an absence of »true« character-species of association (cfr. LANDOLT 1977), *Iberido carnosae-Athamantetum siculi* is sufficiently differentiated in its floristic, coenological, bioclimatic and chorological features.

Tab. 4. Sporadic species.

Rel. 1: *Centaurea brulla*, *Coronilla valentina*, *Matthiola fruticulosa fruticulosa*, *Mercurialis annua*, *Pallenis spinosa*.

Rel. 2: *Reseda alba*, *Sedum acre*, *Sedum rupestre*.

Rel. 3: *Reseda alba*.

Rel. 5: *Rhamnus alaternus*, *Sedum album*.

Rel. 6: *Convolvulus elegantissimus*, *Festuca circummediterranea*, *Rhamnus alaternus*.

Rel. 7: *Mercurialis annua*, *Dasypyrum villosum*, *Sedum album* (1).

Rel. 8: *Euphorbia characias*.

Rel. 10: *Euphorbia characias*.

Rel. 12: *Sedum rupestre*.

Rel. 13: *Fumaria capreolata capreolata*, *Helianthemum oelandicum incanum*, *Poa bulbosa*, *Saxifraga tridactylites*.

Rel. 14: *Helianthemum oelandicum incanum*, *Hippocrepis glauca*, *Osyris alba*, *Thesium humifusum*, *Satureja montana* (1).

Rel. 15: *Convolvulus cantabrica*, *Geranium molle*.

Rel. 19: *Poa bulbosa*, *Alyssum diffusum*, *Calamintha nepeta*, *Ruta chalepensis*, *Sanguisorba minor.*

Rel. 20: *Ruta graveolens*, *Euphorbia spinosa*.

Rel. 21: *Ruta chalepensis*, *Osyris alba*, *Euphorbia spinosa*, *Petrorhagia saxifraga gasparrinii*.

Rel. 22: *Bromus rubens*, *Dasypyrum villosum*, *Echium vulgare*.

Rel. 23: *Bromus rubens*, *Dasypyrum villosum*, *Asparagus acutifolius*, *Bromus scoparius*.

Rel. 24: *Satureja montana*.

Rel. 25: *Stachys germanica salviifolia*, *Trachynia distachya*, *Satureja montana* (1).

Rel. 26: *Fumaria capreolata capreolata*, *Bituminaria bituminosa*.

Rel. 29: *Convolvulus cantabrica*, *Helianthemum oelandicum incanum*, *Satureja montana*.

Rel. 30: *Aethionema saxatile*.

Rel. 32: *Seseli tortuosum* (2), *Sesleria juncifolia juncifolia* (2), *Helianthemum oelandicum incanum*.

Rel. 35: *Echium plantagineum*, *Stipa austroitalica austroitalica*.

Rel. 36: *Sanguisorba minor.*

Tab. 5. Localities, date and coordinates of the relevés.

Rel. 1: Matera (gravina), 23/05/2006, 16°36'47'' E, 40°40'12'' N;
Rel. 2: Matera (gravina), 23/05/2006, 16°36'45'' E, 40°40'17'' N;
Rel. 3: Matera (gravina), 23/05/2006, 16°36'36'' E, 40°40'24'' N;
Rel. 4: Matera (gravina), 17/05/2006, 16°37'33'' E, 40°40'34'' N;
Rel. 5: Matera (gravina), 17/05/2006, 16°37'15'' E, 40°40'24'' N;
Rel. 6: Matera (gravina), 17/05/2006, 16°37'38'' E, 40°40'23'' N;
Rel. 7: Matera (gravina), 17/05/2006, 16°37'38'' E, 40°40'26'' N;
Rel. 8: Matera (gravina), 15/05/2006, 16°37'36'' E, 40°40'28'' N;
Rel. 9: Matera (gravina), 15/05/2006, 16°37'36'' E, 40°40'18'' N;
Rel. 10: Matera (gravina), 15/05/2006, 16°37'39'' E, 40°40'32'' N;
Rel. 11: Matera (gravina), 15/05/2006, 16°37'23'' E, 40°40'18'' N;
Rel. 12: Matera (gravina), 23/05/2006, 16°36'37'' E, 40°40'36'' N;
Rel. 13: Murgia di Lamapera, 20/06/2005, 16°20'10'' E, 40°55'12'' N;
Rel. 14: Murgia di Lamapera, 20/06/2005, 16°20'06'' E, 40°54'58'' N;
Rel. 15: Murgia di Lamapera, 20/06/2005, 16°20'20'' E, 40°54'52'' N;
Rel. 16: Lama di Poggiorsini, 25/05/2005, 16°16'59'' E, 40°57'35'' N;
Rel. 17: Lama di Poggiorsini, 25/05/2005, 16°16'59'' E, 40°57'39'' N;
Rel. 18: Murgia di Lamatorta, 25/05/2005, 16°16'16'' E, 40°57'54'' N;
Rel. 19: Murgia di Lamatorta, 25/05/2005, 16°16'12'' E, 40°57'47'' N;
Rel. 20: Murgia di Lamatorta, 25/05/2005, 16°16'13'' E, 40°57'41'' N;
Rel. 21: Murgia di Lamatorta, 25/05/2005, 16°16'09'' E, 40°57'37'' N;
Rel. 22: Monte Castello, 13/05/2005, 16°15'19'' E, 40°57'55'' N;
Rel. 23: Monte Castello, 13/05/2005, 16°15'25'' E, 40°57'58'' N;
Rel. 24: Pulicchie, 18/06/2005, 16°25'27'' E, 40°54'11'' N;
Rel. 25: Pulicchie, 18/06/2005, 16°25'28'' E, 40°54'20'' N;
Rel. 26: Murgia di Lamapera, 30/05/2006, 16°20'31'' E, 40°54'53'' N;
Rel. 27: Murgia di Lamapera, 30/05/2006, 16°20'29'' E, 40°54'47'' N;
Rel. 28: Murgia di Lamapera, 30/05/2006, 16°20'36'' E, 40°54'45' N;
Rel. 29: Murgia di Lamapera, 30/05/2006, 16°20'40'' E, 40°54'52'' N;
Rel. 30: Murgia di Lamapera, 06/06/2006, 16°19'54'' E, 40°55'12'' N:
Rel. 31: Murgia di Lamapera, 06/06/2006, 16°19'53'' E, 40°54'55'' N;
Rel. 32: Murgia di Lamapera, 06/06/2006, 16°20'03'' E, 40°55'02'' N;
Rel. 33: Murgia di Lamapera, 06/06/2006, 16°20'24'' E, 40°54'50'' N;
Rel. 34: Monte Castello, 14/06/2006, 16°15'16'' E, 40°58'03'' N;
Rel. 35: Monte Castello, 14/06/2006, 16°15'19'' E, 40°58'04'' N;
Rel. 36: Monte Castello, 14/06/2006, 16°15'23'' E, 40°58'03'' N;

