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### The main Plant community types of the alpine belt of the Apennine chain

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# The main Plant community types of the alpine belt of the Apennine chain

C. BLASI, R. DI PIETRO, P. FORTINI and C. CATONICA

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**ABSTRACT** - This paper deals with the occurrence of the main plant community types occurring within the alpine bioclimatic belt in the Central Apennines. The study area was represented by three mountain groups, the Gran Sasso, Maiella and Laga mountains. These three mountain chains are those in which, out of the entire Apennine area, alpine vegetation is best expressed. The vegetation has been investigated following the Braun-Blanquet phytosociological approach. During the field work 135 relevés were collected. The raw data were further treated with multivariate analysis procedures to find objective clusters on a statistical basis. Several plant community types, belonging to different phytosociological classes, such as *Elyno-Seslerietea*, *Salicetea herbaceae*, *Thlaspietea rotundifolii*, *Asplenieta trichomanis*, were identified. In particular two new phytosociological associations, *Galio-Silenetum acaulis* and *Potentillo-Festucetum alfredianae*, and several new sub-associations are described in this paper. In order to express the occurrence and autonomy of the Apennine alpine bioclimatic belt also in coenological terms, a new *Seslerion apenninae* sub-alliance, named *Leontopodio-Elynenion*, is here proposed.

**KEY WORDS** – Alpine belt vegetation, central Apennines, chorology, phytosociology, syntaxonomy

From a bioclimatic and biogeographic point of view, the central Apennines have always been considered one of the most interesting areas in the Italian peninsula. The presence of very high peaks in this range, apart from allowing the development of a peculiar flora, has played an important role in the preservation of species (and, in some cases, of whole plant community types) with a typ-

ical endemic or circumboreal/Arctic-alpine feature, which spread down the Peninsula following the Quaternary cold periods. The northern Apennines, instead, although they are located close to the Alps, do not reach altitudes sufficient for the preservation of a similar high-altitude vegetation (cfr. TOMASELLI, 1994; 1997).

The delimitation of the various altitudinal belts in the central Apennines has often resulted in a conflict of opinions among the various authors who have dealt with the subject. The position of the central Apennines, stretching out in the Mediterranean basin, and the millenary human land use, which often transformed vegetation and landscapes in a xeric sense, have led to Italy's peninsular territory being considered as almost entirely enclosed within the Mediterranean region. Only recently, and due, among other factors, to the marked increase in the quality of climatic data collection and statistical processing, and to the increased availability and reliability of the basic umbro-thermic data, some authors (BLASI, 1994; BIONDI & BALDONI, 1994; RIVAS-MARTÍNEZ, 1995; 1996a) have pointed out that almost the whole of the central Apennines belong, in fact, to the Temperate Region, while, strictly speaking, only a narrow coastal belt belongs to the Mediterranean Region. Even the bioclimatic delimitation of an actual "alpine belt" in the Apennines is recent. PIGNATTI (1979), while considering the central Apennines as belonging entirely to a poorly defined "Mediterranean Zone", highlighted the fact that in massifs, such as the Gran Sasso and the Maiella, there were extrazonal community types with typical "alpic" features within the *Sesleria tenuifolia* sub-alpine belt. BALDONI *et al.* (1999), on the basis of bioclimatic indices (RIVAS-MARTÍNEZ, 1995), emphasised the development of a real alpine belt on the Gran Sasso, starting from an altitude of about 2400 m a.s.l.

The vegetation that has developed above the timberline in the central Apennines has, in the past, been the subject of many phytosociological studies which focused on the various aspects of the vegetation (FURRER & FURNARI, 1960; BAZZICHELLI & FURNARI, 1961; GIACOMINI & FURNARI, 1961; BRUNO *et al.*, 1965a; 1965b; BRUNO & FURNARI, 1966; BONIN, 1969; LAKUSIC, 1969a; MIGLIACCIO, 1970; AVENA & BRUNO, 1975; FEOLI-CHIAPPELLA & FEOLI, 1977; BONIN G., 1978; BAZZICHELLI & FURNARI, 1979; BONIN & VEDRENNE, 1979; AVENA & BLASI, 1980; PEDROTTI, 1982; FEOLI-CHIAPPELLA, 1983; PETRICCIONE, 1993; ABBATE *et al.*, 1994; GRACANIN, 1994; PIGNATTI, 1994; PETRICCIONE & PERSIA, 1995; BIONDI *et al.*, 1997; 1999; 2000; DI PIETRO *et al.*, 2001). In most cases, though, such studies aimed only at identifying the plant communities within areas of limited extent, or at most within a single mountain massif. On the other hand, broad-based summaries comparing the vegetational data of large sections of the territory are still scarce. As far as the alpine and sub-alpine belts are concerned, some authors have concentrated their attention on the dwarf-shrub communities

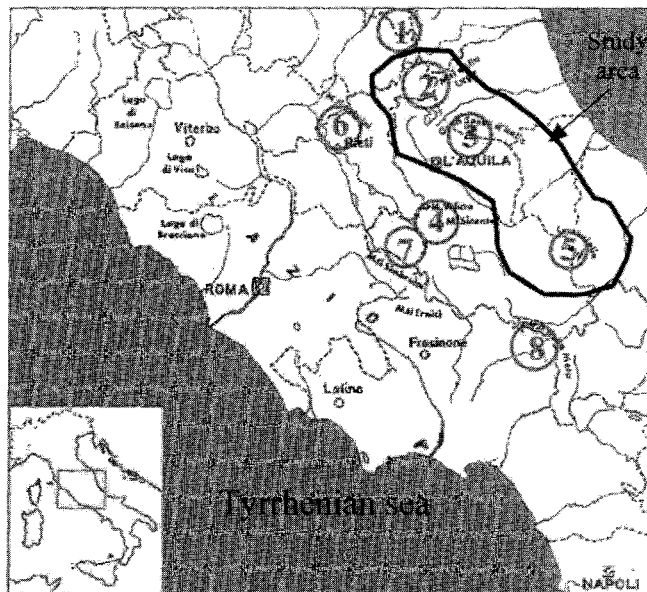


FIGURE 1 - The study area (bordered by a bold line) included the Laga mountains (2), the Gran Sasso range (3) and the Majella mountain (5), which are the three mountain systems where a real alpine bioclimatic plain occurs. The other numbers indicate the other major central Apennines mountainous massifs, such as Sibillini mountains (1), Velino-Sirente (4), Mount Terminillo (6), Simbruini-Ernici range (7), Abruzzo National Park mountains (8).

(MIGLIACCIO, 1966; PETRICCIONE, 1988; BLASI *et al.*, 1989, 1990, 1991; STANISCI *et al.*, 1994; STANISCI, 1997), while others have focused on grasslands, both secondary (which are fairly common and mostly due to man's slow but inexorable destruction, of the chamaephytic and nanophanerophytic vegetation especially through cutting and firing) and primary (less common and often restricted to rocky or scree sites inaccessible to man). Only a few contributions (FEOLI-CHIAPPELLA & FEOLI, 1977; PEDROTTI, 1983; PETRICCIONE & PERSIA, 1995; BIONDI *et al.*, 1999; 2000) deal with those communities whose northern boreal character is more marked. From a physiognomical point of view, these communities can be associated with the so-called "alpine tundra" which, though in a discontinuous and sporadic way, and certainly impoverished in facies when compared with that of the Alps, is nonetheless present in the highest mountain belt of the Apennines. Apart from confirming the presence of the bioclimatic alpine belt on the Gran Sasso, the present paper reports its occurrence on other Apennine massifs, such as the Laga mountains and the Maiella. This contention is supported by bioclimatic and coenological data.

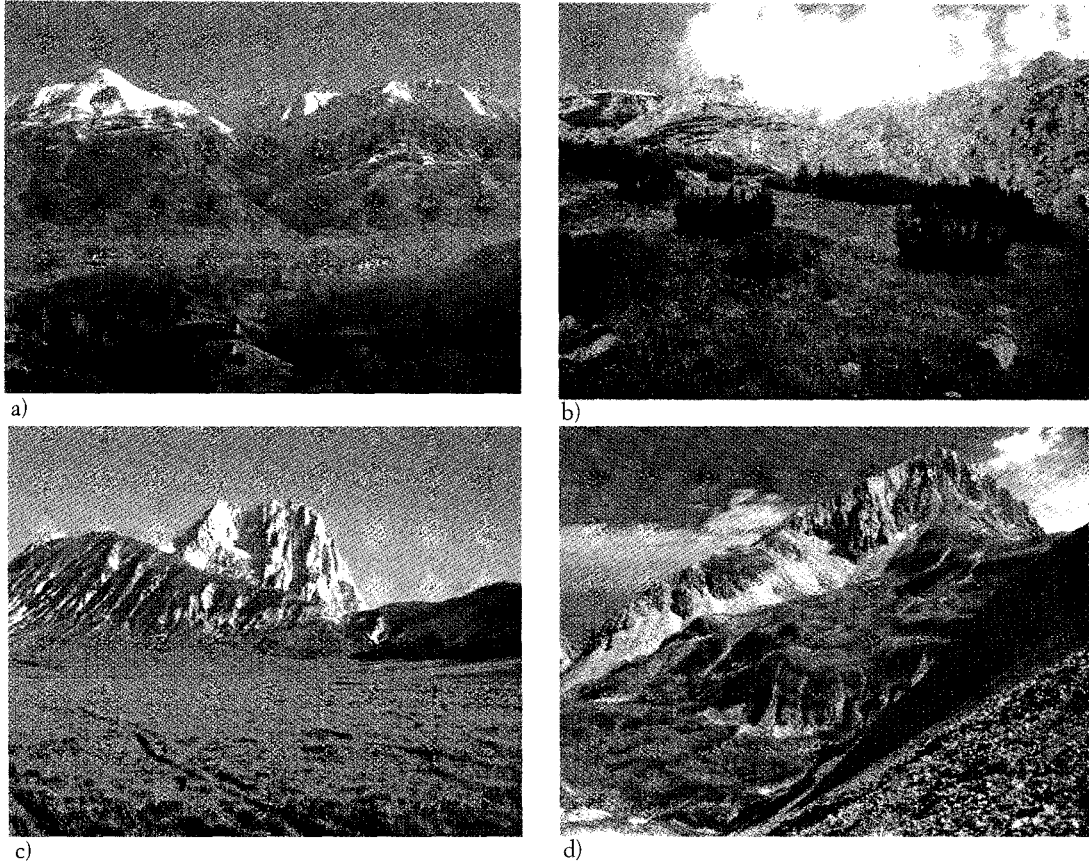


FIGURE 2 - a) Tyrrhenian slope of the Laga mountains (photo R. Di Pietro). b) the Maiella summit area with scattered individuals of *Pinus mugo* within the sub-alpine belt (photo R. Di Pietro). c) Mount Corno Grande (2912 m a.s.l.) viewed from Campo Imperatore plain (photo R. Di Pietro). d) Northwestern side of the Gran Sasso massif (photo L. Rosati).

## MATERIALS AND METHODS

### Study area

The study area (Figures 1 and 2) includes the highest part of three mountain chains of central Italy, namely the Gran Sasso range, and the Majella and Laga mountains. The core of the Gran Sasso massif is formed by limestone deposits over 3000 m thick, belonging to the Latium-Abruzzi carbonate unit (upper Triassic-lower Paleogene). Above 1500 m a.s.l., the massif has a very rugged morphology, with dissected steep limestone ridges alternating with large tectonic basins which have well-developed karst features (Campo Imperatore, Campo Pericoli). The north-western sector, which includes the highest peaks of the chain ranging from 2400 to 2914 m., represented the field work area in the Gran Sasso massif.

With the 2790 m of Mount Amaro, the Maiella mountains contain the second highest Apennine peak, after the Gran Sasso, with which it shares the same broad

geo-lithological features. As far as geomorphology is concerned, the Maiella mountains are characterised by a very gentle summit profile leading to the development of a relatively large area in both the sub-alpine and alpine belt. By way of comparison, above 2500 m the Maiella mountains have an overall area of 11 km<sup>2</sup> against the 2 km<sup>2</sup> of the Gran Sasso (GIRAUDI, 1998).

The Laga mountains are an anticline of about 20 km oriented NNW-SSE at the boundary between Lazio, Abruzzo and Marche, characterised by five peaks exceeding 2400 m a.s.l. While most of the central Apennines consist mainly of limestone rocks, the Laga mountains are characterised by a series of permeable sandstone beds intermixed with fairly impermeable clayey levels (Messinian age) known as "the Laga Formation" (PAROTTO & PRATURLON, 1975; ADAMOLI, 1988). This lithological feature, which represents an element of marked discontinuity within the Apennine chain, has important implications in terms of flora and vegetation (cfr. TONDI, 1992; TONDI & PLINI, 1995).

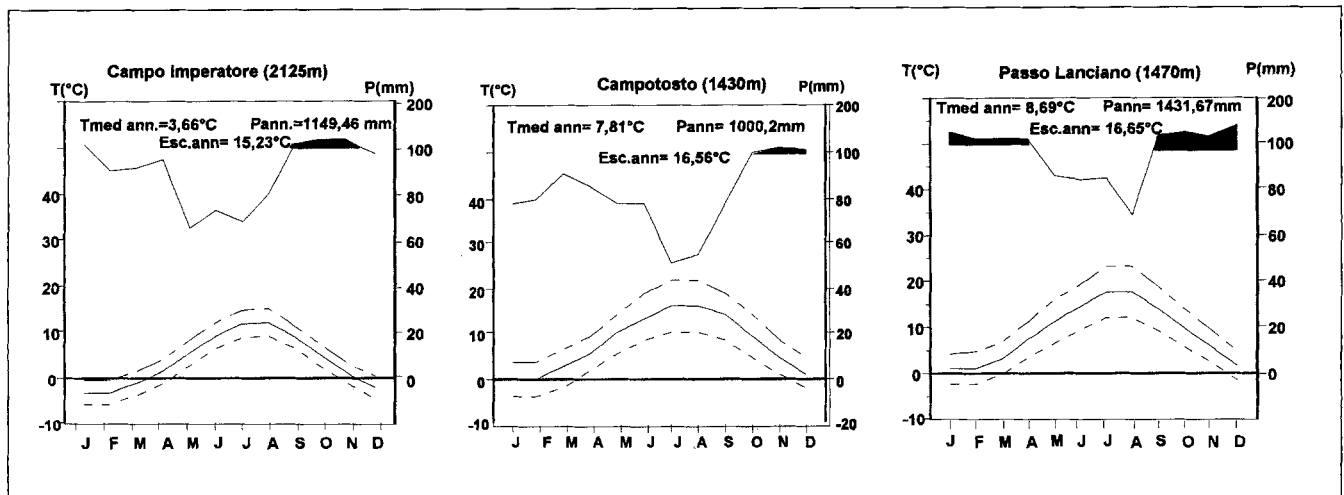


FIGURE 3 - Umbro-thermic diagrams of the main thermo-pluviometric stations within the study area (Servizio idrografico del ministero dei lavori pubblici, period: 1960-1994).

