GRASSLAND VEGETATION ON THE ARCHAEOLOGICAL SITES OF THE CALTAGIRONE AREA (SOUTHERN ITALY)

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Abstract - The area of Caltagirone is situated in the southern region of the Ereian Mountains, a group of hills rising in central-eastern Sicily. In this area, which has long been subject to man's activity, xerothermic grasslands are to be found among the crops and the small areas occupied by woody vegetation. They are well represented in the archaeological sites to be found in the area. The aim of this paper is to provide information about the grasslands located on some of the archaeological sites in order that suitable measures can be taken to manage these areas. The study was carried out by means of phytosociological surveys. The data collected made it possible to distinguish different communities. On the slopes and on rocky sites the *Ampelodesmos mauritanicus* community is frequent, on thinner soil the *Cymbopogon hirtus* community is often to be found, and on very poor soil the *Asphodelus microcarpus* community is present. On sandy soil the *Stipa capensis* community is present here and there. On clayey slopes communities dominated by *Arundo pliniana* and *Festuca fenas* are to be found. These communities belong to the classes *Tuberarietea guttatae* or *Stellarietea mediae* (*Brometalia rubenti-tectori* order). On some sites the vegetation includes species both from the xerophilous communities (*Tuberarietea guttatae*) and from the ruderal communities (*Stellarietea mediae*). The communities identified belong to the same dynamic series: the series of Mediterranean evergreen vegetation of the class *Quercetea ilicis*.

Key words - Grassland communities, Archaeological sites, Sicily

Introduction

The territory of Caltagirone has been the subject of various geobotanical studies. In the past a floristic survey was carried out (Taranto & Gerbino 1945) and subsequently there have been vegetation surveys in the Santo Pietro's woodland reserve (Furnari, 1965, De Marco & Furnari, 1976). Our earlier works, which focused on the vegetation of a well defined area, were carried out as part of multidisciplinary studies regarding abandoned fields (Poli Marchese *et al.* 1985, 1990) and the bassin of the Simeto river

(Poli Marchese & Maugeri, 1991). In recent years a study has been carried out on the dynamics of the vegetation after fire (Margani, 1988; 1999).

In the course of the surveys carried out it was observed that the territory has been greatly affected by man's activities given that since the distant past it has been used for agriculture. An exception to this is the area occupied by the cork oak woodland (St. Pietro's wood), a vast natural reserve, where there are woodlands macquis and other natural plant communities.

In the course of the studies carried out in territory of Caltagirone, we have shown that there are relatively widespread areas where the cultivated land has been abandoned leading to the formation of herbaceous xerophilous vegetation made up of dry grasslands. These areas are often used for pasture.

This study focuses on those areas where the grasslands are well represented and which are of particular importance for the territory in that they include three of the important archaeological sites in which the territory abounds.

The aim of this study is to identify the grassland vegetation which characterizes these areas and to point out its dynamic tendencies in order to provide information that could be used in vegetation restoring regarding the archaeological sites.

STUDY AREA

The study area is situated on the south eastern side of the island of Sicily, in the northern part of the territory of Caltagirone, where the altitude varies between 320 and 600 m a.s.l.. The three archaeological areas are situated in the St. Mauro district, the St. Ippolito district and on Mt. Balchino (Poggio La Guardia).

The territory lies in the southern section of the Ereian mountains, which constitute a transitional phase, from a geographic point of view, between the northern Sicilian chain (Madonie-Nebrodi-Peloritani) and the Hybleian plateau. The territory has a predominantly hilly relief and different areas can be identified according to the varying lithological nature of the land. From the geological map of Lentini (1984) the following areas can be distinguished:

- sandy with gravel and clay, sometimes with sand-silt intercalations –lower Pleistocene period
- clayey marl with quarz sand of the upper Tortonian period; soil belonging to the evaporitic series of the Messinian period with white diatomites, vacuous limestone and chalk.

In the south western part of the town in the area where the St. Mauro district is situated, there are wide plateaux with calcareous concrete intercalations.

CLIMATE

The climatic data were taken from the Sicilian Region's annual hydrological reports for the years 1926-1985. They regard the meteorological station of Caltagirone (513 m). At this station the mean annual rainfall is 552.1 mm and the minimum and maximum annual rainfall are 6 mm and 81.8 mm respectively. The annual mean of temperature is 16.1 while the maximum annual average is 20.1°C and the minimum

12.1 °C. The udothermogram is given in figure 1; it shows that the territory has a thermomediterranean attenuated climate. This can also be seen in the bioclimatic map of the Mediterranean area (Emberger *et al.* 1963).

METHOD

The study was carried out applying the phytosociological method. Different types of vegetation were identified. For each type of vegetation the most significant finding are shown. Given the heterogeneity of the territory and man's continually changing intervention, it was only possible to indicate the highest syntaxa. In some communities groups of species belonging to different syntaxa are present. They were identified according to the predominant floristic group present. In many cases the communities described here only represent transitional dynamic stages.

As regards the phytosociological classification carried out reference was made principally to the systems proposed by Rivas-Martinez (1975; 1977; 1978), Rivas-Martinez & Izco (1977) and Izco (1977),which best correspond with the composition of the communities studied.

The dynamic successions were established with the "habitat-comparison" (Braun-Blanquet, 1964) method, which is based on estimating the developmental age of vegetation types under similar habitat conditions.

RESULTS

The grasslands studied have a variable floristic composition: next to purely nitrophilous-ruderal species - indicating the fields have been abandoned quite recently- xerophilous grassland species characterised by therophytes or perennials are often to be found. Viceversa the vegetation more characteristic of xerophilous species contains a certain number of nitrophilous-ruderal elements. The vegetation is, therefore, floristically very heterogeneous.

Often there is a mosaic effect because of the presence of groups of species with different phytosociological significance.