UPGMA clustering (Fig. 4) of syntaxonomical units already referred to *Centaureo--Campanuletalia*, *Asplenietalia glandulosi* and *Onosmetalia frutescentis* orders showed a first major bifurcation between the Greek communities of *Campanulion versicoloris* (group CV) and the other units. The chasmophytic vegetation of south-eastern Italy

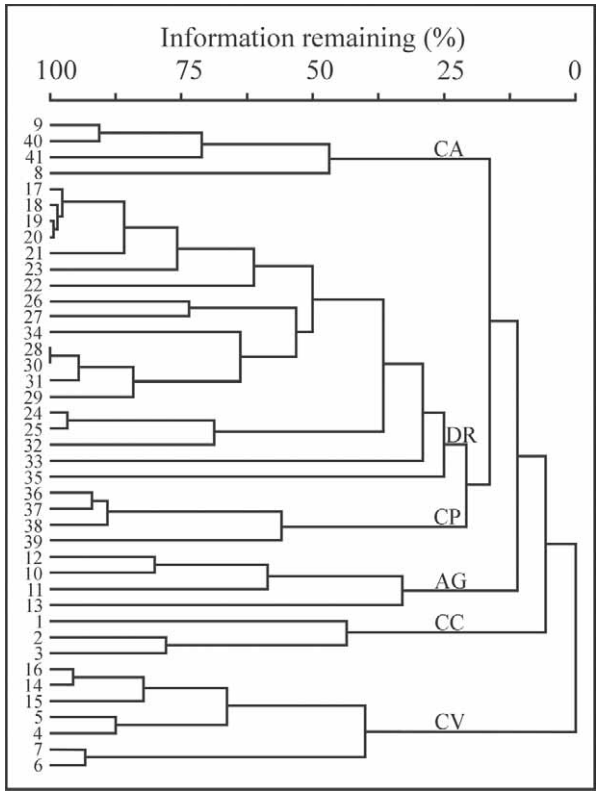

Fig. 4. Cluster dendrogram (UPGMA; Sørensen similarity coefficient) of the communities reported in Tab. 6 based on the frequency of each species within the different syntaxonomical units. CV – *Campanulion versicoloris*; AG – *Asperulion garganicae*; CP – *Centaurion pentadactyli*; DR – *Dianthion rupicolae*; CA – *Caro multiflori-Aurinion megalocarpae*; CC – *Centaureo-Campanulion*.

(group CA) was shown to be floristically closer to *Asplenietalia glandulosi* than to *Onosmetalia frutescentis*. NMS ordination yelded a 3 Axis solution that explained 77.1% of the variation in the raw data (Axis 1= 48.6%, Axis 2= 16.0% and Axis 3= 12.5%), with a final stress of 12.7. The NMS ordination plots seem to support the results of the cluster analysis (Fig. 5).

Despite some floristic autonomy, the south-eastern Italian communities, grouped as CA (Figs. 4, 5), are closer to the subordinate syntaxa of the alliances *Dianthion rupicolae* Brullo et Marcenò 1979 (group DR) and *Centaureion pentadactyli* Brullo, Scelsi, Spampinato 2001 (group CP), both of the order *Asplenietalia glandulosi*. The presence of a