### Bioclimate

Although located in the sub-alpine plain, the Campo Imperatore umbro-thermic station (the highest one in the Gran Sasso range situated at 2132 m a.s.l.), still exhibits the significant drop in the precipitation curve typical of the Mediterranean climate (Figure 3). Given the relatively cold summer temperatures, however, no drought stress periods occur in this site. The WNW-ESE orientation of the Gran Sasso chain is an effective barrier against the humid winds coming from the Adriatic Sea, and leads to strong differences in the amount of precipitation on the opposite slopes. Though less evident, a similar situation also occurs in the Maiella and Laga mountains. On the basis of the data published for Lazio (BLASI, 1994), the whole study area should be included in the cold axeric subregion of the Temperate Region.

The altitude of the bioclimatic belt boundaries were calculated through the Compensated Thermicity Index which is related to different bioclimatic parameters such as yearly average temperature, average minimum temperature of the coldest month, and average maximum temperature of the warmest month (RIVAS-MARTÍNEZ, 1995). Since it was impossible for us to calculate this index through data collected directly in the study area, the missing temperature values were obtained from the umbro-thermic stations (L'Aquila, Assergi, Campotosto, Castel del Monte e Isola del Gran Sasso Sulmona, Guardiagrele, S.Eufemia a Majella, Pescocostanzo, Passo Lanciano, Palena, Popoli, Capracotta), using regressive lines. A high correlation between these para-

meters resulted for both the Gran Sasso ("r" t. min = 0.99, "r" t. med = 0.97, "r" t. max = 0.97), and the Maiella ("r" t. min = 0.97, "r" t. med = 0.98, "r" t. max = 0.99). The boundary between the alpine and sub-alpine bioclimatic belts runs at 2550 m a.s.l. in both the Gran Sasso and the Maiella, while lack of an adequate number of thermo-pluviometric stations in the Laga mountains prevented us from calculating a reliable regressive line for this area.

### Vegetation data

During the field work, which was carried out following the Braun-Blanquet phytosociological approach (BRAUN-BLANQUET, 1964), a total of 135 relevés were performed. The raw data were further treated with multivariate analysis procedures to find objective clusters on a statistical basis using the Syntax 5.02 software package (PODANI, 1994). The following scale was adopted for transforming the Braun-Blanquet values into numerical values (VAN DER MAREEL, 1979): r=1; + = 2; 1 = 3; 2 = 5; 3 = 7; 4 = 8; 5 = 9. For the classification of relevés (Figure 4), we used the chord distance and the average correlation in the quantitative data. For the ordination, a PCA with superimposed partition (PODANI, 1993) was performed (Figure 5). For species nomenclature, reference was made to CONTI (1998) and ANZALONE (1994; 1996), while for life forms and chorology to PIGNATTI (1982). With regard to those species whose taxonomic rank is still uncertain, TUTIN *et al.* (1964-1980; 1993) and GREUTER *et al.* (1984-1989) were also consulted. Both chorological and life form tables, which were cal-

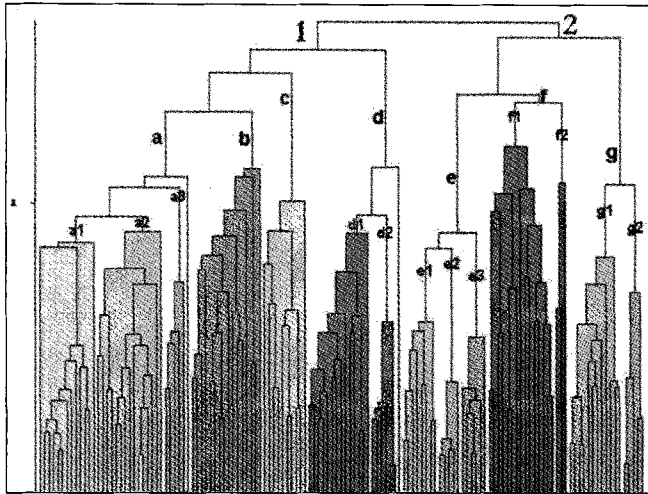


FIGURE 4 - Dendrogram of the complete set of relevés. a1 = *Carici Salicetum retusae typicum*; a2 = *Carici-Salicetum elynetosum*; a3 = *Carici-Salicetum trifolietosum thalii*; b = *Leontopodio-Elynetum*; c = *Caricetum kitaibelianae-rupestris*; d1 = *Armerio Salicetum herbaceae gnaphalietosum magellensis*; d2 = *Armerio-Salicetum herbaceae trifolietosum thalii*; e1 = *Galio-Silenetum acaulis typicum*; e2 = *Galio-Silenetum trifolietosum thalii*; e3 = *Galio-Silenetum alyssetosum cuneifolii*; f1 = *Potentillo-Festucetum alfredianae*; f2 = *Potentillo-Festucetum* var. with *Papaver alpinum*; g1 = *Arabido-Cerastietum thomasi typicum*; g2 = *Arabido-Cerastietum festucetosum alfredianae*. Because of the compression of the alpine belt in the Apennines, the sequence of the groups does not seem to follow a syntaxonomical order (at least at a level higher than association).

culated to sub-association level, are shown in Figure 7. Following the chorotype and the life form names, a sequence of three values (%) appear in the tables, corresponding to the presence (n), the frequency (f) and the specific cover index (c) of that chorotype or life form in the cluster, respectively. In particular, the normal spectrum (n), which is hardly ever used in this kind of analysis, indicates the % ratio between the total number of species of one chorotype or life form and the total number of species occurring in a given plant community type. It provides essential information concerning the floristic (and, consequently, the structural and chorological) "base" from which each plant community type draws upon in its physiognomical expression. The frequency spectrum (f) is probably the most appropriate for coenological information, whereas the cover spectrum (c), represents the "real" quantitative structural and chorological expression of the various plant communities. The cover spectrum is based on the "specific cover index" of the species in the different plant community types (cfr. BRAUN-BLANQUET, 1964).

All the names of the new sintaxa published in this paper are in accordance with the rules of ICPN (WEBER *et al.*,

2000). When not expressly specified in the text, the groups of characteristic species of the new sintaxa proposed in this paper are clearly indicated in the phytosociological tables.

## RESULTS

### Numerical analysis

The dendrogram (Figure 4) shows two main clusters (1 and 2) which are sub-divided into several sub-clusters. Cluster 1, which is composed of the relevés belonging to *Salix retusa*, *Elyna myosuroides*, *Carex rupestris* and *Salix herbacea* community types (sub-clusters a, b, c and d, respectively), is characterised by plant communities which developed in environmental conditions where real soils occur (even though these may sometimes appear very shallow). On the contrary, Cluster 2 is composed of plant communities, such as those dominated by *Silene acaulis* (subcl. "e"), *Festuca alfrediana* (subcl. "f") and *Cerastium thomasi* (subcl. "g"), growing mainly on scree and cliff-faces where the soils are often composed of nothing but a thin layer of organic matter. Within these two main clusters, seven sub-clusters can be identified (each of which consists of a single community type), and these can in turn be divided into sub-associations and variants (e.g. a1, a2, b1....). The single relevé which is isolated from the rest in subcluster "a" corresponds to a *Salix retusa* stand which occurs at a lower altitude and, consequently, is enriched in species which do not occur in the other relevés.

The PCA (with superimposed partition) calculated along three major axes (Figure 5), shows a distinct grouping along the first two axes of *Salix*, *Elyna* and (though slightly less clearly) of *Carex* communities. The distinct grouping of the *Silene acaulis* communities, on the other hand, is revealed only along the third axis. The situation regarding the scree and sub-vertical cliff communities is more complicated because of the significant overlapping amongst polygons representing the different community types. Despite the complexity of this general overlapping, however, the scree cluster forms a clearly identifiable group within both PCA diagrams.

The distribution of the clusters along the first PCA axis (Figure 3b) can probably be correlated to a gradient, moving, left to right, from edapho-xerophilous to relatively edapho-mesophilous environmental conditions. Within this gradient, the *Carex rupestris* community (sub-cluster "c") behaves as an intermediate vegetational type between the vegetation of the screes and that of the slopes. The only thing to note about the distribution of the clusters along the second axis is the isolation of *Salix herbacea* community relevés (cluster "d"). This iso-

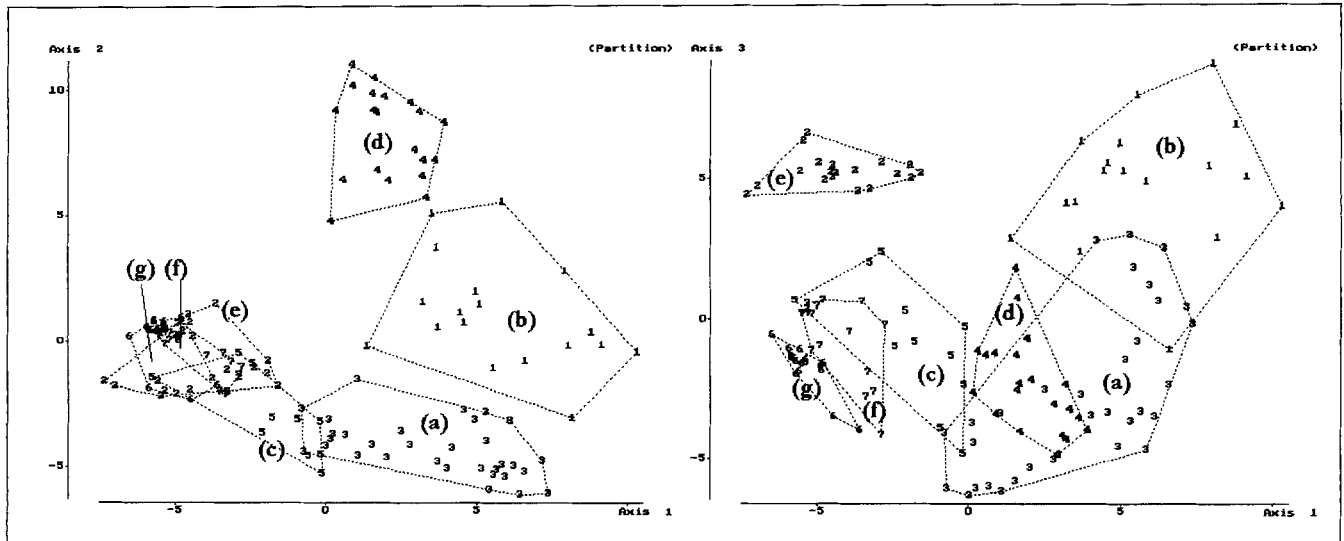


FIGURE 5 - PCA diagram with partition superimposed on the three main axes where the variance explained by each of the three axes is the following: 14.88 (axis 1), 13.10 (axis 2), 10.10 (axis 3). The letters correspond to the main clusters identified in the dendrogram of Figure 4. 1(b): *Leontopodio-Elynetum*; 2(e): *Galio-Silenetum acaulis*; 3(a): *Carici Salicetum retusae*; 4(d): *Armerio-Salicetum herbaceae*; 5(c): *Caricetum kitaibelianae-rupestris*; 6(g): *Arabido-Cerastietum thomasii*; 7(f): *Potentillo-Festucetum alfredianae*. To note, the segregation of *Galio-Silenetum* and *Arabido-Cerastietum* on the third axis, whereas these were more or less mixed with those of *Potentillo-Festucetum* on the first two axes.

lation is probably related to the particular environment (snow-bed) in which this community type habitually develops. The distribution along the third axis does not seem to reveal any particular correlation.

#### Plant communities

##### *Elyna myosuroides* swards (group “b” in Figures 4 and 5; Phytosoc. table 1)

Within the Apennines, *Elyna myosuroides* grasslands occur exclusively in the Gran Sasso range, the Laga mountains and the Maiella massif. Given its ability to tolerate extremely harsh conditions, *E. myosuroides* tends to form typical swards along ridges or hill crests (Figure 6e) where the incessant winds prevent all but a thin layer of snow from settling, and determines marked ranges in temperature.

As far as soil composition is concerned, *Elyna myosuroides* does not seem to be associated with a specific type of parent material, forming well-structured communities both on sandstones and on limestones with pH values ranging from 6.1 to 7.2 (*data ined.*).

In synecological terms, *E. myosuroides* is by far the dominant species of the community (cfr. phytosoc. table 1) where it is accompanied by a group of species which occur at high frequency, such as *Potentilla crantzii*, *Silene acaulis*, *Helianthemum oelandicum* subsp. *alpestre*, *Alchemilla colorata*, *Armeria canescens*, *Persicaria vivipara*, *Carex kitaibeliana*, *Festuca violacea*,

*Poa alpina*, *Draba aizoides* and *Erigeron epiroticus*.

As far as syntaxonomy is concerned, there are various references in phytosociological literature to the *Elyna myosuroides* communities of the central Apennines. Both *Elynetum s.l.* (BRUNO *et al.*, 1965b; BRUNO & FURNARI, 1966), and the *Elynetum apenninicum* (LAKUSIC, 1969a; MIGLIACCIO, 1970) have been placed in the *Seslerion apenninae* alliance<sup>1</sup>. Further, FEOLICHIAPPELLA & FEOLI (1977) described *Leontopodio-Elynetum*, which was included in the *Oxytropido-Elynetum* alliance and *Elyno-Seslerietea* class (whereas in PETRICCIONE & PERSIA, 1995 it was placed in the class *Festuco-Seslerietea* as being on the Maiella mountain. *Leontopodio-Elynetum* was recently lectotypified (BIONDI *et al.*, 2000) and moved, according to the OHBA (1974) scheme, to the class *Carici-Kobresietea*, although ORIOLO (2001), having excluded the occurrence of this class in the eastern Alps and the Apennines, again places *Leontopodio-Elynetum* in the *Seslerion apenninae* alliance. Meanwhile, PEDROTTI (1983) described *Carici-Elynetum* as a new association in the flysch substrate of the Laga mountains.