The data available made it possible to identify the following plant communities.

NITROPHILOUS-RUDERAL GRASSLANDS

In the areas where the fields have recently been abandoned and the substrates have a certain nitrogen content, communities characterised by an abundance of annual species can be found. These communities are well distributed in the territory but are most common where the soil is not deep and where the land is at times used for pasture.

The most common communities are those dominated by *Avena barbata* (tab. 1) or by *Lolium rigidum* (tab. 2). As can be seen from the tables and the graphs these communities are characterised by a predominance of nitrofilous-ruderal species and therefore belong to the order *Brometalia rubenti-tectori* Rivas-Martinez & Izco 1977, class *Stellarietea mediae* R. Tx., Lohmeyer & Preising in R. Tx. 1950 sensu Rivas-

Martinez (1975) ampl. 1977. In their genesis and floristic composition they are to be related to analogous types of vegetation present in various areas of Sicily described by other authors (Gentile, 1962; Poli Marchesc *et al.*, 1995; Brullo & Marcenò, 1983 and others).

On mainly clayey soil a community dominated by *Festuca fenas* (tab. 3) is widespread. Here some permanent grassland species of the class *Lygeo sparti-Stipetea tenacissimae* Rivas-Martinez 1978 are also present.

A community with *Festuca fenas* has been described for Provence hy Loisel (1976) and identified as a sub-association (*festucetosum*) of *Galactito-Echietum plantaginei* Mol. 1937. It is located on humid soils, where mesohygrophilous species are also present.

On sandy soils, in particular where the ground is level, where the soil is impoverished or tamped, the *Stipa retorta* community (tab. 4) is to be found. This is to be considered, according to Gentile (1962) and other authors, a vegetation type that indicates sandiness and tamping of soils subject to summer drought. It often becomes established, as secondary vegetation, where the soil has been laid bare.

This type of vegetation also belongs to *Brometalia rubenti-tectori* but annual xerophilous grassland species of the *Tuberarietea guttatae* Br.-Bl. (1940) 1952 class and perennials of the *Lygeo-Stipetea* class are also present showing the dynamic tendency of the community.

XEROPHILOUS GRASSLANDS

Next to the clearly nitrophilous-ruderal grassland there are xerophilous grassland vegetation types.

This vegetation appears in fields that have long since been abandoned and that are used for pasture but not regularly.

Time and pasturing, as has been noted by various authors including Rivas-Martinez (1977), favour the development and the distribution of species and of communities characterised by perennial species. These communities are characterised by poaceae with a more or less developed root system. They include: grassland characterised by *Cymbopogon hirtus* (tab. 5), situated on sunny slopes, in areas that have not been greatly eroded and where the soil is not deep. Sometimes this community -albeit discontinuously- covers extensive surfaces. In the community there are a certain number of perennial xerophilous grassland species of the class *Lygeo-Stipetea*, syntaxon which includes herbaceous vegetation types dominated by perennial species with steppe characteristics.

These types of vegetation are distributed in the territories of the Mediterranean region, which has a very dry climate (Rivas-Martinez 1978). As has been pointed out by Brullo et al. (1990) and other authors *Lygeo-Stipetea* grasslands are to bc considered as vicarious *Festuco-Brometea erecti* Br.-Bl. & Tx. 1943 vegetation, which in the Mediterranean region is present in the territories with a rather damp, cold climate (Rivas-Martinez et al. 1992).

The *Cymbopogon hirtus* community (tab. 5), in which *Brometalia rubenti-tectori* nitrophilous-ruderal grassland species are still well represented, cannot be further defined from a phytosociological point of view, in that it represents a transitional

stage between the nitrophilous-ruderal grasslands and the xerophilous *Lygeo-Stipetea* communities. The presence of different groups of species with different phytosociological role indicates the lack of stability of the vegetation, which is frequently subject to man's intervention. It is widespread in some xeric sites of the territory.

Where the soil is more subject to erosion the early stages of the herbaceous vegetation are characterised by the presence of *Asphodelus microcarpus* (tab. 6), a species that is well represented on surfaces with outcropping rocks (see Poli Marchese *et al.* 1985; 1988; 1995; Di Benedetto, 1981).

Ferula communis is often associated with *Asphodelus* and in certain sites (rel. n. 5) it is the dominant species. This is an apparently homogeneous type of vegetation but it has a certain floristic variability. The presence of elements of perennial xerophilous species of the *Lygeo-Stipetea* class would indicate that the vegetation belongs to this syntaxon. The presence of a considerable number of species of syntaxa belonging to the nitrophilous- ruderal vegetation leads to the conclusion that this is a plant community still closely linked to man's activity in the territory. Here there are mosaics of vegetation with a great deal of interpretation, all conditioned by the pasturing to which they are periodically subject. Similar types of vegetation are known in other territories of the Mediterranean area and Sicily, including volcanic areas (Di Benedetto, 1983; Poli & Grillo, 1974-'75; Poli Marchese et al. 1995).

