ANNALI DI BOTANICA
Ann. Bot. (Roma), 2010

FLORISTIC CHANGES ALONG THE TOPOGRAPHICAL GRADIENT IN MONTANE GRASSLANDS IN MONTI PICENTINI (CAMPANIA, SW ITALY)

SPADA F.[1*], CUTINI M.[2], PAURA B.[3]

[1]Dip.to di Biologia Vegetale, Università degli studi di Roma "La Sapienza", P.le A.Moro 5, 00185 Roma, Italia*
corresponding author: francesco.spada@uniroma1.it
[2]Dip.to di Biologia, Università degli studi di Roma Tre, Viale G.Marconi 446, 00146 Roma, Italia
e-mail: cutini@uniroma3.it
[3]Dip.to SAVA, Università del Molise, Via De Sanctis 86100 Campobasso, Italia
e-mail: fobos@unimol.it

ABSTRACT - Populations of xerotolerant species (*Achnatherum calamagrostis, Stipa crassiculmis* subsp. *picentina,* are scattered along a wide altitudinal gradient on slopes at mid- and high elevation in Monti Picentini, a subcoastal mesozoic limestone ridge in Tyrrhenian Southern Italy.
Their stands are widespread in grasslands of mostly secondary origin. At lower altitudes these grasslands replace former deciduous forest communities dominated by oaks or beech, while at higher altitudes they reach the summits, where they apparently merge into the remnants of the still partially grazed, zonal climatogenic, grasslands ranging above the local tree-line.
Nevertheless primary stands of these grasslands are to be found around the many clusters of highly dynamic sites of the montane and sub-alpine levels, scattered around screes and rocky outcrops of the prevalently dolomitic morphology of the slopes. This virtual continuity of non arboreal communities across more than 1000 metres of the local topographical gradient, where azonal, relic stands of *Pinus nigra* s.l. are transitional between the grasslands and the surrounding zonal broadleaved forest vegetation, stresses patterns of the coenological changes between *Festuco-Brometea* and *Elyno-Seslerietea* along the catena, which suggest fragmentary persistence of a paleozonation.

KEY WORDS - GRASSLANDS, PALEOZONATION, PHYTOGEOGRAPHY, PHYTOSOCIOLOGY, SOUTHERN APENNINE.

GENERALITIES

A high species density is found in the district of Monti Picentini in W Campania (S Italy). Within an area of 94000 ha, 1260 species have been recorded (Moraldo *et al.*, 1981-82; 1985-86). Diversity pattern show high concentration of endemic, subendemic, disjunct and rare *taxa* compared to other neighbouring districts (La Valva *et al.*, 1976; Martinovsky *et al.*, 1974-75).

Temperate deciduous forests with meso-eutrophilic character (*Quercus cerris*, *Tilia platyphyllos*) are climatogenic on gentle slopes. Stands of the subendemic *Acer lobelii, Alnus cordata* are common in the *Q.cerris* forest of lower altitudes, while within the *Fagus-Ilex* forests of the upper forest belt, stands of rare associates (*Staphylea pinnata, Betula pendula, Taxus baccata, Abies alba*) occur.

Stands of grasslands are scattered across a more than thousand meters long topographical gradient, from middle elevations (400 m a.s.l.) to local sum-

Received October 01, 2009
Accepted November 02, 2009

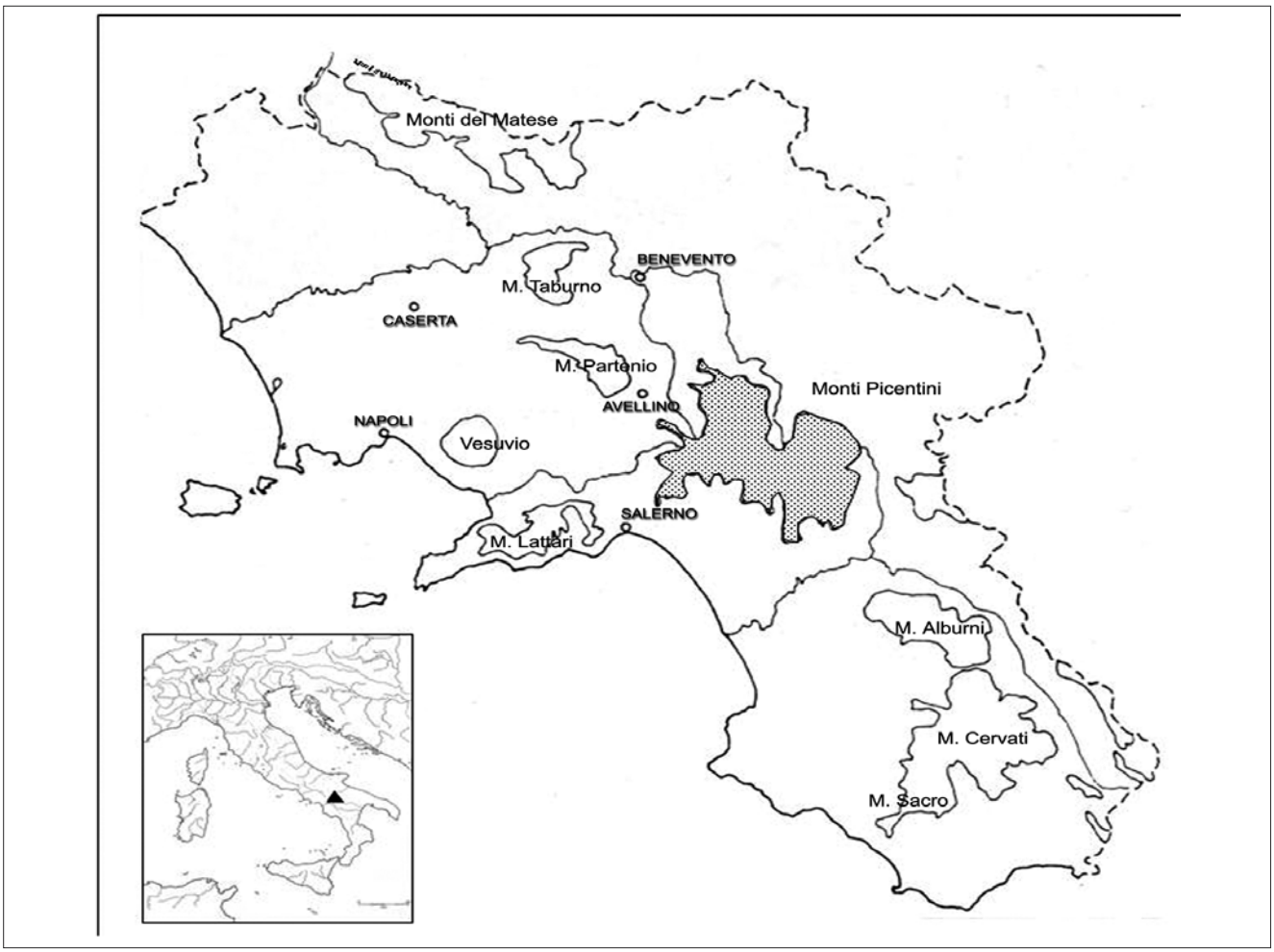

Figure 1. Location of the study area

mits (1800 m a.s.l.). Most of the stands are secondary but the local topography provides, at any altitude, highly dynamic sites (Budetta *et al*., 1993; Bonardi *et al*., 1988) where permanent communities of grassland species can be considered as primary stands.