On the basis of the phytosociological data available at present, and given the rarity of guide species in the Apennines, it is our opinion that all the *Elyna myosuroides* stands occurring in central Italy are representative of one single association. On the basis of CNP (WEBER *et al.*, 2000), this association coincides with

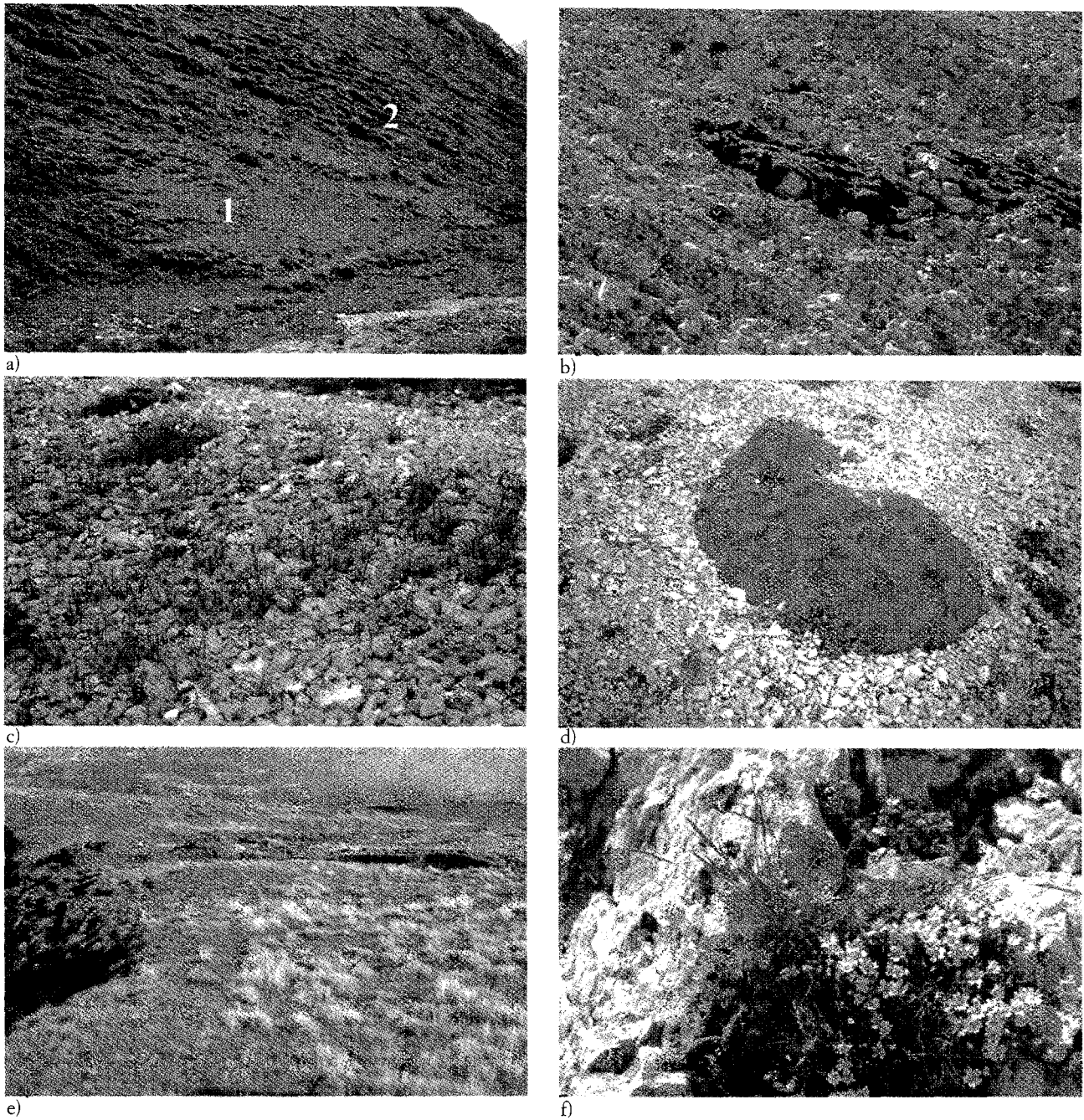


FIGURE 6 - a) *Carici-Salicetum retusae* (1) and *Armerio-Salicetum herbaceae* (2) which alternate with each other in relation to micro-convexity and micro-depression of the slopes in a gully subjected to prolonged snow cover (Campo Pericoli, Gran Sasso) (photo R. Di Pietro). b) *Salix retusa* community type (*Carici-Salicetum retusae*) occurring in moist and relatively stable talus slopes in the proximity of "Conca degli Invalidi". (photo R. Di Pietro). c) *Carex rupestris* vegetation (*Caricetum kitaibelianae-rupestris*) colonising a windy plateau with a high and fine-textured debris component near the site "Sella of Monte Aquila" (photo R. Di Pietro). d) A typical single *Silene acaulis* cushion (*Galio majellensis-Silenetum acaulis*) (photo C. Blasi). e) *Elyna myosuroides* swards (reddish color) located in the proximity of the windy northeastern ridge of Mount Gorzano (Laga mountains). The yellowish vegetation represents high altitude stands of *Nardus stricta* (photo R. Di Pietro). f) *Arabido-Cerastietum thomasii festucetosum alfredianae* at the top of Mount Corno Grande (2912 m a.s.l.). It represents the highest community type of the whole Apennine chain (photo R. Di Pietro).

*Leontopodio-Elynetum*<sup>2</sup>. It is interesting to note, however, that although *Leontopodium alpinum* subsp. *nivale* was considered as truly characteristic in the original

phytosociological table, it does not seem to be absolutely linked to the *Elyna* stands where it is highly scattered or, more frequently, absent.



Although *Leontopodio-Elynetum* has been described on limestone substrates, it seems to be well-suited to represent also the *Elyna* communities occurring on the clayey-arenaceous substrates of the Laga mountains where only slight floristic differences have been recorded.

*Salix herbacea* snow-bed vegetation (group “d” in Figures 4 and 5; Phytosoc. Table nr. 2)

*Salix herbacea* is a very rare species in the Apennines which forms noticeable communities only in the Gran Sasso range and the Laga mountains. It occurs very sporadically also in the Sibillini mountains (PAOLUCCI, 1891, PAGANELLI, 1957; BALLELLI *et al.*, 1977) and in one single station on Mount Catria (BALLELLI *et al.*, 1981), while its occurrence on the Maiella mountain (DINTER, 1996) has to be confirmed.

On the Gran Sasso, *S. herbacea* communities are mainly found on the north-facing slopes of large gullies in which the snow cover can remain for a long time. In this environment, *Salix herbacea* seems to prefer the drainage line for melting snow, where the slope profile appears to be lightly cushioned because of superficial solifluxion phenomena (Figure 6a). In addition to *Salix herbacea*, by far the most abundant species of the community (cfr. phytosoc. table 2), other elements, often common in a snowbed environment, such as *Sibbaldia procumbens*, *Plantago atrata*, *Persicaria vivipara*, *Luzula italica*, *Festuca rubra* subsp. *commutata*, *Poa alpina* and *Gnaphalium hoppeanum* subsp. *magellense*, may also be found. On the other hand, the occurrence of stony pastures species, such as *Carex kitaibeliana*, *Minuartia verna*, *Draba aizoides* and *Achillea oxiloba* subsp. *barrelieri* seems to be a peculiarity. In the Laga mountains, where the strong clay component occurring in the flysch substrate determines a higher degree of water retention, *Salix herbacea* seems to be more widespread in the high altitude areas. In floristic terms, the main physiognomic feature of the *Salix herbacea* communities in the Laga mountains is the abundance of *Trifolium thalii* and *Plantago alpina* s.l.?

In syntaxonomical terms, the *Salix herbacea* communities of the study area are assigned to the *Armerio majellensis-Salicetum herbaceae*<sup>a</sup> recently described in the Gran Sasso range. This paper, in addition to confirming the presence of this association on the Gran Sasso, extends its distribution to the Laga mountains area. Given the differences in substrate between the Gran Sasso range and the Laga mountains, this association has been divided into two sub-associations named respectively *Armerio-Salicetum gnaphalietosum majellensis* subass. nov. hoc loco (Holotypus rel. n°2 in Table 2), in which *Gnaphalium hoppeanum* subsp. *magellensis*

behaves as an endemic vicariant of the alpic *Gnaphalium hoppeanum* subsp. *hoppeanum*, and *Armerio-Salicetum trifolietosum thalii* subass. nov. hoc loco (Holotypus rel. n°19 in Table 2), which is characterised by the high degree of cover of *Trifolium thalii*, *Plantago alpina* and *Deschampsia flexuosa*. Nevertheless, since *S. herbacea* communities in the Laga mountains lack *Armeria canescens*, we have decided to use the same association type for both areas, and to express the diversity in terms of sub-associations. In our opinion, both the floristic and ecological differences between these two sites are not sufficient to justify the occurrence of two distinct associations related to such a rare and scattered environmental type. Moving towards the northern Apennines and the Alps, *Armerio-Salicetum* is substituted by *Salicetum herbaceae* s.s., while in the Balkans (LAKUSIC, 1969b) this association is substituted by the *Salicetum herbaceae dinaricum* and southwards by the *Salicetum herbaceae macedonicum*.

*Salix retusa* stands (group “a” in Figures 4 and 5; Phytosoc. Table nr. 3)

Given the high ecological plasticity of the guide species, the Apennine *Salix retusa* communities occur in a heterogeneous pattern of environmental conditions which ranges from snowbed to scree (cfr. phytosoc. table 3). In the Gran Sasso area, *Salix retusa* communities tend to occupy the micro-convexity of the north-facing slopes of the typical gullies which connect mountain ridges to the intramontane high-altitude basins. Often these small humps are found alternated with micro-depressions populated by *Salix herbacea* (Figure 6a), but in some cases (BIONDI *et al.*, 2000) *Salix retusa* may also play the role of differential species in the same *Salix herbacea* stands. At higher altitudes (over 2600 m a.s.l.), where the percentage of debris and rocks strongly increases, *Salix retusa* communities assume an important role in the colonisation and consolidation of those north-facing scree slopes which are characterised by a prolonged snow cover (Figure 6a and 6b).

The environments characterised by *S. retusa* communities on the Maiella range also appear to be very rich in debris, although this occurs on flattish ground. These *Salix* carpets represent a favourable environment to host other species. In fact, although the physiognomy of the Maiella communities follows precisely the extension of the *Salix* population, *Elyna myosuroides* and *Helianthemum oelandicum* subsp. *alpestre* may become co-dominant, whereas in the Laga mountains this role is played by *Trifolium thalii*.

All the *Salix retusa* communities investigated in this paper belong to the *Carici-Salicetum retusae*, although,

when compared with the typical aspect of this association (BIONDI *et al.*, 1999), there is a lack of *Soldanella alpina* and *Trifolium noricum* subsp. *praetutianum*. Thus, in addition to the Gran Sasso, the area of distribution of this association extends to both the Maiella and the Laga mountains with the new sub-associations *elynetosum myosuroidis*<sup>5</sup> subass. nov. hoc loco (Holotypus rel. n°14 in Table 3) and *trifolietosum thalii*<sup>6</sup> subass. nov. hoc loco (Holotypus rel. n°31 in Table 3)

Both FURRER & FURNARI (1960) and BAZZICHELLI & FURNARI (1979) describe communities named “*Salix retusa* and *Juncus monanthos* type” where these two species exhibit comparable values of abundance and where *Soldanella alpina* also shows high percentages. This community type can be included in the humid fringe of the *Carici-Salicetum* in the form of a new sub-association named *Carici-Salicetum juncetosum monanthi* subass. nov. (Holotypus hoc loco, rel. nr° 2, Table 7 in FURRER & FURNARI, 1960) using *Juncus monanthos*, *Astrantia pauciflora* subsp. *tenorei* and *Soldanella alpina* as differential species. Some relevés (Table 11, rel. 8-11) described in BIONDI *et al.* (1999) and included by these authors in the variant with *Persicaria vivipara* of the *Carici-Salicetum* must be referred to this sub-association. Although it is very common across the entire alpine range, *Salix retusa* is a very sporadic species in the Italian peninsula, where it is restricted to just a few sites in the central Apennines (cfr. MARTINI & PAIERO, 1988). As far as the Balkan-Apennine biogeographical province is concerned (*sensu* RIVAS-MARTÍNEZ, 1996b), the *Carici-Salicetum* is substituted by the *Soldanello-Salicetum retusae* in the Dinarid Alps and by the *Salicetum retusae-reticulatae macedonicum* in Macedonia. The *Salicetum retusae-reticulatae* and the *Carici parviflorae-Salicetum* may be considered as Alpine and Pyrenean vicariads, respectively.

***Carex rupestris* swards (group “c” in Figures 4 and 5; Phytosoc. Table nr. 4)**

*Carex rupestris* is one of the rarest species in the Apennines, where, at present, it is known only in the Gran Sasso range. In ecological terms, its typical environment is rocky ridges or windy plateaux with a high, fine-textured debris component (Figure 6d). In addition to *Carex rupestris*, *Carex kitaibeliana*, *Poa alpina*, *Festuca violacea* subsp. *italica*, *Sesleria tenuifolia*, *Edrajanthus graminifolius* and *Achillea oxyloba* subsp. *barrelieri* may also play an important physiognomical role in the community (cfr. phytosoc. table 4). This community type is included in the *Caricetum kitaibelianae-rupestris* described recently in the Gran Sasso range (BIONDI *et al.*, 2000) with also a sub-association named *artemisiето-*

*sum erianthae*. In our opinion, the occurrence of this sub-association should be excluded since *Artemisia petrosa* subsp. *eriantha* exhibits an ecology which is strongly related to that of the typical aspect of the association, where it behaves as a low-frequency species. On the contrary, our data lead us to recognise an interesting variant with *Salix retusa*, which characterises sites with coarser superficial debris or deeper soil pockets underneath. In comparison with the *Caricetum rupestris* described for the Alps (cfr. GRABHERR, 1993), the Apennine communities are characterised by strong endemic and south-eastern European components, and by the absence of many species having a strictly alpic distribution, such as *Sesleria sphaerocephala* and *Minuartia cherlerioides*. Many floristic and coenological similarities emerge when the Apennine *Caricetum kitaibelianae-rupestris* is compared with the *Trifolio-Caricetum rupestris* of the Balkans (HORVAT *et al.*, 1974) and with the *Seslerio-Caricetum rupestris* of western Rhodopi and Macedonia (SIMON, 1958). In addition to several mountainous species with a broad distribution, such as *Aster alpinus*, *Minuartia verna*, *Silene acaulis* and *Helianthemum oelandicum* subsp. *alpestre*, there are (especially in the *Trifolio-Caricetum*) various amphi-Adriatic species, such as *Carex kitaibeliana*, *Edrajanthus graminifolius* and *Trinia dalechampii*. Nevertheless, the Balkan communities still exhibit significant links with the Alpine biogeographic region (*Nigritella nigra*, *Cerastium alpinum*, *Sesleria coerulea*, *Festuca rupicola*, *Trifolium noricum*, *Vaccinium uliginosus*), as well as several local characteristic species which do not cross the Adriatic sea.

