Emanuele Bocchieri & Gianluca Iiriti

A contribution to the knowledge of the vascular flora of the continental carbonate formations situated on the Central Eastern margins of the Campidano plain (Southern Sardinia)

Abstract

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The Authors report on results of floristic research carried out on some of the continental carbonate formations situated in Southern Sardinia, in which 291 taxonomic units were found, included in 63 families and 204 genera. This report also highlights problems existing for the conservation of flora in a territory where grazing, brush fires and in particular quarrying activity and archaeological excavations limit and/or prevent the development of vegetation cover. Analysis of flora has furthermore shown the predominance of species with stress-tolerant (SR) and competitive-ruderal (CR) strategy.

Introduction

Botanic investigation on continental carbonate formations has been carried out by numerous experts, including Pichi-Sermolli (1948), Baldini (1996), Mazzecchi & Selvi (1999), Chiarucci & De Dominicis (2001), Angiolini & al. (2004), Chiarucci (2004) and Frignani & al. (2004). The presence in Sardinia of similar formations induced us to study these sites with the aim of learning something of their floristic composition. In this phase of study, we examined those formations emerging as "islands" along the central eastern margins of the Campidano plain, an area where human activity is placing their conservation at serious risk. They face risks from quarrying activity for the production of materials for the building industry, including lime and its derivates. The rocky substratum had induced the local population to use these areas for grazing and this, taken together with frequent brush fires, has had a negative impact on vegetation cover. The area is also involved in archaeological studies with excavations in the vicinity of ancient nuraghic settlements. In this area, never before investigated from a botanical point of view, extensive alteration of the land risks cancelling either entirely or to a great extent these biotopes which also have significant geological interest.

Study area

The area under consideration, covering some 800 ha, consists of discontinuous rocky outcrops of a carbonatic nature and falls within the municipalities of Furtei, Nuraminis, Samatzai, Segariu and Serrenti, shown in the following sheets of the Military Geographical Institute: F. 547 sections I and II; F. 548 sections III and IV (Fig. 1).

From a geological point of view, the area belongs to the marine formation of the lower Miocene consisting of greyish-white biohermal and biostromal limestone of the Aquitanian age. These rocks, particularly rich in fossils, originated from ancient coral reefs which evolved on the eastern borders of the Miocene sea basin. These coral-produced limestones, whose sides display heteropic transition to sandstones and marles with plankton micro-fauna (Foraminifers), rest on a substratum of andesitic volcanic rocks dating from the Oligocene whose volcanic structures contributed to the creation of a shallow sea environment suited to the development of reef-building organisms. The largest of these formations are the "Cuestas of Furtei-Segariu" and the "Cuestas of Coa Margine" which as a result of erosion processes stand out in the landscape as white ridges lying in NNW-SSE direction, with a steep face towards the west and a gently sloping plateau-like back towards the east, with cross profile typical of the "cuestas". These formations rank as geological monuments and deserve protection for their geo-morphological, landscape, palaeo-ecologic and educational characteristics (Barca & Di Gregorio 1999).

In order to provide climate data for the area under study the Authors utilised rainfall data from the Nuraminis weather station over the period 1922-2001, whereas temperature data were collected from the Sanluri station for the period 1985-2001. Mean values of data provided by the Regional Hydrographic Service of Sardinia are summarised in Table 1 and were processed to create the shade-temperature diagram which shows that the period of drought, briefer than in other areas in southern Sardinia, begins in the second week of June and ends in the month of September (Fig. 2). As shown in figure 3, rainfall trends are highly variable and irregular. Dominant winds blow from the north-western quadrant and are particularly strong in the area under study.

In this territory there are a number of nuraghic villages, including that of Santa Maria, at the foot of Monte Coa Margine, and Samatzai, whose ruins date back to 1200 BC. Coins and remains associated with marble columns and mosaics dating from the Roman period have also been found.