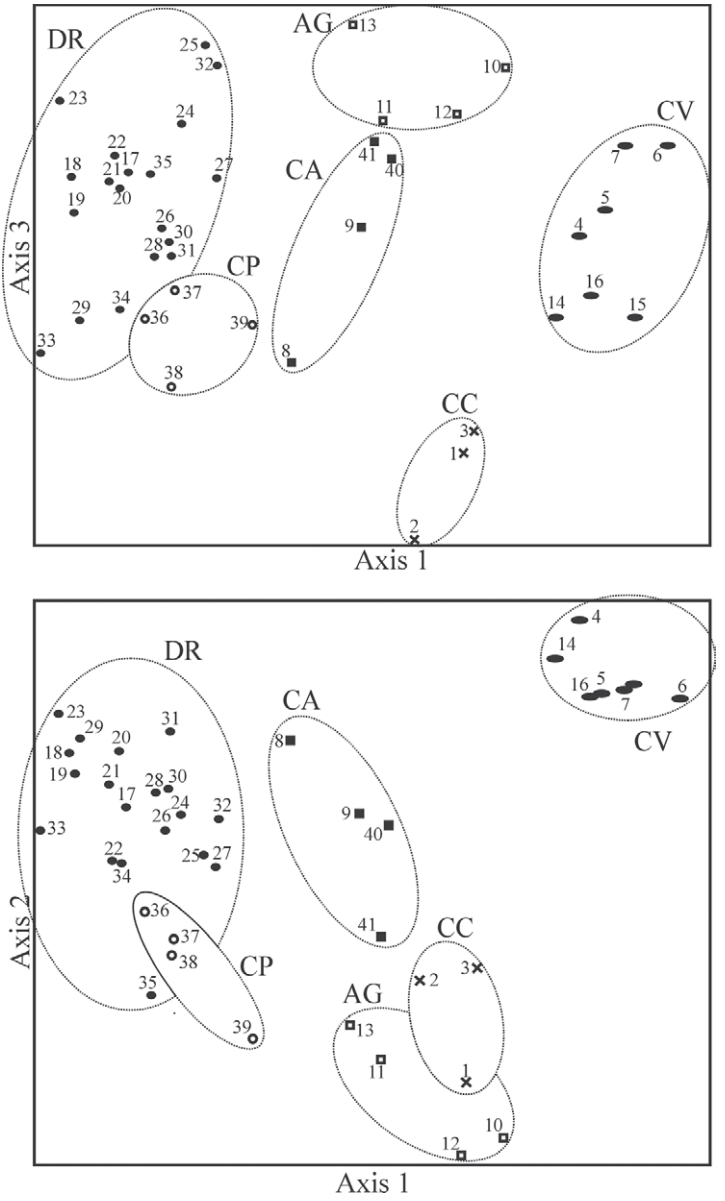

Fig. 5. NMS ordination plots of the communities reported in Tab. 6 based on the frequency of each species in the different syntaxonomical units. Abbreviations as in Fig. 4.

rather high percentage of Mediterranean and European species with a range mainly centred in the East differentiates these communities within the *Asplenietalia glandulosi* chasmophytic vegetation rather than justifying their assignment to the order *Onosmetalia frutescentis*, which is so rooted in the southern Balkans.

Tab. 6. List of syntaxonomical units utilized in the various multivariate analysis procedures.

n.	syntaxonomical unit	alliance	order	source
1	*Campanulo-Centaureetum dalmaticae* H-ić (1934) 1939	*Centaureo-Campanulion*	*Centaureo Campanuletalia*	Pavletić and Trinajstić 1997
2	*Campanulo-Centaureetum kartschianae* Lausi et Poldini 62	*Centaureo-Campanulion*	*Centaureo Campanuletalia*	Lausi and Poldini 1962, Poldini 1989
3	*Micromerio-Euphorbietum wulfenii* Lausi et Poldini 62	*Centaureo-Campanulion*	*Centaureo Campanuletalia*	Lausi and Poldini 1962, Poldini 1989
4	*Inulo parnassicae-Ptilostemetum chamaepeuce* Theocharopoulos et al. 2001	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Maroulis and Georgiadis 2005
5	*Aubrieta deltoidea-Peucedanum achaicum*	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Maroulis and Georgiadis 2005
6	*Saxifrago chrysosplenifoliae-Athamantetum macedonicae* Maroulis et Georgiadis, 2006 typical subgroup	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Maroulis and Georgiadis 2005
7	*Saxifrago chrysosplenifoliae-Athamantetum macedonicae* Maroulis et Georgiadis, 2006 *Dianthus pinifolius* subsp. *lilacinus* subgroup	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Maroulis and Georgiadis 2005
8	*Campanulo-Aurinietum leucadeae* Bianco, Brullo, Pignatti et S. Pignatti, 1988	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Bianco et al. 1988
9	*Aurinio-Centaureetum apulae* Bianco, Brullo, Pignatti et S. Pignatti, 1988	*Campanulion versicoloris*	*Onosmetalia frutescentis*	Bianco et al. 1988
10	*Centaureetum subtilis* Bianco, Brullo, Pignatti et S. Pignatti, 1988 *centaureetosum*	*Asperulion garganicae*	*Centaureo Campanuletalia*	Bianco et al. 1988
11	*Centaureetum subtilis* Bianco, Brullo, Pignatti et S. Pignatti, 1988 *scabiosetosum*	*Asperulion garganicae*	*Centaureo Campanuletalia*	Bianco et al. 1988
12	*Scabiosetum dallaportae* Bianco, Brullo, Pignatti et S. Pignatti, 1988	*Asperulion garganicae*	*Centaureo Campanuletalia*	Bianco et al. 1988

Tab. 6. – continued

n.	syntaxonomical unit	alliance	order	source
13	*Aubrieto-Campanuletum garganicae* Bianco, Brullo, Pignatti et S. Pignatti, 1988	*Asperulion garganicae*	*Centaureo Campanuletalia*	BIANCO et al. 1988
14	*Sideritis Roeseri et Alkanna Graeca* Ass. Quézel 1964	*Campanulion versicoloris*	*Onosmetalia frutescentis*	QUÉZEL 1964
15	*Stachys Candida et Galium boryanum* Ass. Quézel 1964	*Campanulion versicoloris*	*Onosmetalia frutescentis*	QUÉZEL 1964
16	*Asperula arcadiensis et Hypericum vesiculosum* Quézel 1964	*Campanulion versicoloris*	*Onosmetalia frutescentis*	QUÉZEL 1964
17	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *typicum*	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
18	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *anthemidetosum ismeliae* (Brullo et Marcenò 1979) Brullo, Marcenò et Siracusa 1998	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
19	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *centaureetosum todari* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
20	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *ericetosum siculae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
21	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *brassicetosum macrocarpae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
22	*Scabioso creticae-Centaureetum ucriae* Brullo et Marcenò 1979 *brassicetosum drepanensis* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998