***Silene acaulis* cushions (group “e” in Figures 4 and 5; Phytosoc. Table nr. 5)**

The dwarf-cushions dominated by *Silene acaulis* s.l.<sup>8</sup> are probably the most evident expression of the so called “alpine tundra” in the Apennines. Within the study area, this vegetation type mainly occurs in the proximity of scree or in sites characterised by abundant superficial debris. As for *Salix retusa* communities, also in *Silene acaulis* community types both structure and minimum area is strictly linked to the size of the *Silene acaulis* cushion. In fact, this species, which tends to cover uniformly the small bulges of the profile, forms a sort of matrix composed of humus, organic matter in different stages of decomposition, and living roots, which is rapidly colonised by other species. As a consequence, all those *Silene acaulis* cushions which appear to be physiognomically homogeneous and whose dimensions are consistent with the minimum area of the community, behave as a “sample area”, which is clearly distinguishable in ecological, structural and floristic terms

from the surrounding stony environments. The main species of the *Silene acaulis* community type are *Galium magellense*, *Achillea oxyloba* subsp. *barrelieri*, *Androsace vitaliana*, *Draba aizoides*, *Poa alpina*, *Cerastium thomasi* and *Armeria canescens* (cfr. phytosoc. table 5).

Apennine *Silene acaulis* communities are placed in the new association *Galio magellensis-Silenetum acaulis* ass. nov. hoc loco (Holotypus rel. n°6 in Table 5), the distribution area of which, in addition to the study area, may include other Apennine massifs exceeding 2400 m a.s.l., such as the Sibillini mountains and the Velino range. In the latter area, the *Saxifraga speciosae-Silenetum cenisiae* was described (PETRICCIONE, 1993), but, given the scale used by the author to define the minimum area<sup>9</sup>, it cannot be used as a reference for the phytosociological relevés presented in this paper.

The *Galio-Silenetum* is divided into three sub-associations. *Galio-Silenetum typicum* subass. nov. has been defined in the Gran Sasso, and is characterised by the exclusive occurrence of *Androsace vitaliana* subsp. *praetutiana* which joins the other characteristic species of the association such as *Silene acaulis*, *Galium magellense* and *Achillea oxyloba* subsp. *barrelieri*. The other sub-association, *trifolietosum thalii* subass. nov. hoc loco (Holotypus rel. n°9 in Table 5) occurs on the clayey-arenaceous substrate, very rich in sand, of the Laga mountains, where it is characterised by the high frequency and abundance of *Trifolium thalii* and *Plantago alpina*. At a very high altitude, on the more or less flat, stony ground of the Maiella, the other sub-association, *alyssetosum cuneifolii* subass. nov. hoc loco (Holotypus rel. n°17 in Table 5), occurs.

#### *High altitude scree micro-chamaephytic vegetation (group "g" in Figures 4 and 5; Phytosoc. Table nr. 6)*

Between 2600 m a.s.l. and the top of mount Corno Grande (the highest Apennine peak, 2914 m a.s.l.) the environment is characterised by a strongly rugged morphology with cliffs and scree. The vegetation of "alpine" scree differs from that of the sub-alpine belt in its lack of species of relatively large size, such as *Festuca dimorpha*, *Heracleum pyrenaicum* subsp. *orsinii*, *Isatis apennina*. On the contrary it is mainly composed of some small-size rosulate hemicryptophytes such as *Papaver alpinum* subsp. *ernesti-mayeri*<sup>10</sup>, *Draba aspera* and *Arabis alpina*, and nano-chamaephytes such as *Hutchinsia alpina*, *Saxifraga oppositifolia*, *Androsace mathildae* and *Cerastium thomasi* (cfr. phytosoc. table 6). This last species, which is the dominant element in the community, is endemic, and its presence is limited to the higher peaks of the central Apennines, while *Papaver ernesti-*

*mayerii* represents the junction element with the lower altitude scree. The abundance of *Arabis alpina* in the community is probably due to a high degree of moisture occurring in the scree as a result of the long-lasting snow cover and the melting waters which flow even in the summer. This community type has been referred to the *Arabido-Cerastietum thomasi* described for high altitude scree and cliffs of the Corno Grande (BIONDI *et al.*, 2000). It was formerly included in the *Festucion dimorphae* (nom. inv. Art. 8), and belongs to the *Linario-Festucion dimorphae*, which is a *Tblaspietalia rotundifolii* central and southern Apennine endemic alliance. In the proximity of the Corno Grande peak (2850-2912 m a.s.l.), where the cliff rocks are subject to continuous erosion, a characteristic sub-association (Figure 6e), named *Arabido-Cerastietum festucetosum alfredianae* subass. nov. hoc loco, occurs (Holotypus rel. n°14 in Table 6).

#### *The vegetation of high altitude rock fissures (group "f" in Figures 4 and 5; Phytosoc. Table nr. 7)*

The cliffs of the Corno Grande and Pizzo Cefalone (and probably of other high peaks of the Gran Sasso chain such as Corno Piccolo and Pizzo Intermesoli) are colonised by a eso-comophitic vegetation featured by the occurrence of *Festuca alfrediana*<sup>11</sup> (cfr. phytosoc. table 7). Where the rocks are still compact or only slightly fissured, the typical community type is characterised by the dominance of *Festuca alfrediana* and by the occurrence of very few other species. Among the species which more frequently join *F. alfrediana* are elements strongly linked to cliff environments, such as *Campanula tanfanii*, *Saxifraga sedoides*, *S. caesia*, *S. paniculata*, *S. exarata* subsp. *ampullacea*, *Potentilla apennina*, *Valeriana salianca* and other species which exhibit a higher degree of ecological amplitude, such as *Salix retusa*, *Silene acaulis* and *Poa alpina*. This community type represents a new association named *Potentillo apenninae-Festucetum alfredianae* ass. nov. hoc loco (Holotypus rel. n°3 in Table 7), which belongs to the *Saxifragion australis*, the central Apennine *Potentilletalia caulescentis* endemic alliance.

In relation to other cliff types, where the rocks are deeply fissured and tend to crumble, species growing on the scree, such as *Campanula cochlearifolia*, *Arabis alpina*, *Saxifraga sedoides* and *Papaver ernesti-mayeri*, may also be well represented in the community. Given the few relevés available at the moment, this community type has been provisionally defined as a variant with *Papaver alpinum* subsp. *ernesti-mayeri* of the *Potentillo-Festucetum*.

chorotypes	Leontopodio-Elynetum			Galio-Silenetum typ.			Galio-Silenetum trifol.			Galio-Silenetum alyss.			Carici-Salicetum ret.			Carici-Salicetum elynet.			Carici-Salicetum trif.			Armerio-Salicetum gnaph.			Armerio-Salicetum trif.			Caricetum rupestris-kitaibel.			Arabido-Cerastietum			Arabido-Cerastietum fest.			Potentillo-Festucetum		
	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c	n	f	c
Circum-Artic-Alp.	29.7	29.3	48.0	28.0	25.3	61.7	23.1	27.5	58.7	18.2	19.8	70.8	18.8	16.8	9.6	19.6	25.2	33.3	23.5	25.7	14.0	23.1	29.9	63.1	29.0	35.1	48.1	19.2	26.2	50.6	13.0	30.0	39.8	25.0	20.6	16.1	12.1	20.6	16.2
Eudem. C - S - App	4.3	1.7	0.5	12.0	17.9	11.7	7.7	5.0	0.8	9.1	7.4	0.7	6.3	12.1	6.1	7.8	7.5	1.2	7.8	8.9	6.3	4.6	4.9	1.1				4.3	4.8	1.8	8.7	8.0	9.8	8.3	14.7	19.4	9.1	16.0	30.8
Eudem. C - App.	5.4	4.1	2.0	16.0	27.4	11.7	23.1	17.5	11.4	13.6	12.3	1.2	6.3	5.3	1.3	3.9	3.9	0.6	9.8	8.9	1.9	6.2	2.5	1.2	6.5	5.3	0.1	17.0	12.4	2.1	17.4	25.0	32.3	25.0	32.4	44.9	12.1	16.0	6.5
Eudem. -App.	4.3	3.5	2.9	8.0	4.2	1.5							4.7	4.7	3.4	7.8	5.1	1.5	5.9	5.3	0.2	3.1	3.5	1.5				2.1	4.1	3.8	8.7	2.0	0.3				3.0	0.8	0.2
Euroasiat	4.3	6.4	6.0				7.7	12.5	1.2	9.1	6.2	1.1	4.7	3.7	1.0	3.9	3.9	0.5	3.9	4.4	0.5	3.1	5.3	2.3	12.9	10.6	3.3	6.4	2.8	0.6							3.0	2.3	0.7
Europ.-Caucas	3.2	4.8	4.0										3.1	2.1	1.5	2.0	4.7	7.8	2.0	1.8	0.2	7.7	4.2	1.0	3.2	3.2	1.6	2.1	2.8	2.0				6.1	1.5	0.5			
Euroslb.	5.4	3.3	4.0										3.1	1.6	0.6	3.9	1.6	0.7				6.2	2.8	1.3	3.2	2.1	0.7												
Medit-Mont.	4.3	1.1	0.4							9.1	12.3	2.7	1.6	0.5	5.0													2.1	1.4	1.5				3.0	6.9	9.7			
Orof. C. Europ.	2.2	4.4	1.8	4.0	5.2	1.5				4.5	6.2	0.6	1.6	3.2	1.1	3.9	5.5	2.4	3.9	3.5	1.3	3.1	5.6	4.9	9.7	9.6	6.5	4.3	4.1	0.8	4.4	1.0	0.2				6.1	1.5	0.5
Orof. C-S-Europ.	3.2	1.9	4.3							4.5	3.7	0.9	1.6	6.8	5.4	2.0	5.1	30.3	2.0	3.5	47.6	3.1	2.8	0.7	3.2	3.2	2.6	4.3	6.2	13.7	4.4	7.0	1.2	8.3	8.8	12.4	6.1	8.4	12.4
Orof. SE-Europ.	9.7	11.5	8.0	12.0	7.3	5.1	7.7	2.5	0.1	22.7	21.0	9.9	17.2	17.9	8.3	13.7	17.7	14.5	17.7	14.2	7.8	9.2	16.2	9.7	9.7	6.4	2.4	14.9	13.8	8.9	8.7	2.0	0.3				3.0	2.3	0.7
Orof. S-Europ.	18.3	16.1	9.8	16.0	10.5	6.3	7.7	5.0	0.3	4.5	6.2	9.5	23.4	21.1	11.7	23.5	13.4	6.3	11.8	7.1	2.1	23.1	17.3	11.7	6.5	2.1	0.7	17.0	15.9	10.5	21.7	19.0	19.8	25.0	20.6	7.0	21.2	18.3	20.5
Orof. SW-Europ.	4.3	5.3	4.9				15.4	22.5	26.4				1.6	1.1	0.1	2.0	0.8	9.0	3.9	7.1	16.2	3.1	1.4	1.3	9.7	17.0	30.3	2.1	1.4	0.2	4.4	1.0	0.8				6.1	2.3	0.7
Amphidrahtics	5.4	3.5	1.8	4.0	2.1	0.4	7.7	7.5	1.0	4.5	4.9	2.6	4.7	2.6	0.5	3.9	3.9	0.8	5.9	6.2	1.6	3.1	2.8	0.4	3.2	1.1	0.1	4.3	4.1	3.5	8.7	5.0	1.5	8.3	2.9	0.3	6.1	2.3	0.7
subcosmop.	2.2	2.8	1.7										1.6	0.5	5.0	2.0	1.6	0.2	2.0	1.8	0.2	1.5	0.7	9.0	3.2	4.3	3.6							3.0	0.8	0.2			
Life forms																																							
Ch.	23.4	18.3	17.8	36.0	41.1	66.3	38.4	35.0	45.8	31.8	29.6	69.7	21.8	23.9	60.0	17.6	23.8	43.8	19.6	27.6	57.8	18.4	20.2	52.3	19.3	17.3	40.0	34.0	37.9	39.0	21.7	23.0	24.4	41.7	41.3	52.1	37.5	44.9	42.8
G.	4.2	6.6	4.7	4.0	2.1	0.1				4.5	6.2	4.1	6.5	3.2	2.7	9.8	7.8	6.4	5.8	4.4	1.3	3.0	4.2	1.3	3.2	6.3	3.3	4.2	3.4	2.3				3.1	0.8	0.2			
H. caesp	19.1	24.7	44.0	20.0	24.2	21.2	23.0	27.5	34.1	13.6	14.8	4.5	15.6	24.7	17.3	17.6	25.0	26.4	21.5	28.3	28.8	26.1	27.8	20.1	25.8	32.9	26.0	17.0	31.0	52.5	17.3	20.0	24.4	25.0	29.4	33.6	21.8	26.3	33.8
H. ros	19.1	21.1	16.3	12.0	10.5	4.7	7.6	12.5	8.2	18.1	23.5	16.9	17.1	16.8	9.0	21.5	16.9	7.0	25.4	16.8	6.3	15.4	22.5	13.3	29.0	26.6	20.7	12.7	7.8	1.5	26.0	19.0	6.5	5.8	3.0	0.8			
H. scap	28.7	25.3	15.7	20.0	16.8	6.0	30.7	25.0	11.8	31.8	25.9	4.7	35.9	27.8	10.2	27.4	23.2	14.3	23.5	20.3	4.4	30.7	22.5	8.7	16.1	9.5	3.7	23.4	13.7	5.3	30.4	37.0	44.4	25.0	23.5	11.2	28.1	21.7	22.1
P	1.0	0.2																																					
T	4.2	3.8	1.4	8.0	5.3	1.6							3.1	3.6	0.5	5.8	3.3	1.9	3.9	2.6	1.1	6.1	2.8	4.1	6.4	7.4	6.1	8.5	6.2	1.0	4.3	1.0	0.1				3.1	0.8	

FIGURE 7. - Chorotypes and life form spectra calculated from simple presence "n", frequency "f" and cover "c" values.