Scanty fragments of tussocks grasslands with *Achnatherum calamagrostis* are restricted on steeper slopes, rock crevices, cliffs and screes at lower altitudes, while rare and small populations of the endemic *Stipa crassiculmis* subsp. *picentina* occur near the summits. Fragments of evergreen forest (*Quercus ilex, Arbutus unedo*), thicket and stands of xerophilic mediterranean dwarf-shrubs (*Cistus salvifolius*, *Helichrysum italicum, Erica terminalis*) usually fringe these outpost, independently from elevation (often above 1500 m a.s.l.).

This suggests relictuality for a consistent stock of both drought-resistant, continental species, as well as of mesophilic ones, stressing the refugial status of the area during previous climatic fluctuations (see Brown & Lomolino, 1998).

The Area

The district of Monti Picentini encompasses a NW-SE Apenninic mountain-ridge with low density of human settlements (Fig. 1). The main elevations range from 1809 m a.s.l. (M. Cervialto), to 1780 m (M. Polveracchio) and 1574 m (M. Boschetiello) and apparently do not reach the upper climatogenic for-

est limit. Dolomitic limestones prevail and give origin to a highly heterogeneous and dynamic morphology, with deep and steep valleys and gorges. Morphology on summits locally shapes a topographic tree-line which allows the development of isolates of primary subalpine grasslands. These acted as original nuclea of the present-day large secondary grassland, due to a long impact by domestic herbivores. Paradigmatic for the local patterns of geomorphology and vegetation is the area of Vallone della Caccia where most of the rare species are concentrated and where the data have been recorded.

The study-area is located within the Parco Regionale dei Monti Picentini, and is part of the EU Special Protection Area "M. Polveracchio, M. Boschetiello, Vallone Caccia-Senerchia". Here many vegetation types can be classified into the EC Directive 92/43 priority Habitats "(Sub)-Mediterranean pine forests with endemic black pines" (9530*), "Apennine beech forests with *Taxus* and *Ilex*" (9210*) and "Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)" (6210*) (CEC, 2007; Biondi *et al*., 2009).

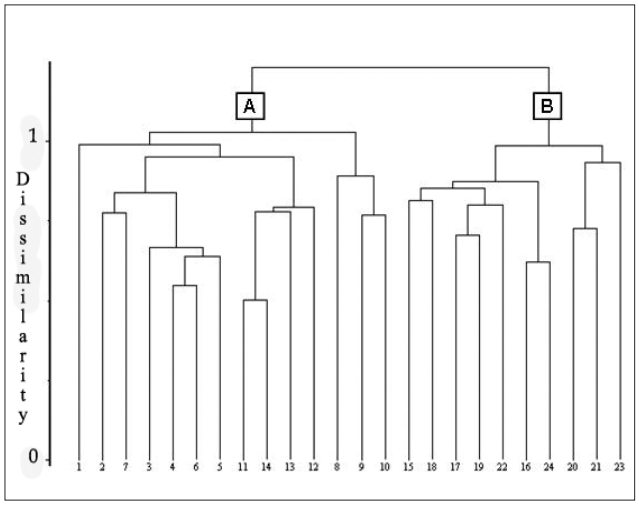

Figure 2. Vegetation changes along the topographical gradient at Vallone della Caccia.
(1) Riverine thickets (Alnus cordata, Hypericum hyrcinum, Ostrya carpinifolia)
(2) Fragments of Erica terminalis heaths
(3) Cushion chamephyta and tussock graminoids (Onosma echioides, Scabiosa crenata, Achnatherum chalamagrostis, Satureja montana)
(4) Deciduous forest (Ostrya carpinifolia, Quercus cerris, Sesleria autumnalis, Vinca minor)
(5) Pinus nigra stands in open habitats
(6) Beech-forest (Fagus sylvatica, Ilex aquifolium, Taxus baccata)
(7) Summit grasslands (Bromus erectus, Koeleria splendens, Festuca circummediterranea, Avenula praetutiana)
(8) Rocky habitats on summits (Oxytropis caputoi, Anthyllis montana, Sesleria tenuifolia, Helianthemum canum, Stipa crassiculmis)

Aims And Methods

Here focus is given to some coenological characters of the local grassland communities, matching the high degree of anomalies in the vegetation patterns along the topographical gradient (Fig. 2). Results of an inventory based on classic phytosociological analysis from stands within the watershed of Vallone della Caccia is presented. Morphologically highly dynamic and heterogeneous sites, where the unexpected species and communities are scattered, have been selected following a stratified sampling design (strata: land-slips, screes, rocky outcrops).

A data set of 24 samples and 154 species has been processed by Agglomerative Classification (Quantitative data, Dissimilarity ratio, Chord distance) according to SYN-TAX 2000 (Podani, 2001).

This coenological approach to the local phytodiversity is intended to provide information on community history. It is therefore focused on affinities among communities beyond the level of local *microspecies* (cfr. *Stipa* sp.pl.; Pignatti, 1982), here considered to be essential for an interpretation of vegetation mosaic consistent with data from vegetation history, phytogeographical evidence and biome structure at the continental scale (zonobiomes *sensu* Walter 1983:cfr. Bailey, 1996 and Brieckle, 2002). The syntaxonomic ranking follows Biondi (2000) and Biondi *et al.* (1995). The nomenclature follows Pignatti, 1982; for *Stipa* see Moraldo, 1986.