Tab. 6. – continued

n.	syntaxonomical unit	alliance	order	source
23	*Bupleuro dianthifolii-Scabiosetum limonifoliae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
24	*Anthemido cupanianae-Centaureetum busambarensis* Brullo et Marcenò 1979 *scabiosetosum creticae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
25	*Anthemido cupanianae-Centaureetum busambarensis* Brullo et Marcenò 1979 *poetosum bivonae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
26	*Putorio calabricae-Micromerietum microphyllae* Brullo et Marcenò 1979 *dianthetosum rupicolae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
27	*Brassico tinei-Diplotaxisietum crassifoliae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
28	*Erucastretum virgati* Brullo et Marcenò 1979 *typicum*	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
29	*Erucastretum virgati* Brullo et Marcenò 1979 *limonietosum sibthorpiani* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
30	*Erucastretum virgati* Brullo et Marcenò 1979 *centaureetosum tauromenitani* Pirola ex Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
31	*Erucastretum virgati* Brullo et Marcenò 1979 *centaureetosum sequenzae* Brullo et Marcenò 1979	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998
32	*Erucastretum virgati* Brullo et Marcenò 1979 *edraianthetosum siculi* Brullo, Marcenò et Siracusa 1998	*Dianthion rupicolae*	*Asplenietalia glandulosi*	Brullo and Marcenò 1979 in: Brullo et al. 1998

Tab. 6. – continued

n.	syntaxonomical unit	alliance	order	source
33	*Diantho rupicolae-Centaureetum aeolicae* Barbagallo, Brullo et Signorello 1983	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO and MARCENÒ 1979 in: BRULLO et al. 1998
34	*Erucastretum virgati* Brullo et Marcenò 1979 *senecionetosum gibbosi*	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO et al. 2001
35	*Erucastretum virgati* Brullo et Marcenò 1979 *centaureetosum ionicae* Brullo, Scelsi et Spampinato 2001	*Dianthion rupicolae*	*Asplenietalia glandulosi*	BRULLO et al. 2001
36	*Centaureo-Dianthetum pentadactyli* Brullo, Scelsi et Spampinato 2001	*Centaurion Pentadactyli*	*Asplenietalia glandulosi*	BRULLO et al. 2001
37	*Centaureo-Dianthetum longicaulis* Brullo, Scelsi et Spampinato 2001	*Centaurion Pentadactyli*	*Asplenietalia glandulosi*	BRULLO et al. 2001
38	*Centaureo-Dianthetum aspromontani* Brullo, Scelsi et Spampinato 2001	*Centaurion Pentadactyli*	*Asplenietalia glandulosi*	BRULLO et al. 2001
39	*Arabido-Centaureetum aspromontanae* Brullo, Scelsi et Spampinato 2001	*Centaurion Pentadactyli*	*Asplenietalia glandulosi*	BRULLO et al. 2001
40	*Piptathero holciformis-Campanuletum versicoloris* ass. nov.			
41	*Iberido carnosae- Athamantetum siculi* ass. nov.			

Discussion

The expansion of rupicolous vegetation studies in south-eastern Italy, specifically in Murgia of Matera and Alta Murgia, which were not previously considered in the paper by BIANCO et al. (1988), has opened a new interpretation of the relevant syntaxonomical scheme. Indeed, the high frequency of *Athamanta sicula* in these new areas would suggest, together with the presence of the other character-species of *Asplenietalia glandulosi* (*Teucrium flavum*, *Melica minuta*, *Ficus carica*, etc.), a possible assignment of the vegetation to this latter order rather than to *Onosmetalia frutescentis.* This hypothesis was confirmed by comparing the vegetation types of these areas with other syntaxa subordinate to these two orders and to *Centaureo-Campanuletalia* (Tab. 6). The outcomes of ordination and classification procedures highlight how the Greek vegetation referred to as *Onosmetalia frutescentis* forms a separate, floristically well-differentiated, group. The order includes East Mediterranean rupicolous communities of the lower belts and encompasses species typically present in Greece, Turkey, Syria and Lebanon (QUÉZEL 1964). DIMOPOULOS et al. (1997) identify 20 order and alliance character-taxa, 70% of which consist of Greek endemic plants and Balkan species. *Carum multiflorum*, which is also present in *Potentilletalia speciosae* and *Petromaruletalia pinnatae*, is ranked as a class character-species; whereas *Scrophularia lucida* is not given special diagnostic importance (DIMOPOULOS et al. 1997). Then, out of the 20 character-species, only *Campanula versicolor* is present in south-eastern Italy. Despite the high population variability of this species, it is not possible to differentiate Italian populations from Balkan populations with the presently available data (PIGNATTI 1982, KOVACIC 2004); however, the long isolation of the opposite coasts of the Adriatic Sea and the different environmental conditions make the hypothesis of an ecotype differentiation likely.

The floristic compositions of the four associations of the Murge and Serre ridges have higher similarity with the communities described for the South of Italy rather than the trans-Adriatic communities of *Onosmetalia frutescentis*, which harbour a lot of Balkan endemisms.

This interpretation is in line with similar observations reported by MARCHIORI et al. (2001) in a floristic survey of Apulia, where they argued for the establishment of an autonomous biogeographic unit characterized by a greater similarity to the Campania-Calabria and Sicily districts to update the traditional biogeographic subdivisions.