*Life-forms and Chorology (Figure 7)*

*Leontopodio-Elynetum*, *Armerio-Salicetum*, *Caricetum kitaibelianae-rupestris* and *Galio-Silenetum* exhibit a relatively high percentage of circumboreal chorotype (18–30%), which sharply increases, passing from normal to cover spectrum, as a consequence of the high cover rate of the guide species (up to 70%). At the same time, both endemics (especially the central-Apennine ones) and south-eastern European species are very well represented. In particular, the former become dominant in those habitats developed on scree, cliffs or rocky surfaces where associations, such as *Arabido-Cerastietum*, *Festucetum alfredianae* and *Galio-Silenetum*, occur. The scarce contribution of the montane-Mediterranean chorotype is due to the high average altitude of the study area, which was entirely included in the alpine belt. The Eurasian *s.l.* element (including the Euro-Caucasian) shows highly variable frequencies, which range between 13.8% (*Armerio-Salicetum trifolietosum*) and 0 (*Galio-Silenetum typicum* and *Arabido-Cerastietum*). Considering the vegetation of the study area as a whole, however, the Eurasian *s.l.* barely exceeds 6% in frequency and 2.5% in cover. The limited role of the Eurasian *s.l.* element, in which species which are not strictly linked to a high altitude environment are commonly found (in our case *Trifolium repens*, *Agrostis tenuis*, *Bellis perennis*, *Luzula campestris*, *Gymnadenia conopsea*), points to a very low influence of the climatophilous vegetation community types of the underlying altitudinal belt, such as dwarf-shrub heathlands and beech woodlands. Of particular interest is the role of the strictly amphiadriatic species which in some community types, such as the *Arabido-Cerastietum*, exceeds 8% of the entire flora, while the incidence of sub-cosmopolitan species is almost negligible. Comparing these chorological data (only the normal spectrum “n”) with the data regarding the whole central Apennines summit area, including the sub-alpine belt and the upper part of the montane belt (cfr. LUCCHESI, 2000), it emerges that the circumboreal-arctic alpine element (+ 10%), the orophytes *s.l.* (+ 14%) and the endemic element (+ 13%) increase markedly as one climbs to the alpine plain, while all the other chorotypes decrease more or less evidently.

A broad comparison with the rest of the Apennine massif seems to suggest that the central Apennines may be considered a distinct biogeographical area. Although the central Apennines are usually grouped together with the southern Apennines, in the latter the alpine plain is completely absent, as are the many circumboreal, arctic-alpine and orophilous species which have their southernmost distributional border in the central Apennines

(*Elyna myosuroides*, *Salix retusa*, *Salix herbacea*, *Silene acaulis*, *Gentiana nivalis*, *Carex ericetorum*, *Aster alpinus*, *Pedicularis verticillata*, *Oxytropis campestris*). A more interesting comparison may be made with the northern Apennines which, despite the relatively low altitudes, still exhibit some scattered stands of Alpine vegetation, such as *Salix herbacea* communities (cfr. TOMASELLI, 1994). The chorological spectrum of the summit vegetation of the northern Apennines (TOMASELLI & AGOSTINI, 1994) is dominated by the orophilous central-European chorotype (40%), followed by the boreal (20–25%) and eurasiatic (13–15%) ones. Instead, both Apennine endemic *s.l.* and orophylo-southern-European chorotypes are very scarce, with values ranging around 6% and 7.5%, respectively (at least within the alpine plain of the central Apennines these elements show percentage frequencies averaging around 25% and 28%). Furthermore, the northern Apennines (especially the Tuscan-Emilian Apennines) are characterised by a very low number of species which are endemic solely to this area. On the contrary, most of the endemic species of the summit area of the central Apennines exhibit a distribution area strictly limited to this part of the Apennine chain. On the other hand, if the low degree of floristic independence from the Alps leads to regard the summit area of the northern Apennines as the southernmost part of a larger phytogeographical unit which also includes the main central-European massifs (cfr. FOGGI, 1990; TOMASELLI & GUALMINI, 2000), the same cannot be said for the central Apennines, where the high altitude, the great variability of landscape morphology and lithological substrates, and the complex paleogeographic and paleoclimatic history make this area a very important centre of differentiation and conservation of both endemic taxa and arctic-alpine relics.

The life-form table has been calculated only on the basis of the frequency values. Hemicryptophytes emerge as the dominant life-form; they range from a maximum of 71.1% (*Leontopodio-Elynetum*) to a minimum of 51.2% (*Festucetum alfredianae*). The chamaephytic component is also well represented, especially on cliffs and scree, where it may exceed values of 40%. Geophytes and therophytes are very scarce and sporadic and, in some cases, completely lacking. The contribution of phanerophytes is negligible, and is limited to isolated *Juniperus communis* subsp. *alpina* individuals.

## SYNTAXONOMICAL DISCUSSION

Although the plant community types investigated in this paper belong to different phytosociological classes, they

all exhibit a floristic similarity which has a twofold reason. On the one hand, the relatively low altitude of the Apennines determines a limited vertical extension of the alpine belt which causes species and plant communities to be concentrated in a reduced space. On the other hand, some species which often behave as dominants (e.g. *Salix retusa*, *Silene acaulis*, *Carex kitaibeliana*), exhibit a distinct pioneering attitude which allows them to occur in most of the rocky and stony habitats which are typical of the highest part of the Apennines.

As far as *Leontopodio-Elynetum*, *Caricetum kitaibeliana-rupestris* and *Galio-Silenetum acaulis* are concerned, they have been included in the *Elyno-Seslerietea* class, *Seslerietalia tenuifoliae* order and *Seslerion tenuifoliae* alliance. In order to distinguish the primary alpine belt plant community types from those of the underlying sub-alpine belt (the majority of which exhibit a secondary origin and evolution) we propose the institution of a new *Seslerion apenninae* sub-alliance named *Leontopodio nivalis-Elynenion myosuroidis* Blasi & Di Pietro suball. nov. hoc loco (Typus: *Leontopodio-Elynetum*). This sub-alliance, which is characterised by a rich circumboreal/arctic-alpine component included in a strong endemic/orophilous south-eastern-European floristic matrix, expresses in coenological and phytosociological terms, the existence and autonomy of a true Apennine alpine bioclimatic belt. In addition to the bioclimatic indices, the presence of the alpine belt is not confirmed by the presence of single characteristic elements, such as *Elyna myosuroides*, *Carex rupestris*, *Carex parviflora*, *Potentilla crantzii*..., but by that of true community types and vegetational complexes (e.g. *Elynetum-Salicetum-Caricetum*) whose physiognomical, synecological and synchorological features differentiate them clearly from those of the underlying sub-alpine belt vegetation. The latter are often characterised by several *Festuco-Brometea* transgressive species. Since the alliance *Seslerion apenninae* has not yet been validly divided into sub-alliances, the *Leontopodio-Elynenion* requires the description of a new typical sub-alliance. On the basis of art. 28a and 46 of the ICPN, the name of the new sub-alliance of *Seslerion apenninae* must be *Seslerion apenninae* Blasi & Di Pietro (suball. nov.), which has the association *Seslerietum apenninae* Furnari in Bruno & Furnari 1966 as nomenclatural type. This association is also the nomenclatural type of the whole alliance (cfr. note 1). The characteristic species of the *Leontopodio-Elynenion* are the following: *Elyna myosuroides*, *Carex rupestris*, *C. ericetorum*, *C. parviflora*, *C. capillaris* subsp. *capillaris*, *Minuartia verna* subsp. *verna*, *Dryas octopetala*, *Leontopodium alpinum* subsp. *nivalis*, *Helianthemum oelandicum* subsp. *alpestre*,

*Potentilla crantzii*, *Persicaria vivipara*, *Gentiana nivalis*, *G. utriculosa*, *Sedum atratum*, *Oxytropis neglecta*, *Oxytropis campestris*, *Gnaphalium hoppeanum* subsp. *majellensis*, *Antennaria dioica*.

To the other hand, the differential component of the suballiance *Seslerion apenninae* is based on species which find their coenological optimum in the lower sub-alpine belt or in the upper montane belt (*Allium lusitanicum*, *Anthyllis montana* subsp. *atropurpurea*, *Asperula aristata* subsp. *oreophila*, *Carduus affinis*, *Carduus carlinifolius*, *Centaurea ambigua* subsp. *nigra*, *Coronilla vaginalis*, *Festuca laevigata* subsp. *crassifolia*, *Helianthemum nummularium* subsp. *grandiflorum*, *Linum alpinum* subsp. *julicum*, *Linum capitatum* subsp. *serrulatum*, *Minuartia capillacea*, *Oxytropis caputoi*, *Paronychia kapela* subsp. *kapela*, *Polygala alpestris*, *Satureja alpina* subsp. *meridionalis*, *Silene roemeri* subsp. *staminea*, *Silene vallesia* subsp. *graminea*, *Stachys alopecuros*). In addition to this group of species, there are other species (*Allium sphaerocephalon*, *Asperula cynanchica*, *Astragalus sempervirens* subsp. *gussonei*, *Bromus erectus*, *Bunium petraeum*, *Carex humilis*, *Carex macrolepis*, *Centaurea triumfetti*, *Globularia meridionalis*, *Helianthemum oelandicum* subsp. *incanum*, *Hippocrepis comosa*, *Koeleria lobata*, *Laserpitium siler* var. *siculum*, *Leontodon crispus* subsp. *asper*, *Phleum ambiguum*, *Sesleria nitida*, *Teucrium montanum*), which can more commonly be found in the montane belt pastures but which may behave as transgressive elements in the *Seslerion apenninae* plant communities suballiance.

Although *Leontopodio-Elynetum* might exhibit a slight resemblance to the *Elyna myosuroides* primary swards of the boreal region and the Alps, both its occurrence, limited to a narrow and typically extra-zonal ridge area, and the lack of most of the true characteristic species of *Carici-Kobresietea*, have led us to share (at least as far as the Apennines is concerned) the opinion of ORIOLO (2001) who decided to exclude this last class from both the Alps and the Apennines. The most typical features of *Carici-Kobresietea* are those associated either with the steppe-like grasslands of Siberia and central Asia, where several genera, such as *Kobresia*, *Astragalus* and *Oxytropis*, exhibit their centre of distribution, or with the *Elyna* grasslands of Scandinavia where the species of *Seslerietalia coeruleae* are absent or very sporadic and the *Elyna* grasslands are the real climatophilous vegetation covering hundreds of hectares. Moreover, it must be emphasised that, as far as the Alps are concerned, most of the species which OHBA (1974) originally considered as class or order characteristic are also commonly found in *Caricion firmae*, *Caricion ferrugineae*, *Seslerion*

*coeruleae*. The same can be said for the occurrence in the Apennines of *Minuartia verna*, *Gentiana verna* and *Draba aizoides*, which are commonly found in the *Seslerion apenninae* communities of the sub-alpine plain, and, occasionally, even in the *Phleo-Bromion* communities of the upper montane plain. *Elyna myosuroides* and, especially, *Carex rupestris* are extremely sporadic and, their distribution seems to be determined by topography rather than by bioclimate. Thus, we can hypothesise that both *Elyna myosuroides* and *Carex rupestris* exhibit their coenological autonomy at the association level (*Leontopodio-Elynetum* and *Caricetum kitaibelianae-rupestris*), whereas the bioclimatic autonomy (alpine plain) is expressed in terms of a new sub-alliance, (*Leontopodio-Elynenion*). This sub-alliance is included in a more general floristic-biogeographical context characterised by a strong incidence of the endemic and south-eastern-European element, and syntaxonically belongs to the *Seslerion apenninae* alliance and *Seslerietalia tenuifoliae* order. In fact, in the paper in which the *Carici-Kobresietea* class is proposed (OHBA, 1974) the author is aware that in the Mediterranean mountains *Sesleria* communities and *Elyna* communities tend to occupy similar environments, and that consequently they are very closely related in coenological terms. On this basis, OHBA's hypothesis of grouping Apennine communities together with those of the Alps and Pyrenees in the order *Oxytropido-Kobresietalia*, and placing the communities of Dynarids (which share with the Apennines the same biogeographical province) in a separate, distinct order, *Oxytropidetalia dinaricae*, appears to be doubtful. In fact, among the differential species of the *Oxytropidetalia dinaricae*, species such as *Sesleria tenuifolia*, *Edrajanthus graminifolius* and *Carex laevis* (= *Carex kitaibeliana*) were chosen which exhibit a typical amphiadriatic distribution and which already represent the diagnostic species of the *Seslerietalia tenuifoliae* order.

The reference to *Festuco-Seslerietea*, formerly used by other authors for the Apennines (BARBERO & BONIN, 1969; PETRICCIONE & PERSIA, 1995; PIGNATTI, 1994), does not seem to be appropriate to include this kind of vegetation. In fact, this syntaxon exhibits an overly extensive ecological range which means that it is well-suited to include also, in addition to the sub-alpine grasslands, *Bromus erectus* secondary grasslands of the montane belt<sup>12</sup>.

The *Galio-Silenetum* is a community type which is markedly affected by the surrounding vegetational mosaic. In fact, some *Linario-Festucion* scree species, such as *Cerastium thomasi*, *Achyllea oxyloba* subsp. *barrelieri*, *Thlaspi stylosum*, *Viola magellensis*, *Galium mag-*

*ellense* and *Androsace vitaliana* subsp. *praetutiana*, occur in this community although mostly with low frequency values. The dominance of a typical species of the alpine tundra such as *Silene acaulis*, and the stabilising effect that this species has on substrates, providing more or less stable environments, suggests that the *Galio-Silenetum* ought to be included in the *Seslerion apenninae* rather than in the *Linario-Festucion*.