Results

The classification of the samples shows two main

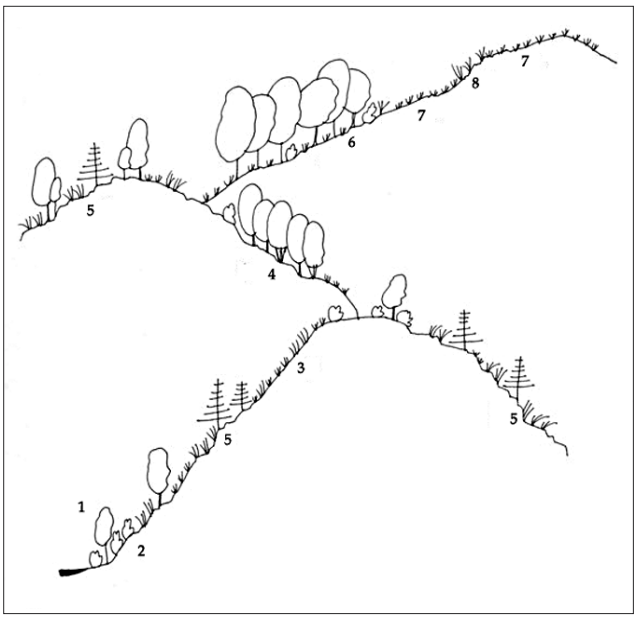

Figure 3. Chord distance dendrogram of the floristic matrix using dissimilarity ratio.

clusters (Fig. 3). They are apparently based (cluster A) on the discriminator value of *Achnatherum calamagrostis, Pinus nigra, Erica terminalis* along with Mediterranean, S or SE European or Pontic chamaephytes of circum-steppic biomes (*Teucrium flavum, Helichrisum italicum, Asperula purpurea, Fumana procumbens, Dorychinium hirsutum, Onosma echioides*). In cluster B, *Stipa crassiculmis* subsp. *picentina*, a micro-endemic local *taxon* of the widespread SE Europaean orophilous *Stipa crassiculmis* of the mountains of the NE Mediterranean regions (itself an outpost of *S. pennata* s.l. of the steppe of C Asia), discriminates the cluster along with *Crepis lacera, Thymus striatus, Dianthus sylvestris, Avenula praetutiana, Centaura deusta, Sempervivum tectorum, Eryngium amethystinum, Acinos alpinus* (Mediterranean or S European orophytes) and the Circumboreal *Poa alpina* which points out a summit flora with a slightly character of tundra biome.

The inspection of cluster A shows that the local isolated populations of *Pinus nigra* and scattered heaths of *Erica terminalis*, are involved in the framework of xerophilic open communities (ground cover around 50%) of dwarf-shrubs on steep slopes, screes and land-slips (*Rosmarinetea officinalis*) colonised both by catadromic species from summit grasslands (*Festuco-Brometea*) and seedlings from surrounding forest on less dynamic sites. Here we recognise a community of secondary grassland of lower altitudes with features of the association *Saturejo montanae-Scabiosetum crenatae* (Biondi, 2000) for which we propose the rank of a local new subassociation, characterized by *Achnatherum calamagrostis* (holotypus Tab. 1, sample-plot n.3). The former association was earlier proposed for Lucania (Corbetta & Pirone, 1981) and later recognized in Calabria (Abbate *et al.*, 1984) as subassociation *scabiosetosum crenatae* of *Saturejo montanae-Brometum erecti* (Avena & Blasi, 1979) and has only later been emendated (Biondi, 2000) into the present *syntaxon*.

In central Europe (Austrian Alps) communities with *Achnatherum* are recognised as the association *Stipetum calamagrostis* (Mucina, 1997; Valachovic *et al.*, 1997), ranked into *Thlaspietea rotundifoliae*. In those districts, such communities often grow in contiguity to stands of *Pinus nigra* (*Erico-Pinetea* in Grabherr & Mucina, 1993), suggesting strong analogies with the vegetation patterns in Monti Picentini. Further South in the peninsula (Monte Pollino area), *Achnatherum* communities have been included in a class of mainly dwarf-shrubs on unstable soils (*Scrophulario-Helichrysetea italicae*) vicariating here, the central European, Alpine and Appenninic *Thlaspietea rotundifoliae* (Brullo *et al.*, 1998). Despite of the geographical vicinity, the floristic affinities of the community of the former class with the reported stands in Monti Picentini seem to be lower.

Erica terminalis behaves as key species for a *facies* of this community, growing on steeper slopes and consolidated debris near the "talweg". It is usually a common associate in both arboreal (see sample-plots n. 10-14) and dwarf-scrub communities along the catenas in narrow valleys of the upper streams of the catchment but is apparently not limited here to riverine gravel banks communities, as it is elsewhere in W Mediterranean districts (Gamisans,

1991; Angius & Bacchetta, 2009).

Cluster B shows transitional characteristics between secondary dwarf-shrubs rich grassland scattered at lower altitudes (*Saturejo montanae-Brometum erecti*) and primary zonal grasslands of mountain areas located above the tree-line (*Seslerietum apenninae*)(Bruno & Furnari, 1966; Biondi *et al.*, 1995; Blasi *et al.*, 2003). In Table 1 it is possible to observe population of *Stipa crassiculmis* subsp. *picentina*, relegated in fragmented summit-grasslands on rocky outcrops with lithosols. This *syntaxon* has been described for sites on cliffs, "cuestas" and systems of secondary ridges in central Apennines (Bruno & Covarelli, 1968; Ballelli & Biondi, 1982; Biondi *et al.*, 1988; Allegrezza *et al.,* 1997) and later recognised in many other locations in southern Apennines (Abbate *et al.*, 1984; Lucchese *et al.*, 1995; Maiorca & Spampinato, 1999). A higher amount of dwarf-shrubs as common associates is distinctive for this community, which displays characteristics of permanent community and is likely to be the remnant of an earlier primary source for the flora of these zonal grasslands (cfr. sample-plots 20-23). Other associates in some of the sample-plots stress affinities with communities of secondary *Bromus erectus* grasslands, widespread throughout the summits in central and Southern Apennines (Avena & Blasi, 1979; Biondi *et al.*, 1995).

Phytohistorical Inferences

Local population of xeromorphic and xerotolerant species are relegated in areas of intense and dynamic geomorphology, surrounded by mesophytic, eutrophilic, climatogenic forest communities on less dynamic sites. It means that the former are located on sites with very low competition and are aggregated in edaphogenic permanent communities, while the latter grow on sites where intense competition processes take place and are in equilibrium with the local macro-climate (deciduous forest). Affinities at continental scale show that most of the species of the edaphogenic permanent communities of the study area belong to an eastern substeppe stock of Western Asia (Zohary, 1973; Horvat *et al.*, 1974; Walter, 1974), were they form climatogenic communities on large areas.