Among the rocky outcrops on steep slopes there is a type of vegetation characterised by *Ampelodesmos mauritanicus* (tab. 7). This is a less xerothermophilous community than the *Cymbopogon hirtus* community and prefers deeper soils. It is well represented in the Mediterranean region and in Sicily in the Mediterranean evergreen vegetation belt, where it constitutes a type of "Mediterranean steppe". It has been considered by many authors to be a defined degradation stage and has been allocated to various syntaxa. The most closed and most highly evolved types have been allocated to *Quercetea ilicis* Br.-Bl. ex A. Bolòs 1950 (*Oleo-Ceratonion* Br.-Bl. 1936 and *Quercion ilicis* (Br.-Bl.1931) 1936 respectively) while some types in Le Marche (Biondi, 1986), Lazio (Filesi *et al.* 1994) and Sardinia (Biondi & Mossa, 1992) have been included in the class *Rosmarinietea officinalis* Br.-Bl. 1946 em. Rivas-Martinez et al. 1991. Other more degraded types, like those found by Maiorca & Spampinato (1998) in Calabria, have been allocated to the class *Lygeo-Stipetea*, order *Hyparrhenietalia hirtae* Rivas-Martinez 1978. Various *Ampelodesmos mauritanicus* communities have been described for Sicily and these, too, have been included in the class *Lygeo-Stipetea*, order *Hyparrhenietalia hirtae* in which a new alliance, *Avenulo-Ampelodesmion mauritanici* Minissale 1993 has been identified. This would bring together all the *Ampelodesmos mauritanicus* communities of Sicily.

In the territory studied, this community appears as a not yet stable vegetation type. There are species of the class *Lygeo-Stipetea,* a few of which belong to the *Hyparrhenietalia hirtae* order. Moreover there is a group of therophyte grassland species of the *Tuberarietea guttatae* class, which become established in the gaps between the tufts of *Ampelodesmos* in open grassland. For this reason it can be considered similar to the vegetation described for Calabria by Maiorca & Spampinato (1998), from which it differs in that there is the presence of *Stellarietea mediae* species and the absence of *Quercetea ilicis* and *Cisto-Micromerietea* Oberd. 1954 species. The presence of species of *Quercetea ilicis* indicate the tendency of the vegetation to

evolve towards Mediterranean evergreen vegetation while the presence of *Brometalia rubenti-tectori* and *Stellarietea mediae* species shows that the territory is affected by man's activity. The natural evolution of this vegetation towards a more stable form is greatly disturbed by the presence of man – above all by the pasturing and burning to which the land is subject.

Among the lowest vegetation stages, the *Thymus capitatus* community (tab. 8) is also worthy of note. This forms, in sites where fires are frequent and where the soil is greatly eroded, a very widespread type of garigue in the Sicilian territory, which according to some authors belongs to *Cisto-Ericetalia* Horvatic 1958, an order which brings together low shrub communities of the central Mediterranean and circum-Mediterranean territories, which are to be found on various types of substrates and are known as a form of garigue.

In the type shown here (tab. 8) there are no species of the order *Cisto-Ericetalia* while there are both species of perennial steppe vegetation (*Lygeo-Stipetea*) and nitrophilous-ruderal species of the *Brometalia rubenti-tectori* (*Stellarietea mediae*) as well as species of the class *Poetea bulbosae* Rivas Goday & Rivas-Martinez 1978. This is a type of vegetation very similar to the herbaceous vegetation of the grasslands subject to man's intervention and can be considered a transition stage between these and the typical *Thymus capitatus* garigue. *Thymus capitatus* communities belonging to the xerophilous grasslands have also been found in other parts of Sicily (see Gentile, 1962).

Rare fragments of bush communities and macquis can be found in the grasslands: on xeric areas there is the *Chamaerops humilis* community, on other sites there are communities characterized by *Spartium junceum, Calicotome villosa* and *Quercus ilex.*

Conclusion

Looking at the vegetation studied and observing the biological spectra of the various communities (fig. 2) it can be said that the therophytes are generally much more abundant in the vegetation types more subject to man's activity and become gradually less frequent as man's influence declines. Viceversa, the perennial species (in particular the emicryptophytes and the chamaephytes) increase as man's activity declines. This is also confirmed by a floristic analysis of the vegetation.

Considering the floristic composition of the different types and in particular the groups of species present belonging to nitrophilous-ruderal grassland (*Brometalia rubenti-tectori*) and xerophilous grassland (*Tuberarietea guttatae* and *Lygeo-Stipetea*) respectively, it can be seen that the various types of vegetation have a variable composition.

The groups of species belonging to the two types of grassland are always present (fig. 3), but in different proportions. In particular the communities with a high percentage of *Brometalia rubenti-tectori* species (for example the *Avena barbata* community) do not include many xerophilous grasslands species. Besides, the groups of species of both the grasslands are present with less differentiated percentage values, although the species of the nitrophilous-ruderal grassland always predominate (*Avena barbata* community, *Lolium rigidum* community).

On the other hand, in some communities the xerophilous grassland species pre-

dominate and *Quercetea ilicis* species begin to appear. Communities of this class have an arboreal or high shrub character and represent the types of vegetation to which the different communities tend to evolve.

From the graph the extent of man's activity and conversely the level of naturalness associated with each community can also be seen. As the curve for *Brometalia rubenti-tectori* and *Stellarietea mediae* species descends, the naturalness obviously increases and so the curve for the xerophilous grassland species rises, with the perennial grassland species being the most abundant of these.

The vegetation dynamics can also be seen from the same graphs in that the curves pass from the stages nearest the crops (left hand side of the graph) to those further away, finally arriving at those where species of the class *Quercetea ilicis* begin to appear (right hand side of the graph). These are types of vegetation that often appear according to the soil conditions and the extent of man's activity. They interpenetrate each other and all represent initial stages of a secondary progressive series in the Mediterranean evergreen vegetation belt (*Quercetea ilicis*).

The dynamic successions are illustrated in figure 4.

The vegetation types distinguished tend to form syntaxonomically more defined communities of *Brometalia rubenti-tectori* and of *Tuberarietea guttatae* and *Lygeo-Stipetea*. The nitrophilous grassland can tend towards xerophilous grasslands, and the latter towards nitrophilous ones depending on the extent of man's intervention.

Further evolution leads to the various types of macquis that were found in the course of the survey.

The final vegetation can be made up either of *Oleo-Ceratonion* communities in the most xeric sites, starting from *Chamaerops humilis* macquis, or of *Quercion ilicis* communities, starting from other types of macquis and passing through woodland communities characterised by *Quercus ilex* or by *Quercus suber*.