Although *Armerio-Salicetum herbaceae* was in the beginning included in the *Arabidion caeruleae* (BIONDI *et al.*, 2000), it is our opinion that this community type would find a more appropriate taxonomical reference in the *Salicion herbaceae*. In fact, even when subjected to prolonged snow cover, both unstable and stable screes are never colonised by *Salix herbacea* communities, which remain linked to more or less conventional snow-beds. Obviously, because of its extremely marginal position with respect to the whole area of distribution of the alliance, *Armerio-Salicetum* represents, in floristic terms, a very impoverished aspect of the latter.

As far as *Salix retusa* communities are concerned, their taxonomical position in terms of alliance, order and class, remains controversial. Some authors (LAKUSIC, 1969 a; 1969 b; HORVAT *et al.*, 1974) include these communities in the *Salicetea herbaceae* class and in the *Salicion retusae* alliance. Others (OBERDORFER, 1994; BIONDI *et al.*, 1999; RIVAS MARTINEZ *et al.*, 2001), while confirming the class, place *Salix retusa* communities in the *Arabidion caeruleae* alliance. Yet others (ENGLISCH *et al.*, 1993; THEURILLAT *et al.*, 1994; VALACHOVIC *et al.*, 1997), maintain these communities in the *Arabidion caeruleae* (of which *Salicion retusae* is considered as synonym), but move this alliance to the *Thlaspietea* class. Despite the geographical marginality of *Arabidion caeruleae* in the central Apennines, this last hypothesis seems to be the most suitable one for the tables presented in this paper. In fact, in the study area, *Salix retusa* stands seem to find their synecological optimum precisely on the more or less consolidated talus slopes characterised by a high degree of soil moisture.

*Arabido-Cerastietum thomasi* has also been placed in the *Thlaspietea rotundifolii*, but in the *Linario-Festucion dimorphae* alliance. Within this Apennine endemic alliance, *Arabido-Cerastietum* occupies the highest fringe in altitude, which is represented by the sub-alliance *Thlaspienion stylosi*. These communities, which were described as "summary associations of the screes of peaks" in AVENA & BRUNO (1975), also seem to be well suited to be included in *Arabido-Cerastietum*.

*Potentillo-Festucetum alfredianae* belongs to the *Asplenieta trichomanis* class where it is placed in the endemic alliance *Saxifragion australis*. The *Potentillo-*

*Festucetum* can be considered a high altitude vicariant of *Potentilletum apenninae*, which was proposed to describe a particular aspect of the vegetation of the Majella rock walls. In the original proposal, this association was first included in *Potentillion caulescentis* and then subsequently transferred to *Saxifragion australis* (cfr. BIONDI *et al.*, 2000). Since the optimum environment for *Potentilletum apenninae* is around 2000 m a.s.l., it can be distinguished from *Potentillo-Festucetum* on the basis of the presence of several species of the sub-alpine plain rocky environment, such as *Primula auricola*, *Rhamnus pumilus*, *Saxifraga australis*, *Asperula aristata*, *Helianthemum oelandicum* subsp. *canum* and *Campanula fragilis* subsp. *cavolini*. However, relevés 15-18 of Table 2 in FEOLI & FEOLI-CHIAPELLA (1976),

which were performed at an average altitude of 2600 m a.s.l. and which were characterised by the occurrence of a taxon recorded as *Festuca* gr. *alpina* (which must be probably reported to *F. alfrediana*), clearly differ from the rest of the table, and appear to be quite similar to those of *Potentillo-Festucetum alfrediana*.

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#### SYNTAXONOMIC SCHEME

##### ELYNO-SESLERIETEA Br.-Bl. 1948

*Seslerietalia tenuifoliae* Horvat 1930

*Seslerion apenninae* Furnari in Bruno & Furnari 1966

*Leontopodio nivalis-Elynenion myosuroidis* suball. nova hoc loco

*Leontopodio nivalis-Elynetum myosuroidis* Feoli-Chiapella & Feoli 1977

*Caricetum kitaibelianaerupestris* Biondi, Allegrezza, Ballelli & Taffetani 2000

*Galio magellensis-Silenetum acaulis* ass. nova hoc loco

*Galio magellensis-Silenetum acaulis plantaginetosum alpinae* subass. nova hoc loco

*Galio magellensis-Silenetum acaulis alyssetosum cuneifolii* subass. nova hoc loco

##### SALICETEA HERBACEAE Br.-Bl. 1948

*Salicetalia herbaceae* Br.-Bl. in Br.-Bl. & Jenny 1926

*Salicion herbaceae* Br.-Bl. in Br.-Bl. & Jenny 1926

*Armerio canescentis-Salicetum herbaceae* Biondi, Allegrezza, Ballelli & Taffetani 2000

*Armerio canescentis-Salicetum herbaceae gnaphalietosum majellensis* subass. nova hoc loco

*Armerio canescentis-Salicetum herbaceae trifolietosum thalii* subass. nova hoc loco

##### THLASPIETEA ROTUNDIFOLII Br.-Bl. 1948

*Tblaspietalia rotundifolii* Br.-Bl. in Br.-Bl. & Jenny 1926

*Linario-Festucion dimorphae* Avena & Bruno 1975

*Tblaspienion stylosi* Avena & Bruno 1975

*Arabido alpinae-Cerastietum thomasii* Biondi, Allegrezza, Ballelli & Taffetani 2000

*Arabido alpinae-Cerastietum thomasii festucetosum alfrediana* subass. nova hoc loco

*Arabidetalia caeruleae* Rubel ex Br.-Bl. 1948

*Arabidion caeruleae* Br.-Bl. in Br.-Bl. & Jenny 1926

*Carici kitaibelianaeretusae* Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999

*Carici kitaibelianaeretusae* *trifolietosum thalii* subass. nova hoc loco

*Carici kitaibelianaeretusae elynetosum myosuroidis* subass. nova hoc loco

*Carici kitaibelianaeretusae juncetosum monanthi* subass. nova hoc loco

##### ASPLENIETEA TRICHOMANIS (Br.-Bl. in Meier & Br.-Bl. 1943) Oberd. 1977

*Potentilletalia caulescentis* Br.-Bl. in Br.-Bl. & Jenny 1926

*Saxifragion australis* Biondi & Ballelli ex Brullo 1993

*Potentillo apenninaeretusae* *alfrediana* ass. nova hoc loco



## NOTES

<sup>1</sup> According to CPN rules, the correct author citation for the alliance is *Seslerion apenninae* Furnari in Bruno & Furnari 1966. However the nomenclatural type of this syntaxon has never been expressly indicated. On the basis of Art. 20 (CPN), the association *Seslerietum apenninae* (since *S. apennina* is the only species of the genus *Sesleria* which occurs in the relevé of the community named by the author simply as “*Seslerietum*”) must be chosen as lectotype of the alliance. As far as the *Seslerietum apenninae* Furnari in Bruno & Furnari 1966 is concerned, the lectotype is indicated hoc loco in the rel. N° 4 pag. 17, in: BRUNO & FURNARI, 1966.

<sup>2</sup> In the same paper in which *Leontopodio-Elynetum* is proposed, the authors argued that this association could also include both *Elynetum apenninicum* Lakusic 1969 (*nom illeg.*) and *Helianthemum alpestris* Migliaccio 1970, which were described in the same geographical area. Since *Helianthemum alpestre* is a prior and probably validly published name (some doubts concerning Art. 7 remain), it should assume nomenclatural priority and consequently *Leontopodio-Elynetum* is a superfluous name (Art. 29c). In the same paper in which Migliaccio describes *Helianthemum alpestris*, however, this same author recognises *Elynetum apenninicum* Lakusic 1969 as a different association. In his opinion *Elynetum apenninicum* characterises very different environmental conditions compared to those of *Helianthemum alpestris*. In fact, although these two associations are rather similar as regards their general floristic composition, *Helianthemum alpestris* as proposed by Migliaccio is completely absent in *Elyna myosuroides*, whereas it is dominant in *Elynetum apenninicum* as well as in *Leontopodio-Elynetum*. Moreover, it is worth noting that *Helianthemum oelandicum* subsp. *alpestre* is absent from the relevé-type by which *Leontopodio-Elynetum* has recently been lectotypified. Both these important floristic-coenological features and some field observations made during this research lead us to consider these two associations as clearly separated. In conclusion, *Leontopodio-Elynetum* easily overlaps with *Elynetum apenninicum* Lakusic 1969, which was described and further recognised in the same place (Majella range), and with which it shares floristic, coenological and physiognomical features. On the other hand, *Helianthemum alpestris* Migliaccio 1970 is a different association in which *Elyna myosuroides* is typically absent.

<sup>3</sup> The species, for its ecology and physiognomy, has been temporarily classified as *Plantago alpina*, but further studies are needed to verify its identity.

<sup>4</sup> According to GREUTER *et al.*, 1984-89 and CONTI, 1998, the taxon *Armeria majellensis* Boiss. which occurs in PIGNATTI, 1982 is considered of doubtful taxonomic status and its reports are probably to be referred to *A. canescens* (Host) Boiss. subsp. *canescens*.

<sup>5</sup> Those relevés which were described as “variant with *Salix retusa*” of the *Leontopodio-Elynetum* in FEOLICHIAPPELLA & FEOLI, 1977, must probably be referred to *Carici-Salicetum retusae elynetosum*.

<sup>6</sup> The relevé published without any syntaxonomical reference in FURNARI (1970) must be referred to this sub-association.

<sup>7</sup> In FURRER & FURNARI, 1960 the guide species of the community is reported as *Juncus trifidus*. According to CONTI, 1998 it is likely that most of the report of *J. trifidus* L. are to be referred to *J. monanthos* Jacq. The real occurrence of *J. trifidus* within the central Apennine is still to be confirmed.

<sup>8</sup> Although *Silene acaulis* subsp. *cenisia* Vierh. has been frequently recorded within the central Apennine main mountain groups, it is probably to be referred to *Silene acaulis* Jacq. or, less frequently, to *Silene acaulis* subsp. *bryoides* (Jord.) Nyman (cfr. FOGGI & RICCI, 1989; CONTI, 1998).

<sup>9</sup> On the basis of its type relevé, *Saxifrago-Silenetum* exhibits a minimum area of about 100 m<sup>2</sup> and *Silene acaulis* cover values ranging around 5-25 %. On the contrary, for *Galio-Silenetum* the minimum area does not exceed 3m<sup>2</sup> and *Silene acaulis* shows abundance-dominance indexes ranging between 4 and 5 (cfr. Figure 6c).

<sup>10</sup> According to KADEREIT (1990), *Papaver degenii* (Urum. & Jáv.) Kutzmanov is to be excluded from the Italian flora, and its records from the central Apennines must be referred to *Papaver alpinum* subsp. *ernesti-mayeri* (Markgr.) Wraber. In our opinion, the sub-association *papaveretosum degenii*, which was indicated in BIONDI *et al.* (2000) as differential of unstable debris environments, does not differ from the typical aspect of the association, which finds its optimum precisely within screes.

<sup>11</sup> This taxon was known in the Italian peninsula under other binomies such as *Festuca vizzavone* Ronn. and *Festuca ovina* var. *briquetii* St.-Yves. According to a recent revision (FOGGI & SIGNORINI, 1997), *F. vizzavonae* is limited to Corsica and occurrences in the Italian peninsula must be referred to *F. alfrediana* Foggi & Signorini, which substitutes the alpine-Pyrenean *F. alpina* in the mountains of southeastern Europe and North Africa.

<sup>12</sup> In a very recent syntaxonomical scheme proposed for Peninsula Iberica and canary island (RIVAS-MARTÍNEZ *et al.*, 2001), it would seem that, according to Art. 23 of the ICPN the name *Festuco-Seslerietea* Barbero & Bonin 1969 has the priority respect to both *Elyno-Seslerietea* Br.-Bl. 1948 *em.* Ohba 1974 and *Seslerietea albicantis* Oberd. 1978 *corr.* Oberd. 1990, these latter being only syntaxonomical synonyms. It is likely, however, that the changed meaning of Art. 47 of CPN (the emendatio is no longer accepted), how it is reported in the 3<sup>rd</sup>. edition of this Code (WEBER *et al.*, 2000), will give back again the priority to the first name proposed (*Elyno-Seslerietea* Br.-Bl. 1948).