As far as deciduous forest can be considered the climatogenic vegetation type in the whole area, the *Erica* heath and the dwarf-shrubs rich grassland on highly dynamic/low-competition sites and eastern affinities, is therefore of more ancient character in the study area, where it represents a relic of previous xeric climatic phases of the last glacial cycle (Bredenkamp *et al.*, 2002).

Considering the pattern of late Quaternary climatic fluctuations and the earlier spread of steppe and sub-desert biomes in the West during the pleniglacials, these communities therefore exhibit relic status in low competition sites within the study area. On the other hand, Caucasian and W Himalayan affinities among the species of the mesophilic forest stock (*Acer lobelii* = *A. cappadocicum*, *Alnus cordata* = *A. cordifolia*; see Spada *et al.*, 1995 and Conti *et al.*, 2005) suggest that these stands and the surrounding district as a whole, are likely to have been affected by a lower degree of pleniglacial climatic constrains. They keep therefore the characters suggested for local forest *refugia* during the last pleniglacial (Spada *et al.*, l.c.).

Moreover, affinities of the local stands of *Pinus nigra* with *Pinus (nigra) pallasiana* communities at the uppermost limit of the arid Mediterranean zonation both in Crimea and Caucasus, can be detected (Walter, 1974). In these territories the species reaches its easternmost range-boundary at the transition between the Mediterranean forest biomes and the biome of the steppe. The stands in Monti Picentini are in contiguity along the local catena with (relic) steppe communities as well (Tab. 1; Fig. 2).

Since a steppe flora established in Southern Europe during the last pleniglacials and a mesic nemoral and woody flora is representative of middle Holocene environmental conditions (Huntley & Webb, 1988), the xerophilic stock of dry and harsh climatic conditions is therefore older than the mesophilic ones, considering the sequence of the major climatic

SYNTAXONOMY

FESTUCO-BROMETEA Br.-Bl. & Tx. 1943 ex Klika & Hadac 1944
Brometalia erecti Br.-Bl. 1936
Sideridenion syriacae Biondi, Ballelli, Allegrezza & Zuccarello 1995
Phleo ambigui-Bromion erecti Biondi & Blasi ex Biondi, Ballelli, Allegrezza, Zuccarello 1995
Saturejo montanae-Brometum ercti Avena & Blasi 1979

ROSMARINETEA OFFICINALIS Rivas-Martinez, Diaz, Prieto, Loidi & Penas 1991
Rosmarinetalia officinalis Br.-Bl. ex Molinier 1934
Artemisio albae-Saturejion montanae Allegrezza, Biondi, Formica, Ballelli, 1997
Saturejo montanae-Scabiosetum crenatae Biondi 2000
achnatheretosum calamagrostis subass.nova

changes from upper Quaternary to middle-Holocene. This suggests that in Monti Picentini the sequence of edaphogenic permanent communities along the topographic "catena" traces out the sequence of zonal biomes along the W-E geographical gradient of present days in the transitional zone between forests and steppe (semideserts).

This implies that in the study area the spatial pattern of vegetation mirror a relative "chronology" of colonisation events. Vallone della Caccia, one of the most dynamic sites in the study area, is therefore paradigmatic for the conservation of a pleniglacial flora in areas, at present, characterized by a Mediterranean and sub-Mediterranean plant cover. The floristic changes within the areas therefore suggest the fragmentary conservation *in situ* of remnants of a paleozonation previous to the Holocene forest recover.

REFERENCES

ABBATE G., AVENA G.C., BLASI C., FASCETTI S., 1984 - *Pastures with* Bromus erectus *Hudson at the Mula, Muletta and Cozzo del Pellegrino Mountains (Western Calabria – Southern Italy)*. Ann.Bot. (Roma), **XLII**: 67-74.

ALLEGREZZA M., BIONDI E., FORMICA E., BALLELLI S., 1997 - *La vegetazione dei settori rupestri calcarei dell'Italia centrale*. Fitosociologia, **32**: 91-120.

ANGIUS R. and BACCHETTA G., 2009 - *Boschi e boscaglie riparali del Sulcis-Iglesiente (Sardegna sud-occidentale, Italia)*. Braun-Blanquetia, **45**: 1-63.

AVENA G.C. and BLASI C., 1979 - Saturejo montanae-Brometum erecti *ass.nova dei settori pedemontani dell'Appennino calcareo centrale*. Arch. Bot. Biogeogr. Ital., **55(1/2)**: 34-43.

BAILEY R.G., 1996 - *Ecosystems Geography*. Springer, 204 pg.

BALLELLI S. and BIONDI E., 1982 - *Carta della vegetazione del Foglio Pergola*. Collana del Programma Finalizzato "Promozione della Qualità dell'Ambiente", **AQ/1/130**. CNR: 1-33.

BIONDI E., (1997) 2000 - *Syntaxonomy of the Mediterranean chamaephytic and nanophanerophytis vegetation in Italy*. Coll. Phytosoc., **XXVII**: 123-145.

BIONDI E., BLASI C., BURRASCANO S., CASAVECCHIA S., COPIZ R., DEL VICO E., GALDENZI D., GIGANTE D., LASEN C., SPAMPINATO G., VENANZONI R., ZIVKOVIC L., 2009 - *Manuale italiano di interpretazione degli habitat della Direttiva 92/43/CEE*. Società Botanica Italiana. Ministero dell'Ambiente e della Tutela del Territorio e del Mare, D.P.N. (*http://vnr.unipg/it/habitat/*).

BIONDI E.,. GUITIAN J., ALLEGREZZA M., BALLELLI S., 1988 - *Su alcuni pascoli a* Sesleria apennina *Ujhelyi nell'Appennino centrale*. Doc. Phytosoc., N.S., **11**: 417-422.

BLASI C., DI PIETRO R., FORTINI P., CATONICA C., 2003 - *The main Plant comminity types of the alpine belt of the Apennine chain*. Plant Biosystems, **137 (1)**: 83-110.

BONARDI G., D'ARGENIO B., PERRONE V., 1988 - *Carta Geologica dell'Appennino meridionale*. Scala 1:250.000. SELCA Firenze.

BREDENKAMP G.J., SPADA F., KAZMIERCZAK E., 2002 - *On the origin of northern and southern hemisphere grasslands*. Plant Ecology, **163** : 209-229.

BRIECKLE S.W., 2002 - *Walter's Vegetation of the Earth*. 4th Ed., Springer. 527 pp.

BROWN J.H. and LOMOLINO M.V., 1998 - *Biogeography*. Sinauer Ass.: 692pp.