This study can be considered to give useful information for the recovery of the plant cover of the areas occupied by the archaeological sites and also for a more efficient use of the sites for tourist purposes.

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RIASSUNTO

Il territorio di Caltagirone è ubicato nella parte meridionale dei Monti Erei, un complesso collinare localizzato nella Sicilia centro-orientale. Tale territorio, da lungo tempo sottoposto a influsso antropico, presenta fra le colture e fra i pochi resti della vegetazione arborea, aree ricoperte da praterie xeriche. Queste sono ampiamente rappresentate nei siti archeologici presenti nel territorio.

Lo scopo di questo lavoro è lo studio delle praterie presenti in alcuni siti archeologici al fine di fornire elementi di conoscenza utili per adeguati interventi al territorio.

L'indagine è stata compiuta attraverso rilevamenti fitosociologici. I dati raccolti hanno consentito di evidenziare la presenza di vari aggruppamenti. Sui pendii inclinati e su substrato accidendato è frequente l'aggruppamento ad *Ampelodesmos mauritanicus*; su suolo superficiale è spesso localizzato l'ag-

gruppamento a *Cymbopogon hirtus*; su suolo molto povero e accidendato l'aggruppamento ad *Asphodelus microcarpus*. Su suolo sabbioso è presente qua e là l'aggruppamento a *Stipa capensis*. Sui pendii argillosi sono presenti aggruppamenti dominati da *Arundo pliniana* e da *Festuca fenas*. Questi aggruppamenti sono da riferire agli ordini *Brometalia rubenti-tectori* e *Tuberarietalia guttatae*.

L'individuazione delle tendenze dinamiche della vegetazione, localizzata nel piano dei *Quercetalia ilicis*, può fornire elementi di conoscenza per interventi di restauro della vegetazione delle aree archeologiche oggetto di studio, per una loro più adeguata fruibilità.

APPENDIX: FURTHER SPECIES

Tab. 4. Rel. 1: Anthyllis maura, Carthamus lanatus, Scolymus granfiflorus; rel. 2: Calamintha nepeta, Filago pyramidata, Hypericum perfoliatum, Lotus cytisoides, Senecio delphinifolius, Tolpis virgata, Misopates orontium, Tordilium apulum, Verbascum sinuatum; rel.3: Atractylis gummifera, Launea resedifolia, Ononis natrix ssp. ramosissima, Teucrium polium, Alkanna tinctoria, Plantago albicans.

Tab.5. Rel. 1: Ammoides pusilla, Arisarum vulgare, Asperula arvensis, Atractylis cancellata, A. gummifera, Convolvulus althaeoides, Hypericum perfoliatum, Lathyrus cicera, L. clymenum, Picris hieracioides; rel.2: Arundo pliniana, Crepis vesicaria; rel. 3: Centaurium pulchellum, Ononis reclinata, Senecio delphinifolius; rel. 4: Echium parviflorum, Gypsophila arrostii.

Tab. 6. Rel. 1: Acanthus mollis, Anemone hortensis, Asperula arvensis, Hippocrepis unisiliquosa, Tetragonolobus purpureus, Theligonum cynocrambe, Verbascum sinuatum; rel. 2: Barlia robertiana, Convolvulus althaeoides, Echium parviflorum, Galium verrucosum, Hypericum perfoliatum, Lathyrus aphaca, L. cicera, Ononis natrix ssp. ramosissima, Ornithogalum montanum, Phagnalon rupestre,Tetragonolobus purpureus, rel. 3: Ononis natrix ssp. ramosissima; rel. 4: Acanthus mollis, Anthyllis tetraphilla, Borago officinalis, Carduncellus pinnatus, Echium parviflorum, Filago pyramidata, Orchis italica, Ornithogalum sp., Plantago serraria; rel. 5: Ammoides pusilla, Bellevalia dubia, Borago officinalis, Ophrys atrata, Ranunculus ficaria, Vivia pannonica; rel.6: Alkanna tinctoria, Biscutella lirata, Cachrys sicula, Dasypirum villosum, Euphorbia terracina, Galium verrucosum, Ophrys fusca, Raphanus raphanistrum, Thapsia garganica; rel.7: Alkanna tinctoria, Cachrys sicula, Cerastium glomeratum, Crepis vesicaria, Dasypirum villosum, Echium italicum, Euphorbia terracina, Linaria reflexa, Paronychia argentea, Raphanus raphanistrum.

Tab. 7. Rel. 1: Anthyllis tetraphilla, Biscutella lyrata, Cachrys sicula, Crepis leontodondoides, Elaeoselinum asclepium, Eryngium campestre, Filago pyramidata, Gipsophila arrostii, Hedysarum glomeratum, Linum bienne, Lotus cytisoides, Micromeria graeca, Petrorrhagia illyrica, Phagnalon saxatile, Salvia verbenaca; rel. 2: Cistus creticus, Delphinium halteratum, Nigella damascena; rel. 3: Bellardia trixago, Cistus monspeliensis, Fumana laevipes, Phagnalon rupestre, Serratula cichoracea, Thymus capitatus.

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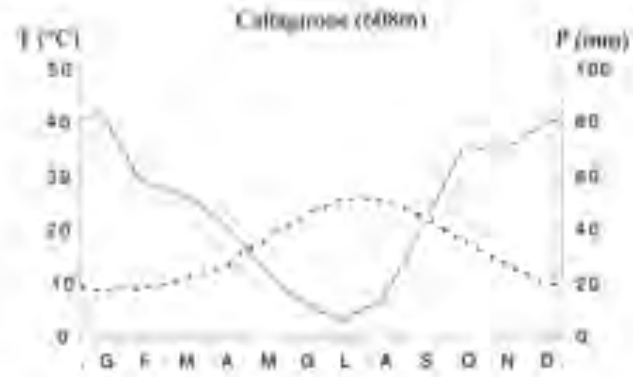

Fig. 1 - Climate diagram (in accordance with Bagnouls & Gaussen 1957) of Caltagirone.