#### APPENDIX 1: Complete list of the syntaxa quoted in the text.

*Arabidetalia caeruleae* Rubel ex Br.-Bl. 1948; *Arabidion caeruleae* Br.-Bl. in Br.-Bl. & Jenny 1926; *Arabido alpinae-Cerastietum festucetosum alfredianae* subass. nova hoc loco; *Arabido alpinae-Cerastietum thomasi* Biondi, Allegrezza, Ballelli & Taffetani 2000; *Armerio majellensis-Salicetum herbaceae* Biondi, Allegrezza, Ballelli & Taffetani 2000; *Armerio majellensis-Salicetum herbaceae gnaphalietosum majellensis* subass. nova hoc loco; *Armerio majellensis-Salicetum herbaceae trifolietosum thalii* subass. nova hoc loco; *Asplenietea trichomanis* (Br.-Bl. in Meier & Br.-Bl. 1943) Oberd. 1977; *Caricetum kitaibelianaë-rupestris* Biondi, Allegrezza, Ballelli & Taffetani 2000; *Caricetum kitaibelianaë-rupestris artemisietosum erianthe* Biondi, Allegrezza, Ballelli & Taffetani 2000; *Carici kitaibelianaë-Elynetum bellardii* Pedrotti 1983; *Carici parviflorae-Salicetum* Rivas-Martínez 1969; *Carici kitaibelianaë-Salicetum retusae* Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999; *Carici kitaibelianaë-Salicetum retusae elynetosum* subass. nova hoc loco; *Carici kitaibelianaë-Salicetum retusae trifolietosum thalii* subass. nova hoc loco; *Carici kitaibelianaë-Salicetum retusae juncetosum monanthe* subass. nova hoc loco; *Caricion ferrugineae* G. Br.-Bl. & J. Br.-Bl. 1931; *Caricion firmae* Gams 1936; *Carici rupestris-Kobresietea bellardii* Ohba 1974; *Elynetum apenninicum* Lakusic 1968; *Elyno myosuroidis-Seslerietea caeruleae* Br.-Bl. 1948 *em.* Ohba 1974; *Elyno-Seslerietea* Br.-Bl. 1948; *Festuco-Brometea* Br.-Bl. & Tüxen ex Br.-Bl. 1949; *Festuco-Seslerietea* Barbéro & Bonin 1969; *Galio majellensis-Silenetum acaulis* ass. nova hoc loco; *Leontopodio nivalis-Elynenion myosuroidis* Blasi & Di Pietro suball. nova hoc loco; *Linario-Festucion dimorphae* Avena & Bruno 1975; *Oxytropido-Kobresietalia* Oberd. 1957; *Oxytropidetalia dinaricae* Ohba 1974; *Phleo ambigu-Bromion erecti* Biondi & Blasi ex Biondi, Ballelli, Allegrezza & Zuccarello 1995; *Potentilletalia caulescentis* Br.-Bl. in Br.-Bl. & Jenny 1926; *Potentilletum apenninae* Feoli & Feoli-Chiapella 1976; *Potentillion caulescentis* Br.-Bl. & Jenny 1926; *Potentillo apenninae-Festucetum alfredianae* ass. nova hoc loco; *Salicetalia herbaceae* Br.-Bl. in Br.-Bl. & Jenny 1926; *Salicetea herbaceae* Br.-Bl. 1948; *Salicetum herbaceae* Rübél 1911; *Salicetum herbaceae dinaricum* Lakusic 1969; *Salicetum herbaceae macedonicum* Lakusic 1969; *Salicetum retusae-reticulatae* Br.-Bl. in Br.-Bl. & Jenny 1926; *Salicetum retusae-reticulatae macedonicum* Horvat 1936; *Salicion herbaceae* Br.-Bl. in Br.-Bl. & Jenny 1926; *Salicion retusae* Horvat 1949; *Saxifragion australis* Biondi & Ballelli ex Brullo 1983; *Saxifrago speciosae-Silenetum cenisiae* Petriccione 1993; *Seslerion apenninae* Blasi & Di Pietro suball. nov. hoc loco; *Seslerietalia tenuifoliae* Horvat 1930; *Seslerietea albicantis* Oberd. 1978 *corr.* Oberd. 1990; *Seslerion apenninae* Furnari in Bruno & Furnari 1966; *Seslerion caeruleae* Br.-Bl. in Br.-Bl. & Jenny 1926; *Soldanello-Salicetum retusae* Horvat 1933; *Thlaspietalia rotundifolii* Br.-Bl. in Br.-Bl. & Jenny 1926; *Thlaspietea rotundifolii* Br.-Bl. 1948.

#### APPENDIX 2: Sporadic species

TABLE 1: REL. 2, *Alyssum montanum* L.: +. REL. 10, *Sibbaldia procumbens* L.: 1. REL. 13, *Saxifraga aizoides* L.: +; *Alchemilla nitida* Buser: +. REL. 14, *Astragalus depressus* L. subsp. *depressus*: +; *Saxifraga adscendens* L. s. l.: +; *Minuartia recurva* (All.) Sch. & Th.: 2. REL. 15, *Carum heldreichii* Boiss.: +; *Alchemilla flabellata* Buser: +; *Bellardiocloa variegata* (Lam.) Kerguelen: +; *Thymus kernerii* Borbàs: +; *Seseli montanum* L.: 1; *Juniperus communis* L. subsp. *nana* (Willd.) Syme.: +. REL. 16, *Androsace vitaliana* (L.) Lapeyr. subsp. *praetutiana* (Sund.) Kres.: +; *Saxifraga oppositifolia* L.: +; *Trifolium pratense* L. subsp. *semipurpureum* (Strobl) Pignatti: 3; *Primula auricola* L.: +; *Trifolium montanum* L. subsp. *rupestris* (Ten.) Nyman: 2.

TABLE 3: REL. 1, *Trifolium montanum* L. subsp. *rupestris* (Ten.) Nyman: 1; *Gymnadenia conopsea* (L.) R. Br.: 1; *Antennaria dioica* (L.) Gaertner: 1; *Pulsatilla alpina* (L.) Delarbre subsp. *alpina*: 1; *Gentiana lutea* L.: 1; *Phleum alpinum* L. subsp. *rhaeticum* Humpries: +; *Linum alpinum* Jacq. subsp. *julicum* (Hyek) Hegi: +; *Cerastium tomentosum* L.: +; *Anemone narcissiflora* L. subsp. *narcissifolia*: +; *Ranunculus sartorianus* Boiss. & Heldr.: +; *Cynoglossum magellense* Ten.: +; *Hieracium villosum* Jacq.: +; *Polygala alpestris* Rchb.: +. REL. 3, *Rumex acetosella* L. s. l.: +. REL. 4, *Festuca rubra* L. subsp. *commutata* (Gaudin) Markgr.-Dann.: 1; *Seseli montanum* L.: +; *Bellis perennis* L.: +; *Thesium alpinum* L.: +. REL. 26, *Coeloglossum viride* (L.) Hartm.: +; *Primula auricola* L.: +; *Juncus monanthos* (Jacq.) A. et Gr.: 3; *Phyteuma orbiculare* L.: +. REL. 27, *Cystopteris fragilis* (L.) Bernh.: +. REL. 31, *Gentiana nivalis* L.: +; *Gentiana columnae* Ten.: +. REL. 32, *Veronica aphylla* L.: +.

APPENDIX 3: *Place and date of relevés.*

TABLE 1: Rel. 1-2-9-10-11-12 summit of M. Gorzano (Laga, Abruzzo slope), 14/07/2000; Rel. 3-4: northeastern slope of M. Gorzano (Laga, Abruzzo slope), 15/07/2000; Rel. 5-6-7-8: summit of M. Pizzo di Sevo (Laga, Latium slope), 18/07/1999; 14/07/2000; Rel. 13-14-15: M. Aquila (Gran Sasso), 17/07/1999; Rel. 16: M. Focalone (Majella), 07/08/1999; Rel. 17-18: Duca Abruzzi (Gran Sasso), 16/07/1999.

TABLE 2: Rel. 1: : M. Aquila (Gran Sasso), 15/07/1999; Rel. 2-4-5-6-7-9-12-14-15: Snow gullies between M. Aquila and Campo Pericoli (Gran Sasso), 15/09/1999. Rel. 3: Conca degli Invalidi (Gran Sasso), 01/08/1999.

TABLE 3: Rel. 1: : above Campo Imperatore (Gran Sasso), 14/07/1999; Rel. 2-3-4: M. Aquila (Gran Sasso), 15/07/1999; Rel. 5-6-7-8-9-10-11-12-13: Corno Grande (Gran Sasso), 02/08/1999. Rel. 14-15-16-17-18-19-27: M. Focalone (Majella), 07/08/1999; 20-21-22-23-24-25-26 towards M. Amaro (Majella), 10/08/1999; : Conca degli Invalidi (Gran Sasso), 01/08/1999. Rel. 28-29-30: summit of M. Pizzo di Sevo (Laga, Latium slope), 18/07/1999; Rel. 31-32: M. Gorzano (Laga, Abruzzo slope), 11/09/1999.

TABLE 4: Rel. 1-2-3-4-5: M. Aquila (Gran Sasso), 11/07/1999; Rel. 6-7-8-9-10-11: Corno Grande (Gran Sasso), 09/09/1999.

TABLE 5: Rel. 1-2-3-4-5-6-7-8: various sites between Corno Grande, M. Aquila, Pizzo Cefalone (Gran Sasso), 07/1999; Rel. 9-10-11-12-13: Pizzo di Sevo and M. Gorzano, 07/1999. Rel., 14-15-16-17-18-19: various sites between M. Focalone and M. Amaro (Majella): 07/1999; 08/1999.

TABLE 6: Rel. 1-2-3-4-5-6-7-8-9-10-11-12: from Conca degli Invalidi to Il Calderone (Gran Sasso): 03/08/1999; Rel. 13-14-15-16-17: Corno Grande peak, 01/08/1999.

TABLE 7: Rel. 1-2-3-4-5-6-7-8-9-10-11-12: Gran Sasso, Pizzo Cefalone. 07/2000; Rel. 13-14: Pizzo Intermesoli, 07/1998. Rel. 15-16-17: Corno Grande, 08/1999.







Table 4: *Caricetum kitaibelianae-rupestris* Biondi, Allegrezza, Ballelli & Taffetani 2000

relevé nr.	1	2	3	4	5	6	7	8	9	10	11
Altitude x 10	240	240	240	238	238	264	258	258	262	260	260
Aspect	.	.	.	.	nw	.	wnw	wnw	nw	nw	nw
Slope	.	.	.	.	3	.	20	25	10	5	5
Area sq. m.	25	10	10	7	5	5	15	16	5	2	3
Cover (%)	40	40	50	50	70	60	70	80	90	70	60
number of species per relevé	17	9	14	23	20	8	11	14	12	9	9
<b><i>Caricetum kitaibelianae-rupestris</i> Biondi et al. 2000</b>											
<i>Carex rupestris</i> All.	3	3	3	3	4	3	3	4	3	3	3
<i>Carex kitaibeliana</i> Degen. ex Bech.	.	2	1	+	+	.	+	1	.	1	3
<i>Silene acaulis</i> (L.) Jacq. s.l.	+	.	2	+	2	.	.	+	3	3	2
<i>Sesleria tenuifolia</i> Schrader subsp. <i>tenuifolia</i>	+	.	.	+	+	.	2	2	.	.	.
<i>Festuca violacea</i> Gaudin subsp. <i>italica</i> Foggi, Rossi & Signorini	+	.	1	2	2	.	.	1	+	.	.
<b>variant with <i>Salix retusa</i></b>											
<i>Salix retusa</i> L.	.	.	.	+	.	3	2	2	3	2	3
<b><i>Leontopodio-Elynenion</i></b>											
<i>Sedum atratum</i> L. subsp. <i>atratum</i>	1	.	.	+	+	.	.	.	+	.	.
<i>Oxytropis neglecta</i> Ten.	+	.	.	1	1	.	.	.	.	.	.
<i>Helianthemum oelandicum</i> (L.) Dum. subsp. <i>alpestre</i> (Jacq.) Ces.	.	+	.	1	+	.	.	2	.	.	.
<i>Persicaria vivipara</i> (L.) Ronse Decraene	.	.	.	.	.	2	+	1	1	.	.
<i>Minuartia verna</i> (L.) Hiern subsp. <i>verna</i>	.	.	1	.	+	.	.	.	.	.	.
<i>Potentilla crantzii</i> (Crantz) Beck ex Fritsch subsp. <i>Crantzii</i>	.	.	1	.	.	.	.	.	+	.	.
<i>Gentiana brachyphylla</i> Vill. subsp. <i>Favratii</i> (Rittener) Tutin	.	.	.	+	+	.	.	.	.	.	.
<i>Gentiana utriculosa</i> L.	.	+	.	.	.	.	.	.	.	.	.
<b><i>Seslerion apenninae</i></b>											
<i>Edrajanthus graminifolius</i> (L.) A. DC. subsp. <i>graminifolius</i>	1	1	+	1	1	1	2	2	2	1	2
<i>Achillea oxyloba</i> (DC.) Sch.Bip. subsp. <i>barrelieri</i> (Ten.) F. Conti	1	.	.	+	.	+	+	1	1	.	.
<i>Anthyllis vulneraria</i> subsp. <i>pulchella</i> (Vis.) Borm.	.	+	.	1	+	.	.	.	+	.	.
<i>Euphrasia italica</i> Wettst.	.	.	+	+	+	.	.	.	.	.	.
<i>Artemisia eriantha</i> Ten.	.	.	.	+	+	.	.	.	.	.	.
<i>Gentiana columnae</i> Ten.	.	.	+	.	.	.	.	.	.	.	.
<b><i>Seslerietalia tenuifoliae; Elyno-Seslerietea</i></b>											
<i>Draba aizoides</i> L. subsp. <i>aizoides</i>	.	.	.	.	.	.	+	+	1	+	+
<i>Anthyllis montana</i> L.s.l.	.	2	+	.	.	.	.	.	.	.	.
<i>Pedicularis verticillata</i> L.	.	+	+	.	.	.	.	.	.	.	.
<i>Trinia dalechampii</i> (Ten.) Janch	.	.	.	+	+	.	.	.	.	.	.
<i>Thymus praecox</i> Opiz subsp. <i>polytrichus</i> (Borbis) J alas	1	.	.	.	.	.	.	.	.	.	.
<i>Aster alpinus</i> L.	.	.	.	+	.	.	.	.	.	.	.
<i>Androsace villosa</i> L.	.	.	.	+	.	.	.	.	.	.	.
<i>Carex firma</i> Host	.	.	.	.	2	.	.	.	.	.	.
<i>Saxifraga caesia</i> L.	.	.	.	.	.	.	.	+	.	.	.
<b>other species</b>											
<i>Poa alpina</i> L. subsp. <i>alpina</i>	+	.	1	1	1	+	.	.	1	1	1
<i>Cerastium thomasii</i> Ten.	+	.	+	+	+	.	+	+	.	.	+
<i>Minuartia recurva</i> (All.) Sch. & Th.	.	.	.	.	.	.	1	1	.	+	.
<i>Saxifraga paniculata</i> Mill.	+	.	.	.	+	.	.	.	.	.	.
<i>Galium magellense</i> Ten.	1	.	.	.	.	.	.	.	.	.	+
<i>Sempervivum arachnoideum</i> L. s. l.	.	.	.	+	+	.	.	.	.	.	.
<i>Festuca alfrediana</i> Foggi & Signorini	1	.	.	.	.	.	.	.	.	.	.
<i>Asperula neglecta</i> Guss	1	.	.	.	.	.	.	.	.	.	.
<i>Androsace vitaliana</i> (L.) Lapeyr. subsp. <i>praetutiana</i> (Sund.) Kres	+	.	.	.	.	.	.	.	.	.	.
<i>Ranunculus brevifolius</i> Ten.	+	.	.	.	.	.	.	.	.	.	.
<i>Thlaspi stylosum</i> (Ten.) Mutel	.	+	.	.	.	.	.	.	.	.	.
<i>Euphrasia minima</i> Jacq. ex DC.	.	.	+	.	.	.	.	.	.	.	.
<i>Trifolium montanum</i> L.	.	.	.	1	.	.	.	.	.	.	.
<i>Gentiana verna</i> L.	.	.	.	+	.	.	.	.	.	.	.
<i>Valeriana montana</i> L.	.	.	.	.	.	+	.	.	.	.	.
<i>Draba aspera</i> Bertol.	.	.	.	.	.	+	.	.	.	.	.
<i>Armeria canescens</i> (Host) Boiss. s. l.	.	.	.	.	.	.	1	.	.	.	.
<i>Arabis alpina</i> L. s. l.	.	.	.	.	.	.	.	.	.	+	.