As far as the relationship with *Centaureo-Campanuletalia* is concerned, this order was originally established to separate the rupicolous communities of the Adriatic area from *Asplenietalia glandulosi*, including those of the alliance *Centaureo-Campanulion* of Trieste karst and of the Gargano area; these latter communities were then better typified through the endemic alliance *Asperulion garganicae* (TRINAJSTIĆ 1980, BIANCO et al. 1988). However, the opportunity to remove the alliance *Centaureo-Campanulion* from *Asplenietalia glandulosi*, to which it had been originally assigned (cf. HORVAT et al. 1974, LAUSI and POLDINI 1962), in favour of a new order was then criticized by POLDINI (1989) on account of the sociological role of *Teucrium flavum*, among other reasons. The obtained results show that, despite the clear-cut floristic differences, the communities of south-eastern Italy share some important species with the communities of *Asperulion garganicae*. The high rate of endemic entities typical of Gargano flora, particularly of rupicolous habitats, and the relatively high percentage of Illyrian and Amphiadriatic species indicate, nonetheless, the ecological autonomy

Tab. 7. Synoptic table of: *Iberido carnosae-Athamantetum siculi* (A); *Aurinio-Centaureetum apulae* (B); *Piptathero holciformis-Campanuletum versicoloris* (C); *Campanulo-Aurinietum leucadeae* (D).

	A	B	C	D
Iberido carnosae-Athamantetum siculi				
Sedum hispanicum	75	.	.	.
Acinos suaveolens	63	.	.	.
Iberis carnosa carnosa	29	.	.	.
Aurinio-Centaureetum apulae				
Centaurea brulla	.	100	8	.
Piptathero holciformis-Campanuletum versicoloris				
Leontodon intermedius	.	.	100	.
Piptatherum holciforme	.	.	42	.
Campanulo-Aurinietum leucadeae				
Aurinia leucadea	.	.	.	96
Dianthus japigicus	.	.	.	43
Centaurea leucadea	.	.	.	26
Centaurea japygica	.	.	.	17
Centaurea nobilis	.	.	.	17
Centaurea tenacissima	.	.	.	13
Caro multiflori-Aurinion megalocarpae				
Carum multiflorum multiflorum	25	50	25	43
Campanula versicolor	.	100	100	100
Aurinia saxatilis megalocarpa	83	90	58	.
Scrophularia lucida	.	70	17	70
Melica transsilvanica	88	.	67	.
Asplenietalia glandulosi/Asplenietea trichomanis				
Parietaria judaica	58	40	58	52
Umbilicus horizontalis	54	40	42	22
Campanula erinus	33	10	42	9
Ficus carica	21	20	25	22
Athamanta sicula	96	10	92	.
Dianthus garganicus	38	40	92	.
Sedum dasyphyllum	.	40	75	39
Teucrium flavum	.	40	33	26
Ceterach officinarum	46	30	8	.
Capparis spinosa	.	.	42	78
Leontodon apulus	63	.	17	.
Melica minuta	.	50	.	22
Asplenium trichomanes	.	30	.	.
Parietaria lusitanica	.	30	.	.
Centranthus ruber ruber	.	.	25	.
Geranium purpureum	25	.	.	.
Other taxa				
Micromeria graeca	96	70	50	17

Tab. 7. – continued

	A	B	C	D
Sedum rupestre	54	10	17	22
Silene vulgaris tenoreana	21	30	25	17
Rhamnus saxatilis infectorius	96	70	75	.
Satureja montana	17	80	92	.
Prasium majus	.	60	67	52
Sedum album	50	30	17	.
Reichardia picroides	42	10	.	43
Convolvulus elegantissimus	88	.	8	.
Emerus majus emeroides	.	20	67	.
Festuca circummediterranea	58	.	8	.
Linum austriacum tommasinii	33	.	33	.
Onosma angustifolia	25	.	33	.
Rhamnus alaternus	.	30	17	.
Valantia muralis	.	10	.	35
Satureja cuneifolia	.	20	.	22
Fumaria capreolata capreolata	8	.	33	.
Trachynia distachya	4	.	.	35
Pistacia terebinthus	.	10	25	.
Dasypyrum villosum	8	.	8	.
Thymus capitatus	.	10	.	4
Echium plantagineum	4	.	.	9
Bituminaria bituminosa	8	.	.	4
Coronilla valentina	.	.	8	4
Asparagus acutifolius	4	.	.	4

In A: *Scorzonera villosa columnae* (42); *Hyoseris radiata radiata* (38); *Thymus spinulosus* (33); *Minuartia verna attica* (25); *Galium corrudifolium* (21); *Helianthemum oelandicum incanum* (17); *Ruta chalepensis* (17); *Convolvulus cantabrica (13); Bromus rubens (8); Euphorbia spinosa (8); Geranium molle* (8); *Osyris alba* (8); *Poa bulbosa* (8); *Sanguisorba minor* (8); *Aethionema saxatile* (4); *Alyssum diffusum* (4); *Arenaria leptoclados* (4); *Bromus scoparius* (4); *Calamintha nepeta* (4); *Echium vulgare* (4); *Hippocrepis glauca* (4); *Petrorhagia saxifraga gasparrinii* (4); *Saxifraga tridactylites* (4); *Seseli tortuosum* (4); *Sesleria juncifolia juncifolia* (4); *Stachys germanica salviifolia* (4); *Stipa austroitalica austroitalica* (4); *Thesium humifusum* (4).

In B: *Arabis turrita* (10); *Asperula garganica* (10); *Helianthemum jonium* (10); *Pistacia lentiscus* (10); *Allium subhirsutum* (20); *Asyneuma limonifolium limonifolium* (20); *Phagnalon saxatile* (60).

In C: *Phagnalon rupestre* (67); *Helictotrichon convolutum* (33); *Euphorbia characias* (17); *Mercurialis annua* (17); *Reseda alba* (17); *Matthiola fruticulosa* (8); *Pallenis spinosa* (8); *Sedum acre* (8).