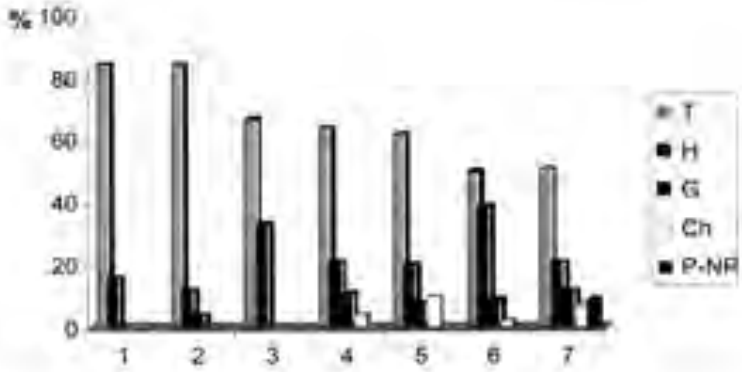

Fig. 2 - Biological spectra of the communities in the tables 1-7.

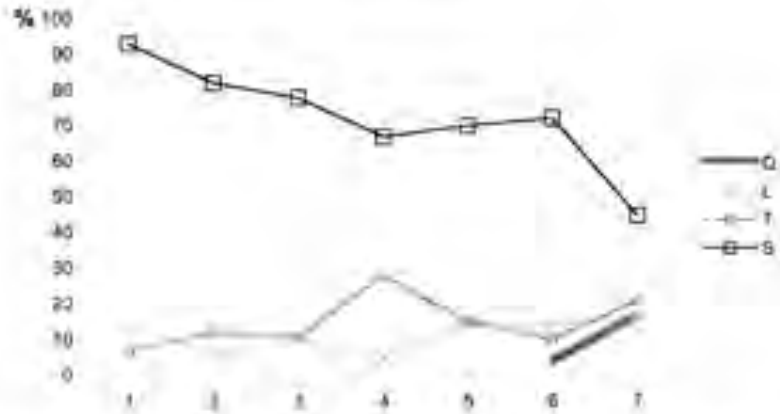

Fig. 3 - Percentage of the species belonging to the different phytosociological classes, tables 1-7. (Q= species of *Quercetea ilicis*, L= species of *Lygeo-Stipetea*, T= specie of *Tuberarietea guttatae*, S= species of *Stellarietea mediae*).