Material and methods

There is no evidence that botanic research has ever been carried out in the areas under consideration. Indeed research in the literature and the *exsiccata* in *Herbarium CAG* yielded no mention of these areas. Thus the Authors carried out a detailed botanical exploration over the period 2002-2005, with regular field trips in the different seasons. The *exsiccata* of the species of greatest interest have been added to *Herbarium CAG*.

The floristic list shows the vascular flora found in the area divided by family; within each family, genera are shown in alphabetical order. Taxonomic units were determined by reference to the following works: "Nuova Flora Analitica d'Italia" (Fiori 1923-1927), "Flora d'Italia" (Pignatti 1982), "Flora Europaea" (Tutin & al. 1968-1980, 1993), Med-

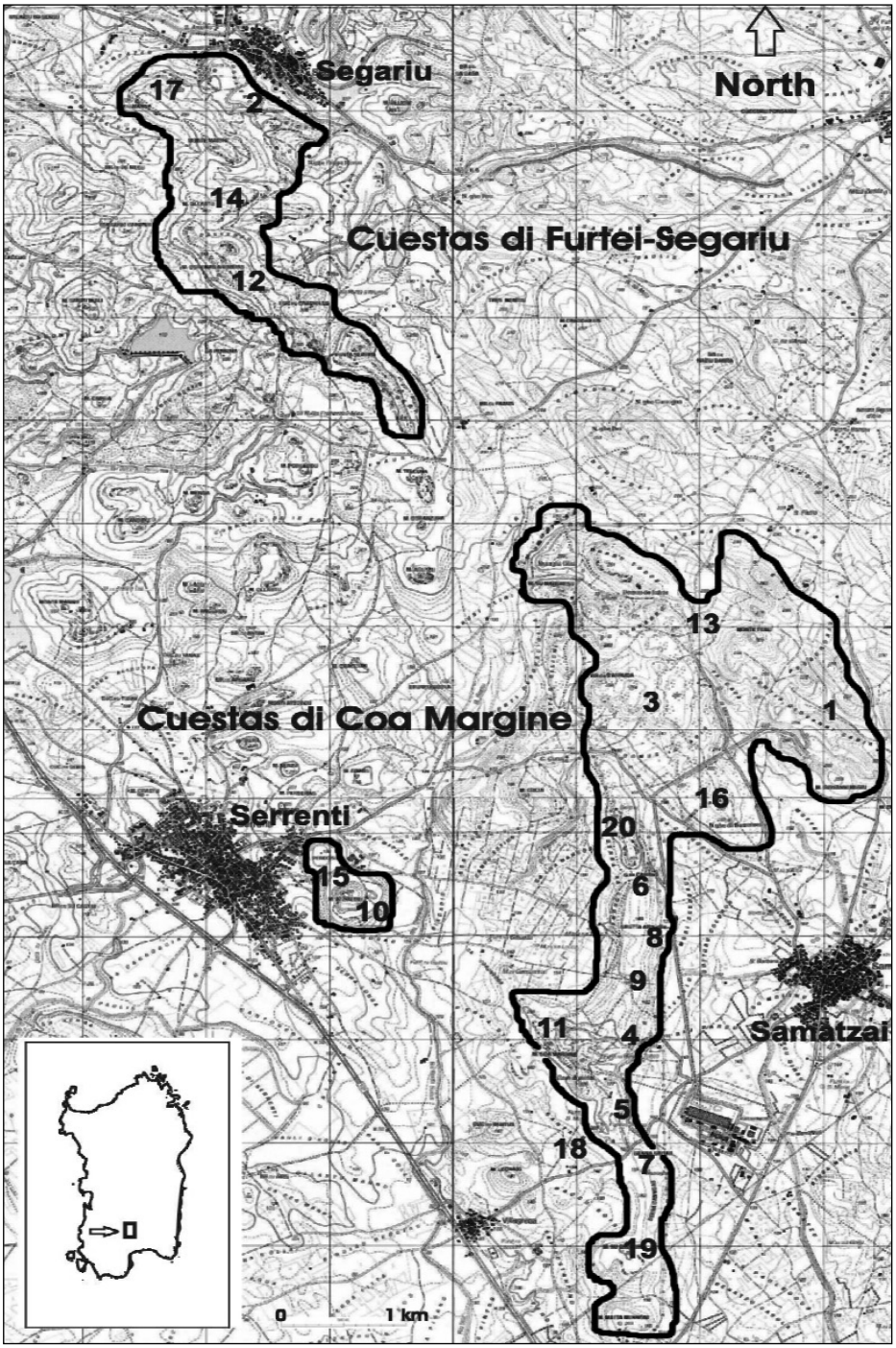


Fig. 1. Study area and its siting in Sardinia. Numbers refer to the localities listed in Table 2.

Table 1. Mean monthly values of maximum, minimum and average temperatures (1985-2001) and rainfall (1922-2001) registered at the temperature and rainfall stations of Nuraminis (°C) and Sanluri (mm).

	J	F	M	A	M	J	J	A	S	O	N	D	Year
max	13.7	14.5	17.4	19.0	23.6	28.4	32.0	32.7	27.9	27.7	19.4	14.3	22.5