In D: *Brachypodium retusum* (78); *Lotus cytisoides* (43); *Dittrichia viscosa* (35); *Crithmum maritimum* (30); *Euphorbia dendroides* (30); *Euphorbia myrsinites myrsinites* (30); *Hyparrenia hirta hirta* (22); *Dorycnium hirsutum* (17); *Limonium japygicum* (17); *Phlomis fruticosa* (17); *Catapodium rigidum* (13); *Quercus ilex* (13); *Sonchus tenerrimus* (13); *Convolvulus althaeoides* (9); *Euphorbia bivonae* (9); *Foeniculum vulgare* (9); *Myrtus communis* (9); *Rostraria cristata* (9); *Acanthus mollis mollis* (4); *Cachrys libanotis* (4); *Carlina corymbosa* (4); *Lagurus ovatus* (4); *Lavatera arborea* (4); *Lonicera implexa* (4); *Melica ciliata* (4); *Phedimus stellatus* (4); *Picris hieracioides* (4); *Sideritis romana* (4); *Smilax aspera* (4); *Stipa capensis* (4).

Tab. 8. List of syntaxa mentioned in the text.

Asperulion garganicae Bianco, Brullo, Pignatti et S. Pignatti 1988
Asplenietalia glandulosi Br.-Bl. et Meier 1935
Asplenietea trichomanis (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977
Aurinio-Centaureetum apulae Bianco, Brullo, Pignatti et S. Pignatti 1988
Campanulion versicoloris Quézel 1964
Campanulo-Aurinietum leucadeae Bianco, Brullo, Pignatti et S. Pignatti 1988
Caro multiflori-Aurinion megalocarpae Terzi et D' Amico all. nov.
Centaureion pentadactyli Brullo, Scelsi et Spampinato 2001
Centaureo-Campanuletalia Trinajstić 1980
Centaureo-Campanulion H-ić 1934
Cisto-Micromerietalia Oberdorfer 1954
Dianthion rupicolae Brullo et Marcenò 1979
Iberido carnosae-Athamantetum siculi Terzi et D' Amico ass. nov.
Onosmetalia frutescentis Quézel 1964
Petromaruletalia pinnatae Zaffran 1990
Piptathero holciformis-Campanuletum versicoloris Terzi et D' Amico ass. nov.
Potentilletalia caulescentis Br.-Bl. in Br.-Bl. et Jenny 1926
Potentilletalia speciosae Quézel 1964

of the Gargano communities (DE FAVERI and NIMIS 1982, BIANCO et al. 1988). This autonomy, which corresponds to the endemic alliance *Asperulion garganicae*, is not mirrored in the relevant character-species because two of these species, *Leontodon apulus* and *Dianthus garganicus*, were frequently recorded in the Murge district and are also present in Serre Salentine, as witnessed by some *exsiccatae* from the University of Bari Herbarium. Therefore, these two species are considered as regional class character-species.

Based on the discussion above, the rupicolous communities of south-eastern Italy are grouped into a new alliance: *Caro multiflori-Aurinion megalocarpae* (typus *Aurinio-Centaureetum apulae* Bianco, Brullo, Pignatti et S. Pignatti 1988, Tab. 7). This alliance covers the chasmophytic communities of the limestone substrate in the thermo- and meso-Mediterranean belts of south-eastern Italy and is located on the eastern part of the distribution area of the order *Asplenietalia glandulosi*. Dominated by Mediterranean entities, the chorological composition of its associations is enriched by several eastern species, both of Mediterranean and, under more continental climatic conditions, European geoelements. Differential and character-species are *Campanula versicolor*, *Carum multiflorum*, *Scrophularia lucida*, *Melica transsilvanica* and *Aurinia saxatilis* subsp. *megalocarpa*. This last one, considered by BIANCO et al. (1988) as a character-species of *Aurinio-Centaureetum apulae*, has also been recorded in the remaining part of Murge with high frequency and abundance; therefore, it has been ranked as an alliance character-species. *Campanula versicolor*, transgressive from *Campanulion versicoloris*, *Carum multiflorum* and *Scrophularia lucida*, obviously have the significance of regional character-species because they are found in other types of communities on the other side of the Adriatic Sea (cfr. DIMOPOULOS et al. 1997). As far as south-eastern European species *Melica transsilvanica* is concerned, it

plays the role of a differential species in this context. It is necessary to point out, however, that the *M. ciliata* – complex (*sensu lato*) is a taxonomically debated group and that the relationships between *M. ciliata* L. and *M. transsilvanica* Schur. need to be finally resolved (TYLER 2004); as a consequence, it is still difficult to precisely assess the sociological role of these taxa in the various zones of their range.

Conclusions

The analysis of chasmophytic vegetation of the Alta Murgia and Murgia of Matera districts allowed us to describe two new associations, *Piptathero holciformis-Campanuletum versicoloris* and *Iberido carnosae-Athamantetum siculi*, which are sufficiently well-distinguished in their floristic, coenological, bioclimatic and chorological features from the associations previously defined by BIANCO et al. (1988) in south-eastern Italy. Comparisons with other syntaxa already referred to the orders *Centaureo-Campanuletalia*, *Asplenietalia glandulosi* and *Onosmetalia frutescentis* show that the south-eastern Italian communities, now grouped in the new alliance *Caro multiflori-Aurinion megalocarpae*, should be more appropriately assigned to *Asplenietalia glandulosi* rather than to the typically south-west Balkan syntaxa. In other words, the eastern species recorded in the south-east of Italy differentiate the relevant communities within a central Mediterranean vegetation order rather than justifying their assignment to *Onosmetalia frutescentis*. Therefore, contrary to the literature, the *Onosmetalia frutescentis* distribution area excludes south-eastern Italy where it is substituted in the thermo- and meso-Mediterranean belts by the alliance *Caro multiflori-Aurinion megalocarpae* of *Asplenietalia glandulosi*.

References

BIANCO, P., BRULLO, S., PIGNATTI, E., PIGNATTI, S.,1988: La vegetazione delle rupi calcaree della Puglia. Braun-Blanquetia 2, 133–151.