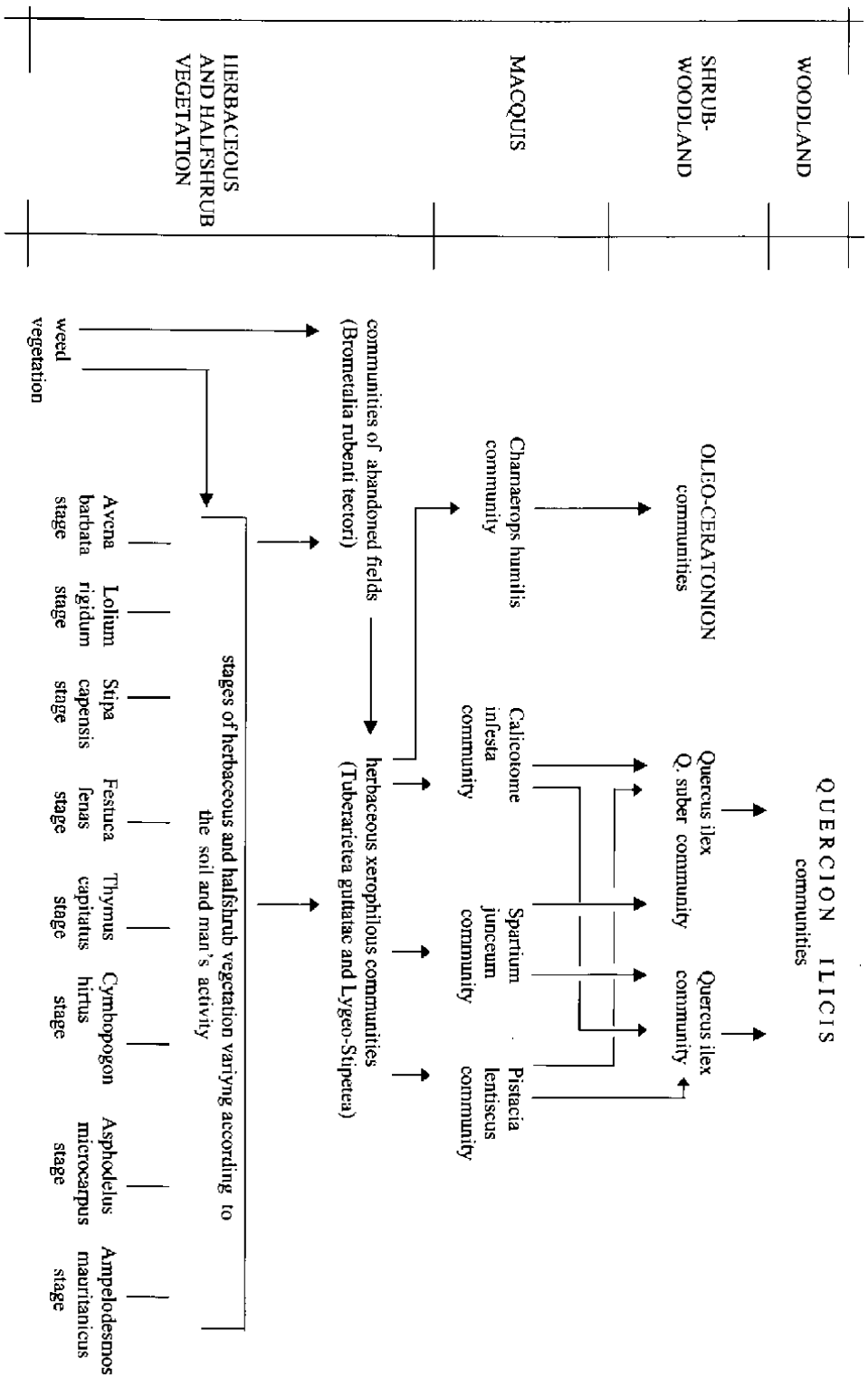

Fig. 4 - Successional pathways of the vegetation.

TABLE I - AVENA BARBATA COMMUNITY

	Altitude (m a.s.l.)	590
	Exsposure	N
	Inclination (°)	5
	Cover of vegetation (%)	95
	Hight of vegetation (cm)	40
	Area m^2	40
	Number of species	19
	Species of Brometalia rubenti-tectori and Stellarietea mediae	
T	Avena barbata	4.4
T	Medicago orbicularis	1.2
T	Lotus ornithopodioides	1.1
T	Medicago hispida	1.1
T	Melilotus sulcata	1.1
T	Trifolium stellatum	+
H	Galactites tomentosa	+
T	Astragalus hamosus	+
T	Anthemis arvensis	+
T	Medicago ciliaris	+
T	Euphorbia helioscopia	+
T	Sonchus asper	+
H	Lolium rigidum	+
T	Anagallis arvensis	+
	Other species	
H	Leucanthemum coronopifolius	1.1
T	Borago officinalis	+
T	Geranium columbinum	+
T	Lavatera trimestris	+
T	Trifolium campestre	+

TABLE 2 - FESTUCA FENAS COMMUNITY

	Altitude (m a.s.l.)	430
	Exsposure	S
	Inclination (¡)	5
	Cover of vegetation (%)	60
	Hight of vegetation (cm)	20
	Area m^2	80
	Number of species	25
T	Lolium rigidum	2.2
	Species of Brometalia rubenti-tectori and Stellarietea mediae	
T	Avena barbata	1.2
T	Anthemis arvensis	1.1
T	Papaver rhoeas	1.1
T	Chrysanthemum coronarium	+
T	Calendula arvensis	+
T	Diplotaxis erucoides	+
T	Lotus ornithopodioides	+
T	Plantago psyllium	+
T	Medicago orbicularis	+
T	Mercurialis annua	+
T	Euphorbia peplus	+
T	Bellardia trixago	+
T	Anagallis arvensis	+
	Other species	
H	Foeniculum piperitum	1.1
T	Vicia pannonica	1.1
T	Raphanus raphanistrum	+
T	Filago pyramidata	+
H	Eryngium campestre	+
T	Dasypyrum villosum	+
G	Mandragora autumnalis	+
H	Atractylis gummifera	+
T	Lathyrus clymenum	+
T	Rumex bucephalophorus	+
T	Campanula erinus	+

TABLE 3 - CYMBOPOGON HIRTUS COMMUNITY

	Altitude (m a.s.l.)	380
	Exsposure	N
	Inclination (¡)	20
	Cover of vegetation (%)	60
	Hight of vegetation (cm)	50
	Area m^2	50
	Number of species	18
H	Festuca fenas	3.3
	Species of Stellarietea mediae	
H	Galactites tomentosa	1.1
T	Avena barbata	+
T	Medicago ciliaris	+
T	Aegilops geniculata	+
T	Gastridium ventricosum	+
T	Melilotus sulcata	+
T	Bellardia trixago	+
	Species of Lygeo-Stipetea	
H	Dactylis hispanica	1.1
	Other species	
T	Bromus lanceolatus	1.1
T	Lathyrus aphaca	+
T	Lathyrus articulatus	+
H	Lolium perenne	+
H	Centaurea nicaensis	+
T	Vicia lutea	+
T	Lavatera trimestris	+
H	Ferula communis	+
T	Linum strictum	+

TABLE 4 - STIPA CAPENSIS COMMUNITY

	Number of relev s	1	2	3
	Altitude (m a.s.l.)	480	510	480
	Exsposure	SE	SE	SO
	Inclination (¡)	15	5	5
	Cover of vegetation (%)	90	80	70
	Hight of vegetation (cm)	'40	30	30
	Area m^2	100	75	100
	Number of species	16	34	24
	Species of Brometalia rubenti-tectori and Stellarietea mediae			
T	Stipa capensis	5.5	3.3	3.3
T	Trifolium stellatum	+	1.2	+
T	Avena barbata	+	+	+
T	Bellardia trixago	1.1	1.2	
G	Galactites tomentosa	+	1.1	
T	Anthemis arvensis	+	+	
T	Echium plantagineum	+	+	
H	Chrysanthemum coronarium	+		+
H	Urospermum picroides		+	+
T	Senecio vulgaris	+		
T	Erodium malacoides		+	
T	Mercurialis annua		+	
	Species of Tuberarietea guttatae			
T	Medicago litoralis	+	1.2	1.1
T	Medicago minima		1.2	
T	Campanula erinus		+	
T	Arenaria leptoclados		+	
T	Ononis reclinata			+
	Species of Lygeo-Stipetea			
G	Asphodelus microcarpus	+	1.1	+
	Other species			
G	Urginea maritima	1.1	2.2	1.2
H	Salvia verbenaca	+	1.1	+
Ch	Gypsophila arrostii		2.2	1.2
T	Silene colorata		1.2	2.3
H	Daucus carota		1.1	+
H	Cachrys sicula		1.1	+
T	Lagurus ovatus		+	+
T	Biscutella lyrata		+	+
T	Dasypirum villosum		+	+
H	Foeniculum vulgare		+	+
	Further species	3	9	6