BRULLO S., SCELSI F., SPAMPINATO G., 1998 - *Considerazioni sintassonomiche sulla vegetazione perenne pioniera dei substrati incoerenti*

dell'Italia meridionale e Sicilia. Itinera Geobotanica, **11**: 403-424.

Bruno F. and Covarelli G., 1968 - *I pascoli e i prati-pascoli della Valsorda (Appennino Umbro)*. Not. Fitosoc., **5**: 47-65.

Bruno F. and Furnari F., 1966 - *Excursion de la société internazionale de phytosociologie dans les Abruzzes (Apennins centraux)*. Not. Fitosoc., **3**: 1-50.

Budetta P., Calcaterra D., Corniello A., De Riso R., Ducci D., Santo A., 1993 - *Appunti di Geologia dell'Appennino meridionale*. Ist. Geol. Appl., **332**: 1-39.

Commission of the European Community, 2007 - *Interpretation Manual of European Union Habitats*. EUR 27. 142 pg.

Conti F., Abbate G., Alessandrini A., Blasi C., 2005 - *An annotated Checklist of the Italian Vascular Flora*. Ministero dell'Ambient e della Tutela del Territorio, Dip.to di Biologia Vegetale-Università degli Studi di Roma "La Sapienza". Palombi Ed., Roma. 420 pp.

Corbetta G. and Pirone G., 1981 - *La vegetazione di Monte Alpi e zone contermini (Tavoletta "Latronico" della Carta d'Italia)*. Collana del Programma Finalizzato "Promozione della Qualità dell'Ambiente", **AQ/1/122**. CNR: 1-38.

Gamisans J., 1991 - *La végétation de la Corse*. Conservatoire et Jardin botaniques, Geneve. 391 pp.

Grabherr G. and Mucina L., 1993 - *Die Pflanzengesellschaften Österreichs*. Teil II. Gustav Fischer Verlag Jena, Stuttgart, New York: 523pp.

Hunley B. and Webb T. (Eds.), 1988 - *Vegetation history*. Handbook of vegetation science 7. Kluwer Academic Publisher, The Netherlands. 803pp.

Horvat I., Glavac V., Ellenberg H., 1974 - *Vegetation Südosteuropas*. Gustav Fischer Verlag, Stuttgart. 768pp.

La Valva V., Moraldo B., Caputo G., 1976 - Pinus nigra *Arn. nel gruppo del Cervialto (M.ti Picentini, Appennino campano)*. Delpinoa, n.s., **18-19**: 3-15.

Lucchese F., Persia G., Pignatti S., 1995 - *I prati a* Bromus erectus *Hudson dell'Appennino laziale*. Fitosociologia, **30**: 145-180.

Maiorca G. and Spampinato G., 1999 - *La vegetazione della Riserva Naturale Orientata "Valle del Fiume Argentino" (Calabria Nord-Occidentale)*. Fitosociologia, **36 (2)**: 15-60.

Martinovsky J.O., Moraldo B., CAPUTO G., 1974-75 - Stipa crassiculmis *P. Smirnov ssp.* picentina, *ssp.n. nel massiccio dei Picentini (Appennino campano)*. Delpinoa, **16-17**: 185-191.

Moraldo B., 1986 - *Il genere Stipa L.* (Gramineae) *in Italia*. Webbia, **40 (2)**: 203-278.

Moraldo B., La Valva V., Ricciardi M., Caputo G., 1981-1982 - *La Flora dei Monti Picentini (Campania). Pars prima:* Selaginellaceae-Umbelliferae. Delpinoa, n.s., **23-24**: 203-291.

Moraldo B., La Valva V., Ricciardi M., Caputo G., 1985-1986 - *La Flora dei Monti Picentini (Campania). Pars altera:* Pyrolaceae-Orchidaceae. Delpinoa, n.s., **27-28**: 59-148.

Mucina L., 1997 - *Conspectus classes of European vegetation*. Folia Geobot. Phytotax., **32**: 117-172.

Pignatti S., 1982 - *Flora d'Italia*. Edagricole, Bologna. 3vol.

Podani J., 2001 - *SYN-TAX V*. Computer Program for data analysis in Ecology and Systematics. UNIDO, Trieste.

Spada F., Valfrè D., Conti F., Isopi R., 1995 - *Long-term dynamics in Central Apennines (Peninsular Italy): the case of* Betula pendula *Roth*. Coll. Phytosoc., **XXIV**: 859-871.

Valachovic M., Dierssen K., Dimopoulos P., Hadac E., Loidi H., Mucina L., Rossi G., Valle-Tendero F., Tomaselli M., 1997 - *The vegetation on screes- a synopsis of higher syntaxa in Europe*. Folia Geobot. Phytotax., **32**: 173-192.

Walter H., 1974 - *Die Vegetation Osteuropas, Nord- und Zentralasiens*. Band VII. Gustav Fischer Verlag, Stuttgart. 452pp.

Walter H., 1983 - *Vegetation of the Earth and Ecological Systems of Geo-biosphere*. 3th edition, Springer. 318 pp.

Zohary M., 1973 - *Geobotanical foundations of the Middle East*. Seiten mit Vegetations Karte, Stuttgard-Amsterdam. 739pp.

Location, Date and sporadic species

Rel. 1. Vallone della Caccia (Senerchia). 24.06.2001. *Bupleurum baldense* Turra subsp. *baldense* +; *Ostrya carpinifolia* Scop. +; *Teucrium chamaedrys* L. subsp. *chamaedrys* 1; *Linum bienne* Miller +; *Reichardia picroides* (L.) Roth +; *Plantago lanceolata* L. 1; *Asparagus acutifolius* L. +. Rel. 2. Vallone della Caccia (Senerchia). 26.07.2002. *Cephalaria leucantha* (L.) Roemer et Schultes +; *Ostrya carpinifolia* Scop. +; *Acer neapolitanum* Ten. +; *Clematis vitalba* L. +; *Stachys recta* L. subsp. *grandiflora* (Caruel) Arcangeli 1. Rel. 3. Vallone della Caccia (Senerchia). 26.07.2002. *Odontites verna* (Bellardi) Dumort subsp. *serotina* (Dumort) 1; *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +. Rel. 4. Vallone della Caccia (Senerchia). 27.07.2002. *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek + ; *Quercus ilex* L. +. Rel. 5. Vallone della Caccia (Senerchia). 20.05.2002. *Odontites verna* (Bellardi) Dumort subsp. *serotina* (Dumort) 1; *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +; *Acer neapolitanum* Ten. +; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek + ; *Quercus ilex* L. + ; *Vincetoxicum hirundinaria* Medicus + ; *Clematis flammula* L. +; *Astragalus de-*