BIANCO, P., CASTELLANO, M. A., PIRO, G., SCHIRONE, B., 1982: Note sulle campanule rupicole italiane: revisione della distribuzione geografica pugliese di *Campanula versicolor* Andrews. Ann. Fac. Agr. Univ. Bari 32, 225–240.

BIANCO, P., SARFATTI, G., 1961: Stazioni di roccia a Monte S. Nicola (Monopoli, Puglia) con osservazioni sull'areale di *Campanula versicolor* Sib. et Sm., *Carum multiflorum* Boiss. e *Scrophularia lucida* L.. Nuovo Giorn. Bot. Ital. 58, 21–55.

BIONDI, E., CASAVECCHIA, S., GUERRA, V., MEDAGLI, P., BECCARISI, L., ZUCCARELLO, V., 2004: A contribution towards knowledge of semideciduous and evergreen woods of Apulia (south eastern Italy). Fitosociologia 41, 3–28.

BIONDI, E., CASAVECCHIA, S., ZUCCARELLO, V., 1997: The *Potentilletalia caulescentis* Br.-Bl. in Br.-Bl. & Jenny 1926 order in Italy. Colloq. Phytosociol. 27, 105–122.

BOENZI, F., RADINA, B., RICCHETTI, G., VALDUGA, A., 1971: Note illustrative della Carta Geologica d'Italia, F° 201 »Matera«. Servizio Geologico d'Italia, Roma.

BRAUN-BLANQUET, J., 1932: Plant Sociology. McGraw-Hill Book Company, New York and London.

BRULLO, S., 1988: Note tassonomiche sulla flora pugliese (Italia meridionale). Braun--Blanquetia 2, 31–32.

BRULLO, S., MARCENÒ, C., SIRACUSA, G., 1998: La classe *Asplenietea trichomanis* in Sicilia. Colloq. Phytosociol. 28, 467–533.

BRULLO, S., MINISSALE, P., SPAMPINATO, G., 1997: La classe *Cisto-Micromerietea* nel Mediterraneo centrale ed orientale. Fitosociologia 32, 29–60.

BRULLO, S., SCELSI, S., SPAMPINATO, G., 2001: La vegetazione dell'Aspromonte, studio fitosociologico. Ed. Baruffa, Reggio Calabria.

CALIANDRO, A., CATALANO, M., RUBINO, P., STEDUTO, P., STELLUTI, M., 2002: Valutazione della consistenza di serie storiche termopluviometriche disponibili nella regione Puglia e applicazioni di procedure di integrazione di dati mancanti. Riv. Agron. 36, 243–255.

CONTI, F., ABBATE, G., ALESSANDRINI, A., BLASI, C., 2005: An annotated checklist of the Italian vascular flora. Ministero dell'Ambiente e della Tutela del Territorio, Direzione per la Protezione della Natura. Palombi Editore, Roma.

CORBETTA, F., FRATTAROLI, A. R., CIASCHETTI, G., PIRONE, G., 2000: Some aspects of the chasmophytic vegetation in the Cilento – Vallo di Diano National Park (Campania-Italy). Acta Bot. Croat. 59, 43–53.

CORBETTA, F., PIRONE, G., 1981: Carta della vegetazione di Monte Alpi e zone contermini (Tavoletta Latronico della Carta d'Italia). C.N.R. Coll. Progr. Final. Promozione della Qualità dell'Ambiente AQ/1/122, 1–38.

CORBETTA, F., UBALDI, D., PIRONE, G., 1988: La vegetazione di altitudine del massiccio del Cervati (Appennino Campano). Doc. Phytosociol. n.s. 11, 465–467.

D'AMICO, F. S., TERZI, M., 2007: Notula alla checklist della flora vascolare italiana: *Piptatherum holciforme* (Bieb.) Roemer et Schultes. Inf. Bot. Ital. 39, 240.

DAVIS, P. H., 1951: Cliff vegetation in the eastern Mediterranean. J. Ecol. 39, 63–93.

DE FAVERI, R., NIMIS, P. L., 1982: *Chamaecytiso-Genistetum michelii*: a new thorny-cushion association in the Gargano Peninsula (SE Italy). Ecol. Medit. 3, 85–98.

DI PIETRO, R., 2001: Aspetti cenologici e distributivi di *Daphne sericea* Vahl. nel Lazio. Fitosociologia 38, 45–61.

DIMOPOULOS, P., SYKORA, K. V., MUCINA, L., GEORGIADIS, T., 1997: The high-rank syntaxa of the rock-cliff and scree vegetation of the mainland Greece and Crete. Folia Geobot. Phytotax. 32, 313–334.

DRING, J., HODA, P., MERSINLLARI, M., MULLAJ, A., PIGNATTI, S., RODWELL, J., 2002: Plant communities of Albania – a preliminary overview. Ann. Bot. (Rome) 2, 7–30.

EUROPEAN COMMISSION, 2003: Interpretation manual of European Union habitats. DG Environment, Nature and Biodiversity, Brussels.

FANELLI, G., LUCCHESE, F., PAURA, B., 2001: Le praterie a *Stipa austroitalica* di due settori adriatici meridionali (basso Molise e Gargano). Fitosociologia 38, 25–36.

FIORI, A., 1923–29: Nuova flora analitica d'Italia. Ed Agricole, Firenze.

FORTE, L., PERRINO, E. V., TERZI, M., 2005: Le praterie a *Stipa austroitalica* Martinovsky ssp. *austroitalica* dell'Alta Murgia (Puglia) e della Murgia Materana (Basilicata). Fitosociologia 42, 83–103.

FRANCINI-CORTI, E., 1966: Aspetti della vegetazione pugliese e contingente paleoegeico meridionale nella Puglia. Ann. Accad. Ital. Sci. For. 15, 137–193.