TABLE 5 - CYMBOPOGON HIRTUS COMMUNITY COMMUNITY

	Number of relev s	1	2	3	4
	Altitude (m a.s.l.)	570	385	380	560
	Exsposure	SO	E	NE	NE
	Inclination (¡)	5	15	15	10
	Cover of vegetation (%)	80	70	50	50
	Hight of vegetation a (cm)	50	80	40	30
	Area m^2	10	60	100	100
	Number of species	25	21	22?	28
	Species of Lygeo-Stipetea				
H	Cymbopogon hirtus	4.4	5.5	2.2	3.3
G	Asphodelus microcarpus	1.1	1.1	2.2	
H	Dactylis hispanica			+	
Ch	Phagnalon saxatile			+	
	Species of Brometalia rubenti-tectori and of Stellarietea mediae				
H	Galactites tomentosa	+	+	1.1	+
T	Lotus edulis	1.2	+		1.2
T	Bellardia trixago	+		1.1	+
T	Chrysanthemum coronarium	1.1	+		
T	Anagallis arvensis	+			+
T	Sonchus oleraceus		+		+
T	Avena barbata			+	+
T	Trifolium stellatum			+	+
T	Trifolium nigrescens				2.2
T	Plantago psyllium				1.2
T	Stipa capensis				1.1
T	Astragalus hamosus		1.1		
T	Calendula arvensis	+			
T	Erodium malacoides	+			
H	Reichardia picroides		+		
H	Urospermum dalechampii		+		
T	Misopates orontium			+	
T	Anthemis arvensis				+
T	Sonchus asper				+
	Other species				
Ch	Lotus cytisoides	1.2	1.1	+	1.2
H	Ferula communis	1.1	1.1	1.1	1.1
G	Urginea maritima	+		1.2	1.1
H	Anthyllis maura		+	+	1.2
T	Tordilium apulum	+	+		+
T	Crupina crupinastrum		+	+	+
Ch	Micromeria graeca			1.2	1.1
T	Lathyrus articulatus		1.2		+
T	Silene colorata			+	+
G	Leopoldia comosa	+	+		
H	Salvia verbenaca	+	+		
T	Malva cretica	+	+		
T	Carthamus lanatus			+	+
Ch	Centranthus ruber			+	+
T	Sedum caespitosum			+	+
T	Sedum rubens			+	+
	Further species	1 0	2	3	2

TABLE 6 - ASPHODELUS MICROCARPUS COMMUNITY

	Number of relev s	1	2	3	4	'5	6	7
	Altitude (m a.s.l.)	605	605	600	610	380	400	410
	Exsposure	SE	SE	SE	SE	NE	NO	NE
	Inclination (¡)	5	30	15	20	15	10	5
	Cover of vegetation (%)	90	80	'90	80	90	80	70
	Hight of vegetation (cm)	60	30	70	70	70	60	50
	Area m^2	100	70	60	100	100	70	100
	Number of species	32	39	23	37	22	19	21
	Species of Lygeo-Stipetea							
G	Asphodelus microcarpus	4.4	3.4	3.4	2.3	2.2	2.2	3.5
H	Dactylis hispanica		3.3	1.2				
H	Psoralea bituminosa	1.2			2.2			
H	Andropogon distachyus				1.2			
	Species of Brometalia rubenti-tectori and Stellarietea mediae							
T	Stipa capensis	2.2	1.2	1.2	2.3	+	1.2	1.2
T	Erodium malacoides	+	+	+	+		+	+
T	Anagallis arvensis	1.2		+	2.2	+	1.1	+
T	Melilotus sulcata	1.2	1.2	2.3	1.1			
T	Sonchus oleraceus	1.1	1.1	2.2	1.2			
T	Lotus edulis	1.1	1.3	2.3	1.2			
T	Calendula arvensis	1.1	+	+		+		
H	Reichardia picroides		+	1.1		+		
T	Mercurialis annua		+		1.1			
H	Urospermum delechampii	+	+					
T	Chrysanthemum coronarium	+		+				
T	Bellardia trixago		+	+				
T	Plantago psyllium		+			+		
H	Galactites tomentosa					1.1		
T	Avena barbata	+						
T	Geranium molle	+						
T	Euphorbia helioscopia		+					
T	Urospermum picroides		+					
T	Euphorbia peplus						+	
T	Sherardia arvensis							+
T	Senecio vulgaris							+
	Other specie							
H	Salvia verbenaca	+	+		1.1	+	+	+
H	Scolymus grandiflorus	+		+	+	1.1		+
Ch	Lotus cytisoides		1.1		1.2	2.2	+	1.1
H	Ferula communis	1.1	1.1	2.2	1.2	3.3		
H	Anthyllis maura	+	+.2		1.2		1.1	
H	Centaurea nicaeensis	1.1	+		+	+		
H	Scabiosa maritima			1.2	+	+		
G	Urginea maritima					+	2.2	+
T	Fedia cornucopiae	+	1.2	+	+			
T	Lathyrus articulatus	+	+	+	+	1.2		
T	Hypochoeris achyrophorus	1.1			1.2		+	
H	Foeniculum vulgare		3.2	1.1	1.1			
H	Atractylis gummifera	1.1	1.1		1.1			
H	Calamintha nepeta	1.1		1.1	1.1			
H	Daucus carota	1.1			1.1			1.1
H	Opopanax chironium	1.1		+	1.1			
G	Asphodeline lutea		+	+	1.1			
G	Leopoldia comosa		+	+	+			
T	Tordylium apulum		+		+	1.2		
	Further species	7	12	1	9	6	9	10