pressus L. +. Rel. 6. Vallone della Caccia (Senerchia). 20.05.2002. *Bupleurum baldense* Turra subsp. *baldense* +; *Odontites verna* (Bellardi) Dumort subsp. *serotina* (Dumort) 1; *Polygala major* Jacq. +; *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +; *Spartium junceum* L. +; *Teucrium chamaedrys* L. subsp. *chamaedrys* 1; *Petrorhagia saxifraga* (L.) Link subsp. *saxifraga* +; *Vincetoxicum hirundinaria* Medicus +. Rel. 7. Vallone della Caccia (Senerchia). 12.07.2002. *Polygala major* Jacq. +; *Quercus pubescens* Willd. +. Rel. 8. Vallone della Caccia (Senerchia). 12.07.2002. *Saxifraga marginata* Sternb. +; *Ostrya carpinifolia* Scop. 1; *Fraxinus ornus* L. 1; *Acer neapolitanum* Ten. +; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek 1; *Cytisus sessilifolius* L. + ; *Quercus ilex* L. +. Rel. 9. Vallone della Caccia (Senerchia). 12.07.2002. *Polygala major* Jacq. +; *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek + ; *Cytisus sessilifolius* L. +. Rel. 10. Vallone della Caccia (Senerchia). 20.05.2002. *Saxifraga marginata* Sternb. +; *Ostrya carpinifolia* Scop. +; *Acer neapolitanum* Ten. 1; *Cytisus sessilifolius* L. +. Rel. 11. Vallone della Caccia (Senerchia). 25.06.2001. *Ostrya carpinifolia* Scop. 1; *Fraxinus ornus* L. 1; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek + ; *Clematis vitalba* L. +; *Alnus cordata* (Loisel) Desf. +; *Reichardia picroides* (L.) Roth +. Rel. 12. Vallone della Caccia (Senerchia). 25.06.2001. *Ostrya carpinifolia* Scop. +; *Fraxinus ornus* L. +; *Acer neapolitanum* Ten. +. Rel. 13. Vallone della Caccia (Senerchia). 25.06.2001. *Bupleurum baldense* Turra subsp. *baldense* +; *Arbutus unedo* L. +; *Fraxinus ornus* L. 1; *Coronilla emerus* L. subsp. *emeroides* (Boiss. et Spruner) Hayek + ; *Cytisus sessilifolius* L. + ; *Clematis vitalba* L. +; *Allium flavum* L. subsp. *flavum* +. Rel. 14. Vallone della Caccia (Senerchia). 25.06.2001. *Arbutus unedo* L. +; *Ostrya carpinifolia* Scop. 1; *Fraxinus ornus* L. 1; *Spartium junceum* L. +; *Quercus pubescens* Willd. +; *Petrorhagia saxifraga* (L.) Link subsp. *saxifraga +; Linum bienne* Miller +. Rel. 15. Monte Boschetiello (Senerchia). 27.07.2002. *Stachys recta* L. subsp. *grandiflora* (Caruel) Arcangeli +. Rel. 16. Monte Boschetiello (Senerchia). 27.07.2002. *Allium flavum* L. subsp. *flavum* +; *Astragalus depressus* L. +; *Petrorhagia saxifraga* (L.) Link subsp. *saxifraga* +; *Euphorbia myrsinites* L. +; *Sedum tenuifolium* (S. et S.) Strobl +; *Jurinea mollis* (L.) Reichenb. +; *Sedum acre* L. +. Rel. 17. Monte Boschetiello (Senerchia). 24.06.2001. *Jurinea mollis* (L.) Reichenb. +; *Allium flavum* L. subsp. *flavum* +; *Bupleurum baldense* Turra subsp. *baldense* +; *Hyppocrepis comosa* L. +; *Anthericum liliago* L. +; *Viola pseudogracilis* Strobl +; *Trifolium scabrum* L. +; *Minuartia verna* (L.) Hiern 1. Rel. 18. Monte Boschetiello (Senerchia). 19.06.2001. *Bupleurum baldense* Turra subsp. *baldense* +; *Petrorhagia saxifraga* (L.) Link subsp. *saxifraga* +; *Stachys recta* L. subsp. *grandiflora* (Caruel) Arcangeli 1; *Teucrium chamaedrys* L. subsp. *chamaedrys* 1; *Sedum tenuifolium* (S. et S.) Strobl +; *Euphorbia myrsinites* L. +; *Plantago argentea* chaix +; *Cynosurus echinatus* L. +; *Carduus macrocephalus* (Desf.) Nyman; *Antoxanthum odoratum* L. +. Rel. 19. Monte Boschetiello (Senerchia). 27.07.2002. *Allium flavum* L. subsp. *flavum* +; *Astragalus depressus* L. +; *Petrorhagia saxifraga* (L.) Link subsp. *saxifraga* +; *Rosa pimpinellifolia* L. +; *Teucrium chamaedrys* L. subsp. *chamaedrys* +; *Viola pseudogracilis* Strobl +; *Trifolium scabrum* L. +; *Jurinea mollis* (L.) Reichenb. +. Rel. 20. Monte Boschetiello (Senerchia). 19.06.2001. *Astragalus depressus* L. 2; *Teucrium chamaedrys* L. subsp. *chamaedrys* +. Rel. 21. Monte Boschetiello (Senerchia). 27.07.2002. *Allium flavum* L. subsp. *flavum* +; *Ceterach officinarum* DC. +; *Cephalaria leucantha* (L.) Roemer et Schultes +; *Bupleurum baldense* Turra subsp. *baldense* +; *Teucrium chamaedrys* L. subsp. *chamaedrys* +; *Minuartia verna* (L.) Hiern 1; *Euphorbia myrsinites* L. +. Rel. 22. Monte Boschetiello (Senerchia). 19.06.2001. *Allium flavum* L. subsp. *flavum* +; *Astragalus depressus* L. +; *Anthericum liliago* L. +; *Valeriana tuberosa* L. +. Rel. 23. Monte Boschetiello (Senerchia). 27.07.2002. *Jurinea mollis* (L.) Reichenb. +; *Rosa pendulina* L. 1; *Hippocrepis comosa* L. +; *Minuartia verna* (L.) Hiern +; *Anthericum liliago* L. +. Rel. 24. Monte Boschetiello (Senerchia). 27.07.2002. *Allium flavum* L. subsp. *flavum* +; *Ceterach officinarum* DC. *+; Rosa pimpinellifolia* L. 1; *Anthericum liliago* L. +; *Euphorbia myrsinites* L. +.