Table 5: *Galio magellensis-Silenetum acaulis* ass. nova hoc loco

relevè nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Altitude x 10	230	246	246	246	246	246	246	246	240	239	239	239	239	239	266	266	266	266	266
Aspect	se	sse	,	,	se	,	,	,	nw	,	nw	,	,	ssw	ssw	ssw	ssw	ssw	ssw
Slope	3	2	,	,	2	,	,	,	5	,	3	,	,	5	5	5	5	5	5
Area sq. m.	1	1,5	1,7	1,8	2	1,5	1,8	1,4	1,2	1,5	1,3	1	1,2	3,6	3,6	3,3	4	4	3,8
Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	90	90	90	90	90	90
number of species per relevè	9	6	12	11	14	15	14	14	8	9	8	8	8	13	11	13	17	13	14
<i>Galio magellensis-Silenetum acaulis</i> ass. nov.																			
										*					*				
<i>Silene acaulis</i> (L.) Jacq. s.l.	5	5	5	5	5	5	5	5	3	4	4	4	5	5	5	5	5	5	5
<i>Galium magellense</i> Ten.	1	+	2	1	.	1	2	+	2	2	2	2	1	+	.	+	+	+	+
<i>Achillea oxyloba</i> (DC.) Sch.Bip. subsp. <i>barrelieri</i> (Ten.) F. Conti	1	1	2	.	1	+	1	1	.	.	.	.	.	+	.	+	+	+	+
<i>Androsace vitaliana</i> (L.) Lapeyr. subsp. <i>praetutiana</i> (Sund.) Kres	2	1	1	1	+	1	1	1	.	.	.	.	.	.	.	.	.	.	.
<i>Galio magellensis-Silenetum acaulis trifolietosum thalii</i> subass. nova																			
<i>Trifolium thalii</i> Vill.	.	.	.	.	.	.	.	.	3	3	2	3	+	.	.	.	.	.	.
<i>Plantago alpina</i> L.	.	.	.	.	.	.	.	.	2	2	+	1	2	.	.	.	.	.	.
<i>Galio magellensis-Silenetum acaulis alyssetosum cuneifolii</i> subass. nova																			
<i>Arenaria grandiflora</i> L. subsp. <i>grandiflora</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	1	1	+
<i>Alyssum cuneifolium</i> Ten.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+
<i>Crepis aurea</i> (L.) Cass. subsp. <i>glabrescens</i> (Caruel) Arcang.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	2	2	1
<i>Leontopodio nivalis-Elynenion myosuroidis</i>																			
<i>Pedicularis verticillata</i> L.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
<i>Persicaria vivipara</i> (L.) Ronse De Craene	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	+	1
<i>Minuartia verna</i> (L.) Hiern subsp. <i>verna</i>	.	.	.	.	.	.	.	.	+	+	+	1	+	.	.	+	+	.	.
<i>Gentiana utriculosa</i> L.	.	.	.	+	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Gnaphalium hoppeanum</i> Koch subsp. <i>magellense</i> (Fiori) Strid.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	+
<i>Elyna myosuroides</i> (Vill.) Fritsch	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Seslerion apenninae, Seslerion apenninae</i>																			
<i>Carex kitaibeliana</i> Degen. ex Bech.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	+	1
<i>Edrajanthus graminifolius</i> L. A. DC. subsp. <i>graminifolius</i>	.	.	.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Festuca violacea</i> Gaudin subsp. <i>italica</i> Foggi, Rossi & Signorini	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anthyllis vulneraria</i> subsp. <i>pulchella</i> (Vis.) Borrm.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+
<i>Seslerietalia tenuifoliae; Elyno-Seslerietea</i>																			
<i>Draba aizoides</i> L. subsp. <i>aizoides</i>	.	.	1	.	1	1	+	1	.	.	.	.	.	.	.	+	+	+	+
<i>Thymus praecox</i> Opiz subsp. <i>polytrichus</i> (Borb.)s) J alas	.	.	+	.	2	3	.	1	.	.	.	.	.	.	.	.	.	.	+
<i>Erigeron epiroiticus</i> (Vierh.) Halacsy	.	.	.	1	+	.	.	.	.	+	.	1	+	+	+	+	.	2	.
<i>Myosotis ambigens</i> (Beg.) Grau	.	.	.	1	.	+	1	1	.	.	.	.	.	.	.	+	.	.	.
<i>Androsace villosa</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+
<i>Acinos alpinus</i> (L.) Moench.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.
<b>other species</b>																			
<i>Poa alpina</i> L. subsp. <i>alpina</i>	1	.	2	1	2	2	3	2	2	2	3	2	2	+	+	.	+	1	.
<i>Cerastium thomasii</i> Ten.	1	2	2	1	+	+	+	+	.	1	.	.	.	.	.	.	.	.	.
<i>Festuca alfrediana</i> Foggi & Signorini	2	2	1	1	2	3	.	.	.	.	+	1	.	.	.	.	.	.	.
<i>Armeria canescens</i> (Host) Boiss.	.	.	.	.	.	1	2	2	.	.	.	.	.	2	1	2	2	2	.
<i>Saxifraga aizoides</i> L.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
<i>Thlaspi stylosum</i> (Ten.) Mutel	.	.	1	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Viola eugeniae</i> Parl.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+
<i>Gentiana brachyphylla</i> Vill. subsp. <i>favratii</i> (Rittener) Tutin	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+
<i>Viola magellensis</i> Porta & Rigo ex Strobl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+
<i>Hypochoeris robertia</i> Fiori	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Saxifraga oppositifolia</i> L.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Sedum atratum</i> L. subsp. <i>atratum</i>	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ranunculus brevifolius</i> Ten.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.
<i>Saxifraga paniculata</i> Mill.	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	.	.	.	.

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Table 6: *Arabido alpinae-Cerastietum thomasi* Biondi, Allegrezza, Ballelli & Taffetani 2000

relevé nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
altitude m a.s.l. (x 10)	273	273	277	282	288	288	286	286	287	269	268	266	291	291	291	291	290	
Aspect	wnw	wnw	w	w	n	sw	sw	wnw	n	nnw	nnw	nnw	sw	ese	sse	sse	sw	
slope	15	15	50	60	50	30	30	30	10	40	40	35	30	40	20	40	60	
Area sq. mt.	50	55	60	50	40	70	40	60	60	50	100	80	70	30	40	15	20	
Cover (%)	20	20	15	10	20	25	20	20	20	30	25	30	20	30	30	10	15	
number of species per relevé	11	9	8	9	9	10	5	5	5	12	8	9	8	10	6	5	5	
<i>Arabido alpinae-Cerastietum thomasi</i>													*					
<i>Cerastium thomasi</i> Ten.	1	1	2	1	2	2	2	2	1	.	1	1	3	3	2	2	1	
<i>Arabis alpina</i> L.	1	1	2	1	1	1	1	+	2	1	2	1	.	+	1	.	.	
<i>Draba aspera</i> Bertol.	+	1	1	1	+	1	+	.	.	+	.	.	1	1	.	.	.	
<i>Arabido alpinae-Cerastietum thomasi festucetosum alfrediana</i> subass. nova																		
<i>Festuca alfrediana</i> Fogg. & Signorini	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	1	2	1
<i>Salix retusa</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	2	.	.
<i>Edrajanthus graminifolius</i> L. A. DC. subsp. <i>graminifolius</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	+
<i>Thlaspienion stylosi</i>																		
<i>Hutchinsia alpina</i> (L.) R. Br.	+	.	+	+	+	+	.	.	+	.	.	+	.	.	.	.	.	
<i>Androsace mathildae</i> Levier	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	
<i>Linario-Festucion dimorphae</i>																		
<i>Papaver alpinum</i> L. subsp. <i>ernesti majeri</i> (Markgr.) Wraber	1	1	+	+	+	.	.	.	.	2	2	3	.	.	.	.	.	
<i>Galium magellense</i> Ten.	1	+	.	+	+	1	2	+	.	1	2	1	+	1	.	2	+	
<i>Viola magellensis</i> Porta & Rigo ex Strobl	.	.	.	.	.	1	.	.	.	+	1	.	.	.	.	.	.	
<i>Thlaspietalia rotundifolii; Thlaspietea rotundifolii</i>																		
<i>Saxifraga oppositifolia</i> L.	+	1	+	+	.	.	.	1	.	+	.	.	.	.	.	.	.	
<i>Saxifraga sedoides</i> L.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	
<i>Campanula cochlearifolia</i> Lam.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	
other species																		
<i>Poa alpina</i> L. subsp. <i>alpina</i>	+	+	+	1	1	2	1	+	+	2	2	2	2	2	1	1	.	
<i>Achillea oxyloba</i> (DC.) Sch.Bip. subsp. <i>barrelieri</i> (Ten.) F. Conti	1	1	.	.	.	+	.	.	.	2	1	2	.	.	.	.	.	
<i>Myosotis ambigens</i> (Beg.) Grau	.	.	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	
<i>Draba aizoides</i> L. subsp. <i>aizoides</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
<i>Saxifraga caesia</i> L.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	
<i>Saxifraga exarata</i> Vill. subsp. <i>ampullacea</i> (Ten.) D. A. Webb	.	.	.	.	.	+	.	.	.	.	.	.	.	+	1	.	.	
<i>Sesleria tenuifolia</i> Schrader subsp. <i>tenuifolia</i>	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	
<i>Festuca violacea</i> Gaudin subsp. <i>italica</i> Fogg. Graz. Rossi & Signorini	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	
<i>Sedum atratum</i> L. subsp. <i>atratum</i>	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	
<i>Gnaphalium hoppeanum</i> Koch subsp. <i>magellense</i> (Fiori) Strid.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	
<i>Senecio squalidus</i> L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	
<i>Taraxacum apenninum</i> Ten.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	
<i>Armeria canescens</i> (Host) Boiss. s. l.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	
<i>Silene acaulis</i> (L.) Jacq. s.l.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	

Table 7 *Potentillo apenninae-Festucetum alfrediana* ass. nova hoc loco

relevé nr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
altitude m a.s.l. (x 10)	250	250	249	248	247	248	248	248	248	248	245	244	267	275	273	278	283
Aspect	wnw	n	nw	w	ws	sw	ene	ne	w	n	ene	ene	ne	n	nnw	nnw	wnw
slope	80	70	65	60	80	70	60	55	70	60	65	60	75	90	60	70	70
Area sq. mt.	3	2,2	4	3	4	2,8	3	5	1,5	3	4	3	1	1,5	1,2	1	2,5
Cover (%)	25	30	25	25	30	35	35	25	20	20	40	40	40	10	15	25	20
number of species per relevé	7	8	10	11	8	10	8	15	7	8	7	8	4	2	5	6	5
<b><i>Potentillo apenninae-Festucetum alfrediana</i> ass. nova</b>																	
	*																
<i>Festuca alfrediana</i> Foggi & Signorini	1	1	1	1	+	2	2	+	+	1	2	2	2	1	1	+	1
<i>Silene acaulis</i> (L.) Jacq. s.l.	.	+	+	1	2	.	1	1	1	+	.	+	1	.	1	.	1
<i>Potentilla apennina</i> Ten.	+	.	+	+	.	+	.	+	+	+	2	2	.	.	.	.	.
<i>Campanula tanfanii</i> Podl.	.	.	.	1	.	+	+	+	+	+	.	+	1	.	.	.	.
<b><i>Potentillo apenninae-Festucetum alfrediana</i> variant with <i>Campanula cochlearifolia</i> and <i>Papaver alpinum</i></b>																	
<i>Saxifraga sedoides</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
<i>Papaver alpinum</i> L. subsp. <i>ernesti majeri</i> (Markgr.) Wraber	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2
<i>Campanula cochlearifolia</i> Lam.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
<b><i>Saxifragion australis; Potentilletalia caulescentis; Asplenietea trichomanis</i></b>																	
<i>Saxifraga exarata</i> Vill. subsp. <i>ampullacea</i> (Ten.) D. A. Webb	+	+	+	.	.	.	+	.	+	.	.	+	.	.	.	.	.
<i>Saxifraga paniculata</i> Mill.	.	+	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.
<i>Valeriana salicina</i> All.	.	+	+	.	.	+	.	.	.	.	+	2	.	.	.	.	.
<i>Saxifraga glabella</i> Bertol.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
<i>Saxifraga caccisa</i> L.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
<b>other species</b>																	
<i>Poa alpina</i> L. subsp. <i>alpina</i>	.	.	.	+	+	+	.	+	.	+	+	+	.	.	.	.	.
<i>Salix retusa</i> L.	.	.	.	+	1	1	.	+	.	.	.	.	2	1	.	2	.
<i>Edrajanthus graminifolius</i> L. A. DC. subsp. <i>graminifolius</i>	.	.	+	.	1	.	.	.	+	+	+	+	.	.	.	.	.
<i>Galium magellense</i> Ten.	+	+	+	.	+	.	.	.	.	.	+	.	.	.	.	.	.
<i>Sedum atratum</i> L. subsp. <i>atratum</i>	.	.	.	+	.	+	.	+	.	.	+	.	.	.	.	.	.
<i>Artemisia eriantha</i> Ten.	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Minuartia verna</i> (L.) Hiern subsp. <i>verna</i>	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.
<i>Saxifraga oppositifolia</i> L.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.
<i>Carex kitaibeliana</i> Degen. ex Bech.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.
<i>Achillea oxyloba</i> (DC.) Sch.Bip. subsp. <i>barrelieri</i> (Ten.) F. Conti	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.
<i>Gentiana brachyphylla</i> Vill. subsp. <i>favratii</i> (Rittener) Tutin	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sesleria tenuifolia</i> Schrader subsp. <i>tenuifolia</i>	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
<i>Festuca violacea</i> Gaudin subsp. <i>italica</i> Foggi, Graz. Rossi & Signorini	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hieracium villosum</i> Jacq.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Myosotis ambigens</i> (Beg.) Grau	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
<i>Botrychium lunaria</i> (L.) Swartz	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Draba aizoides</i> L. subsp. <i>aizoides</i>	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
<i>Helianthemum oelandicum</i> (L.) Dum. subsp. <i>alpestre</i> (Jacq.) Ces.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
<i>Aster bellidiastrum</i> (L.) Scop.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
<i>Trifolium thalii</i> Vill.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+

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