TABLE 7 - AMPELODESMOS MAURITANICUS COMMUNITY

	Number of relev s	1	2	3
	Altitude (m a.s.l.)	480	345	340
	Exsposure	E	N	S
	Inclination (¡)	25	20	20
	Cover of vegetation a (%)	5	30	20
	" " " (%)	6 0	30	45
	Hight of vegetation a (cm)	50	50	60
	" " " e (cm)	40	35	40
	Area m^2	100	100	100
	Number of species	36	22	23
H	Ampelodesmos mauritanicus	2.2	2.2	2.2
	Species of Lygeo-Stipetea			
G	Asphodelus microcarpus	2.2	1.1	1.1
H	Cymbopogon hirtus	1.2	+	+
H	Dactylis hispanica	+	+	+
H	Andropogon distachyus	+.2		
H	Pallenis spinosa			+
	Species of Tuberarietea guttatae			
T	Crupina crupinastrum	+	1.1	+
T	Sideritis romana	1.1		1.2
T	Linum strictum		+	+
T	Andryala integrifolia	+		
T	Helianthemum salicifolium	+		
T	Brachypodium distachyum			+
	Species of Brometalia rubenti-tectori and Stellarietea mediae			
T	Stipa capensis	1.2		+
H	Galactites tomentosa	+	+	
T	Mercurialis annua		+	+
T	Calendula arvensis	+		
H	Reichardia picroides	+		
T	Senecio vulgaris	+		
T	Lotus edulis	+		
T	Anagallis arvensis	+		
T	Avana barbata		+	
T	Catapodium rigidum		+	
T	Sonchus oleraceus	+		
T	Trifolium stellatum		+	
T	Misopates orontium		+	
	Species of Quercetea licis			
NP	Chamaerops humilis	1.1	2.2	1.2
P	Pistacia lentiscus		2.2	1.1
G	Asparagus acutifolius	+		+
G	Arum italicum	+		
	Other species			
Ch	Teucrium polium	1.1	+	+
G	Urginea maritima	+	+	
NP	Teucrium fruticans		1.1	1.1
Ch	Micromeria nervosa		+	+
	Further species	15	3	6

TABLE 8 - THYMUS CAPITATUS COMMUNITY

	Altitude (m a.s.l.)	605
	Exsposure	S
	Inclination (i)	15
	Cover of vegetation (%)	6 0
	Hight of vegetation (cm)	30
	Area m^2	100
	Number of species	32
Ch	Thymus capitatus	2.2
	Species of Lygeo-Stipetea	
H	Psoralea bituminosa	2.2
Ch	Ajuga Iva	+
G	Asphodelus microcarpus	+
	Species of Brometalia rubenti-tectori and Stellarietea mediae	
T	Lotus edulis	2.2
T	Sonchus oleraceus	1.1
T	Anagallis arvensis	1.1
T	Plantago psyllium	+
T	Bellardia trixago	+
	Species of Poetea bulbosae	
H	Poa bulbosa	1.1
H	Salvia verbenaca	1.1
	Other species	
H	Ononis natrix ssp. ramosissima	2.2
H	Carduncellus pinnatus	2.2
H	Atractylis gummifera	1.2
H	Calamintha nepeta	1.2
T	Crepis vesicaria	1.2
H	Festuca fenas	1.2
T	Scorpiurus muricatus	1.2
H	Centaurea nicaeensis	1.1
H	Ferula communis	1.1
H	Opopanax chironium	1.1
T	Tetragonolobus purpureus	1.1
H	Anthyllis maura	+
H	Cynoglossum clandestinum	+
H	Daucus carota	+
H	Foeniculum vulgare	+
H	Kundmannia sicula	+
G	Leopoldia comosa	+
G	Ophrys sphegodes ssp. atrata	+
H	Verbascum sinuatum	+
T	Tordylium apulum	+
T	Medicago litoralis	+

THE VEGETATION ON THE BADLANDS OF "VARICOLORI" CLAYS IN THE MOLISE REGION (ITALY) - FRAMEWORK AND INTERPRETATION

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ABSTRACT - Vegetation on badlands on "varicolori" clays of Molise is studied. This vegetation is distributed in different sectors of the badland profile according to the prevalence of erosion or deposition: 1) the top of badland is usually flat and cultivated; 2) the stable but most intensively eroded zone is colonised by *Poo bulbosae-Camphorosmetum* ass. nova.; 3) the zone of accumulation of fine material is colonised by therophytic communities; 4) the zone of accumulation of landslides is colonised by *Cardopatetum corymbosi*; 5) in the same zone, but in more anthropized and humid sectors develops *Cynaro-Elytrigietum*. A discussion of phytogeographical features of badlands vegetation of Molise and nearby regions follows.

KEY WORDS – Badland, Camphorosmetum, Cardopatetum, Frankenion, Peganion, Agropyretea

INTRODUCTION

Molise (Fig. 1) is very rich in landslips and accelerated erosion, due to a powerful cover of clays all over the main river valleys: the "varicolori" (Miocenic chaotic complex) and the grey Pliocenic clays, with an altitudinal range up to 1000 m a.s.l. The morphology of badlands is very rough, and sharp slopes are a characteristic of this region. The badland flora and vegetation of Italy is rich in peculiar species, such as *Camphorosma monspeliaca*, *Cardopatum corymbosum*, etc. (Fig. 2). Since it is not suitable for agronomic exploitation this habitat has not been altered much and appears as large spots of natural biotopes in an anthropized landscape (crops). For that reason, it has become the object of study of many authors, also interested in setting up a model of correlation between vegetation and geomorphology (Biondi *et al.*, 1992), but they have dealt insofar only with the grey Pliocenic, not the "varicolori" clays.