Table 1

			A														B										
		height a.s.l.	400	700	600	600	900	650	650	800	850	850	400	420	450	400			1350	1550	1500	1400	1450	1500	1500	1500	1600	1500	
		slope (°)	-	40	20	80	35	10	20	50	50	50	45	80	40	25			35	35	20	30	20	65	50	10	20	30	
		aspect	-	NE	S	SE	S	SE	SE	E	SE	E	SW	SE	SE	S			E	SE	SE	SE	S	SE	S	SE	SE	E	
		clasts (%)	20	30	50	-	70	60	40	5	-	5	15	10	15	20			10	10	20	30	40	10	-	70	20	10	
		rocky outcrop (%)	50	60	20	80	20	-	15	70	70	75	50	70	60	50			75	70	15	15	20	30	70	30	35	70	
		cover (%)	60	35	50	40	70	50	50	50	50	60	50	30	45	50			50	50	70	80	75	40	40	70	60	50	
		sample area (mq)	45	40	30	40	30	40	40	40	50	60	30	20	25	40			30	25	35	35	35	35	35	50	60	25	
			1	**2**	**3***	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	frequency	altitudinal gap	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	frequency
		***Saturejo montanae-Scabiosetum crenatae* Biondi 2000**																											
		achnatheretosum calamagrostis																											
Oroph.-S-Medit.		*Scabiosa crenata* Cyr	1	+	3	2	4	3	3	1	1	+	1	2	1	+	V		.	.	.	.	+	.	.	.	1	.	I
Oroph.-S-Europ.		*Achnatherum calamagrostis* (L.) Beauv.	2	3	3	2	1	2	1	1	2	1	2	1	+	1	V		.	.	.	.	.	.	.	.	.	.	-
Oroph.-W-Medit.	***	*Satureja montana L.* subsp. *montana*	.	.	1	2	1	2	+	.	+	+	.	.	+	.	III		1	.	+	.	1	.	+	+	.	.	III
		facies with *Pinus nigra*																											
Illiric		*Pinus nigra* Arnold	.	.	.	.	.	.	.	+	1	2	.	.	.	.	II		.	.	.	.	.	.	.	.	.	.	-
		facies with *Erica terminalis*																	.	.	.	.	.	.	.	.	.	.	-
W-Medit.		*Erica terminalis* Salisb.	.	.	.	+	+	+	.	1	.	.	3	2	3	3	III		.	.	.	.	.	.	.	.	.	.	-
		***Artemisio albae-Saturejion montanae* Allegrezza, Biondi, Formica, Ballelli, 1997**																											
Oroph. SE-Europ.		*Asperula purpurea* (L.) Ehrend. subsp. *purpurea*	.	1	1	+	.	.	+	.	+	.	1	+	+	1	IV		.	.	.	.	.	.	.	.	.	.	-
Illiric-Ital.	**	*Globularia meridionalis* (Podp.) O.Schwarz	.	.	1	.	.	+	+	1	1	+	.	+	1	.	III		+	.	.	.	+	.	.	.	1	.	II
Euri-Medit. Pontic		*Fumana procumbens* (Dunal) G. et G.	.	.	2	1	.	1	.	.	.	+	.	.	.	.	II		.	.	.	.	.	.	.	.	.	.	-
Euri-Medit.		*Dorycnium hirsutum* (L.) Ser.	.	.	.	.	+	.	+	.	.	.	+	.	.	+	II		.	.	.	.	.	.	.	.	.	.	-
		***Rosmarinetalia officinalis* Br.-Bl. ex Molinier 1934**																											
		***Rosmarinetea officinalis* Rivas-Martinez, Diaz, Prieto, Loidi & Penas 1991**																											
Oroph. S-Europ.	**	*Teucrium montanum* L.	+	.	+	.	1	1	.	+	.	.	1	+	1	1	IV		1	.	1	2	1	1	+	+	.	+	IV
Medit.-Mont.		*Aethionema saxatile* (L.) R.Br. subsp. *saxatile*	+	.	.	.	+	+	.	.	.	.	.	.	+	+	II		1	.	.	.	+	.	+	.	.	.	II
Submedit.-Pontic		*Linum tenuifolium* L.	.	+	+	.	+	+	.	.	.	.	.	+	.	.	II		+	.	.	+	.	.	.	.	.	.	II
Euri-Medit.		*Thesium divaricatum* Jan ex Mert. et Koch	1	+	1	+	2	1	1	.	+	.	.	.	1	.	IV		.	.	.	.	.	.	.	.	.	.	-
S-Europ.		*Helichrysum italicum* (Roth) G.Don subsp. *italicum*	+	+	+	.	.	1	+	.	.	.	.	+	1	.	III		.	.	.	.	.	.	.	.	.	.	-
Steno-Medit.		*Micromeria graeca* (L.) Bentham subsp. *graeca*	1	.	.	.	.	+	1	.	+	+	.	.	.	.	II		+	.	.	.	.	.	.	.	.	.	I
SE-Europ.		*Onosma echioides* L.	.	.	.	+	+	+	+	.	.	.	.	.	+	+	III		.	.	.	.	.	.	.	.	.	.	-
Steno-Medit.		*Teucrium flavum* L. subsp. *flavum*	.	.	.	.	.	.	+	.	.	.	.	+	.	+	II		.	.	.	.	.	.	.	.	.	.	-
		***Saturejo montanae-Brometum erecti* Avena & Blasi 1979**																											
Europ.-Caucas.		*Helianthemum oelandicum* (L.) DC. subsp. *canum* (L.) Bonnier	.	1	1	.	.	.	1	.	.	+	.	.	1	.	II		.	1	1	1	.	1	+	1	1	.	IV
Endem.		*Cerastium tomentosum* L.	.	.	.	.	.	+	.	.	+	+	.	.	1	.	II		+	1	.	1	1	+	1	.	1	1	IV
Subendem.		*Chamaecytisus spinescens* (C. Presl) Rothm.	.	1	1	+	+	+	+	.	+	+	2	.	+	1	IV		.	+	+	.	1	+	+	+	.	+	IV
		***Sesleria tenuifolia* local community**																											
Medit.-Mont.	*	*Anthyllis montana L.* subsp. *atropurpurea* (Vukot.) Pignatti*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		1	.	1	.	.	+	1	2	.	1	III
Illiric-Appenn.	*	*Sesleria tenuifolia* Schrader subsp. *tenuifolia*	.	.	.	.	.	.	.	1	1	.	.	1	.	.	II		.	.	.	.	.	2	3	2	2	+	III
Endem.		*Stipa crassiculmis* P.Smirnov subsp. *picentina* Martinovsky, Moraldo et Caputo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		.	.	.	.	.	.	.	1	1	.	I
		***Phleo ambigui-Bromion erecti* Biondi & Blasi ex Biondi, Ballelli, Allegrezza, Zuccarello 1995**																											