GEORGIADIS, TH., DIMOPOULOS, P., 1993: Etude de la végétation supraforestière du Mont Kyllini (Péloponèse-Grèce). Bot. Helv. 103, 149–175.

GIANCOLA, C., STANISCI, A., 2006: La vegetazione delle rupi di altitudine del Molise. Fitosociologia 43, 187–195.

HORVAT, I., GLAVAC, V., ELLENBERG, H., 1974: Vegetation Südosteuropas. Geobotanica selecta 4. Gustav Fischer Verlag, Stuttgart.

KOVACIC, S., 2004: The genus *Campanula* L. (Campanulaceae) in Croatia, circum-Adriatic and west Balkan region. Acta Bot. Croat. 63, 171–202.

KRUSKAL, J. B., 1964: Nonmetric Multidimensional Scaling: a numerical method. Psychometrika 29, 115–129.

KUNTZ, K. L., LARSON, D. W., 2006: Microtopographic control of vascular plant, bryophyte and lichen communities on cliff faces. Plant Ecol. 185, 239–253.

LANDOLT, E., 1977: The importance of closely related taxa for the delimitation of phytosociological units. Vegetatio 34, 179–189.

LAUSI, D., POLDINI, L., 1962: Il paesaggio vegetale della costiera triestina. Boll. Soc. Adriat. di Scienze 52, 3–63.

MAIORCA, G., SPAMPINATO, G., 1999: La vegetazione della Riserva Naturale Orientata »Valle del Fiume Argentino« (Calabria Nord-Occidentale). Fitosociologia 36, 15–60.

MARCHIORI, S., MEDAGLI, P., MELE, C., SCANDURA, S., ALBANO, A., 2001: Caratteristiche della flora vascolare pugliese. Cahiers Options Méditerranéennes 53, 67–75.

MATHER, P. M., 1976: Computational methods of multivariate analysis in physical geography. J. Wiley, London.

MCCUNE, B., GRACE, J. B., 2002: Analysis of ecological communities. MjM Software, Gleneden Beach, Oregon, USA.

MCCUNE, B., MEFFORD, M. J., 1999: PC-ORD. Multivariate Analysis of Ecological Data – Version 4.34. MjM Software, Gleneden Beach, Oregon, U.S.A.

MEDAGLI, P., GAMBETTA, G., 2003: Guida alla flora del Parco. Collana Parcomurgia. Parco Regionale della Murgia Materna, Matera.

MINISTRY FOR THE ENVIRONMENT, LAND AND SEA, 2007: Decreto 5 luglio 2007. Elenco dei siti di importanza comunitaria per la regione biogeografica mediterranea in Italia, ai sensi della direttiva 92/43/CEE. G.U. 170, supp. ord. n.167. [online] URL: http://www.minambiente.it

MORALDO, B., 1986: Il genere *Stipa* L. (Gramineae) in Italia. Webbia 40, 203–278.

MUCINA, L., 1997: Conspectus of classes of European vegetation. Folia Geobot. Phytotax. 32, 117–172.

OBERDORFER, E., 1954: Nordaegaeische Kraut- und Zwergstrauchfluren im Vergleich mit den entsprechenden Vegetationseinheiten des westlichen Mittelmeergebietes. Vegetatio 5–6, 88–96.

PARISE, M., FEDERICO, A., DELLE ROSE, M., SAMMARCO, M., 2003: Karst terminology in Apulia (Southern Italy). Acta Carsologica 32, 65–82.

PIGNATTI, S., 1982: Flora d'Italia. Ed. Agricole, Bologna.

PODANI, J., 1997: A measure of discordance for partially ranked data when presence/absence is also meaningful. Coenoses 12, 127–130.

PODANI, J., 2001: SYN-TAX 2000. Computer programs for data analysis in ecology and systematics. User's manual. Scientia, Budapest.

PODANI, J., 2005: Multivariate exploratory analysis of ordinal data in ecology: pitfalls, problems and solutions. J. Veg. Sci. 16, 497– 510.

PODANI, J., 2006: Braun-Blanquet's legacy and data analysis in vegetation science. J. Veg. Sci. 17, 113–117.

POLDINI, L., 1989: La vegetazione del Carso triestino ed isontino. Ed. Lint, Trieste.

QUEZEL, P., 1964: Végétation des hautes montagnes de la Grèce méridionale. Vegetatio 12, 289–386.

RICCHETTI, G., CIARANFI, N., LUPERTO SINNI, E., MONGELLI, F., PIERI, P., 1988: Geodinamica ed evoluzione sedimentaria e tettonica dell'Avampaese Apulo. Mem. Soc. Geol. It. 41, 57–82.

RIVAS-MARTÍNEZ, S., 2004: Global Bioclimatics. Clasificación bioclimática de la Tierra. URL: http://www.globalbioclimatics.org.

SOKAL, R. R., MICHENER, C. D., 1958: A statistical method for evaluating systematic relationships. University of Kansas Sciences Bulletin 22, 1409–1438.

TERZI, M., D'AMICO, F. S., 2006: Garighe basse a *Centaurea subtilis* L. della Murgia Materana (Basilicata). Quad. Bot. Amb. Appl. 17, 65–72.

TRINAJSTIC, I., 1980: Apercu syntaxonomique de la vegetation des rochers de l'espace Adriatique. Stud. Geobot. 1, 203–213.

TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., VALENTINE, D. H., MOORE, D. M., WALTERS, S. M., WEBB, D. A., 1968–1993: Flora Europaea, 1–5. Cambridge University Press.

TYLER, T., 2004: Studies in the *Melica ciliata* – complex: 1. Distribution of allozyme variation within and among individuals, populations and geographic regions. Pl. Syst. Evol. 248, 1–30.