Medit.-Mont.		*Koeleria splendens* C. Presl.	1	+	1	1	1	2	1	+	.	1	+	+	+	1	V		1	1	2	3	1	1	1	3	1	+	V
Euri-Medit.		*Galium lucidum* All.	.	1	.	+	+	+	+	+	1	+	.	.	.	.	III		1	1	+	+	+	.	.	2	.	+	IV
Euri-Medit.		*Festuca circummediterranea* Patzke	.	1	.	.	.	.	1	.	.	.	.	.	+	.	II		1	2	+	1	2	.	1	.	.	2	IV
S-Europ.	**	*Leontodon crispus* Vill.	.	1	+	.	+	.	+	.	.	+	.	+	.	.	III		.	.	.	.	+	.	+	1	+	.	II
Endem.	**	*Phleum ambiguum* Ten.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	I		+	.	.	1	.	.	.	.	+	.	II
SE-Europ.		*Trinia dalechampii* (Ten.) Janchen	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I		1	1	+	.	1	.	+	2	+	+	IV
Endem.		*Crepis lacera* Ten.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		+	+	+	1	1	.	+	+	.	+	IV
SE-Europ.		*Thymus striatus* Vahl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		+	1	.	.	.	.	1	.	.	2	II
Medit.Mont.		*Dianthus sylvestris* Wulfen subsp. *sylvestris*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		.	+	.	.	.	.	1	.	.	+	II
Endem.		*Avenula praetutiana* (Parl. ex Arcang.) Pign.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		1	.	2	.	1	.	.	.	.	.	II
Endem.		*Centaurea deusta* Ten.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		.	.	+	2	.	.	1	+	+	+	III
		***Brometalia erecti* Br.-Bl. 1936**																											
		***Festuco-Brometea* Br.-Bl. & Tx. 1943 ex Klika & Hadac 1944**																											
Paleotemp.	**	*Bromus erectus* Hudson subsp. *erectus*	1	.	.	.	.	.	+	.	+	+	.	.	.	.	II		1	2	3	3	3	1	1	2	1	2	V
Subcosmop.		*Sanguisorba minor* Scop. subsp. *muricata* Briq.	2	+	+	+	+	+	+	.	.	+	+	+	1	+	V		+	.	.	2	+	.	.	.	.	.	II
Europ.-Caucas.		*Helianthemum nummularium* (L.) Miller subsp. *obscurum* (Celak)	1	.	+	+	+	1	.	.	.	.	.	+	.	+	III		.	.	.	1	.	.	.	.	.	.	I
Subendem.	**	*Carex macrolepis* DC.	.	+	2	.	1	.	.	1	.	.	.	.	.	.	II		.	.	.	.	.	+	+	.	.	.	I
Medit.-Turan.		*Pimpinella tragium* Vill. subsp. *lithophila* (Schischkin) Tutin	.	1	.	.	.	.	+	.	.	+	.	.	.	.	II		.	1	.	+	.	+	+	.	.	1	III
Eurasiat.	*/**	*Carex humilis* Leysser	.	.	+	.	2	.	.	.	.	.	.	.	.	.	I		.	.	+	+	.	.	.	.	+	.	II
Euri-Medit.		*Anthyllis vulneraria* L. subsp. *rubriflora* (DC.) Arcangeli	.	.	.	.	+	.	+	.	.	.	.	.	.	.	I		1	1	+	2	1	1	+	1	.	.	IV
Paleotemp.		*Poa bulbosa* L.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	I		1	1	.	+	+	.	.	2	.	1	III
Medit.-Mont.		*Iberis carnosa* Willd.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	I		+	+	.	1	.	.	.	1	+	.	III
Euri-Medit.		*Thymus longicaulis* C.Presl.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	I		.	1	2	.	1	.	.	2	.	.	II
S Europ-S Siber.		*Onobrychis alba* (Waldst. e Kit) Desv. subsp. *laconica* (Orph. ex Boiss.) Hayek	.	.	.	.	.	.	.	.	.	.	.	.	1	.	I		1	.	+	+	1	+	1	1	+	+	V
Circumbor.		*Poa alpina* L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		.	1	1	.	1	.	.	1	+	1	III
NE-Medit.		*Eryngium amethystinum* L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		1	+	+	.	.	.	+	.	.	+	III
Oroph. S-Europ.		*Acinos alpinus* (L.) Moench	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		+	+	.	2	1	.	.	+	+	.	III
Oroph. S-Europ.		*Sempervivum tectorum* L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-		+	1	.	+	.	+	.	.	.	1	III
		Other Associates****																											
Medit.-Mont.		*Asperula aristata* L. subsp. *scabra* (J. et C. Presl.) Nym.	.	+	1	+	+	.	1	.	.	.	+	+	.	.	III		.	+	+	+	.	.	1	.	.	+	III
Paleotemp.		*Centaurium erythraea* Rafn subsp. *erythraea*	+	.	+	.	+	+	.	.	.	.	.	.	+	.	II		+	.	.	.	+	.	.	.	.	.	I
W- e Centro-Europ.		*Sedum rupestre* L. subsp. *rupestre*	2	.	.	.	.	.	.	.	+	.	.	.	.	+	II		1	+	+	1	.	.	+	+	.	.	III
Europ.		*Carex flacca* Schreber subsp.*serrulata* (Biv.) W. Greuter	+	.	.	.	.	.	+	.	.	.	.	+	+	.	II		.	.	.	.	.	.	.	.	.	.	-
Subatl.		*Brachypodium rupestre* (Host) R. et S.	.	.	.	.	.	.	.	1	1	+	.	.	.	.	II		.	.	.	.	.	.	.	.	.	.	-

* character species of *Seslerion apenninae* Furnari in Bruno & Furnari 1966 and *Seslerenion apenninae* Blasi & Di Pietro 2003

** species of *Festuco-Brometea* transgressive into *Elyno-Seslerietea*

*** considered also character species of *Saturejo montanae-Brometum erecti* Avena & Blasi 1979

**** species usually recorded in Festuco-Brometea communities of stony sites