min	6.4	7.0	8.0	10.0	13.2	15.8	18.2	19.0	16.3	14.6	10.7	7.1	12.1
mean	10.0	10.7	12.7	14.5	18.4	22.1	25.1	25.9	22.1	21.4	15.0	10.7	17.4
mm	65.7	58.4	52.3	53.3	35.0	13.7	4.3	11.6	35.3	59.5	72.1	81.2	542.4

Checklist (Greuter & al. 1984, 1986, 1989), "Flora Iberica" (Castroviejo & al. 1986-2002), "Orchidacee d'Italia" (Grünanger 2001) and "Guide des orchidées d'Europe" (Delforge 2005). As regards endemic flora, we used "Piante endemiche della Sardegna" (Arrigoni & al. 1977-1991) and subsequent updates (Bacchetta & al. 2004a, 2004b, 2005). The floristic list follows the systemic order of "Flora Europaea" (Tutin & al. 1968-1980, 1993) with the exception of some variations following recent taxonomic updates. As to nomenclature updating, we utilised "An Annotated Checklist of Italian Vascular Flora" (Conti & al. 2005) and, when available, revisions of specific taxonomic groups. Mentions of authors are standardised in accordance with Brummitt & Powell (1982).

In the following list, for each taxonomic unit, we show the specific or lower rank binomial, biological form, chorological form, habitat and spread. For less widespread species (sporadic, rare and very rare), in round brackets we provided a reference number (Tab. 2)

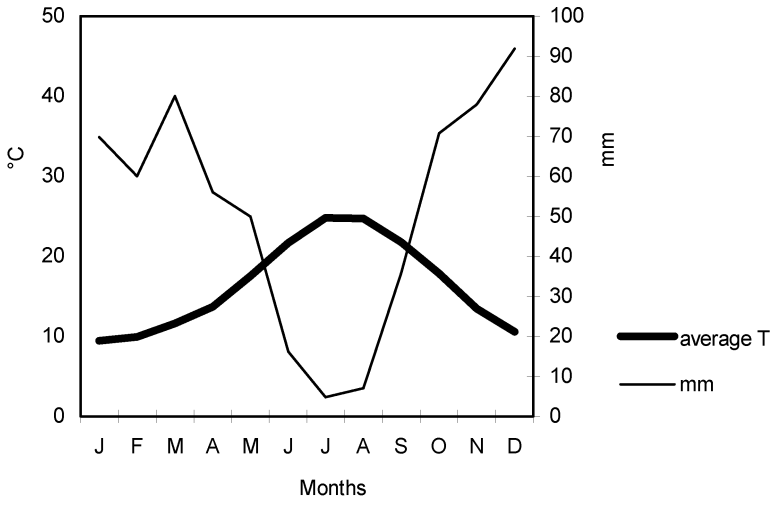


Fig. 2. Shade temperature chart.

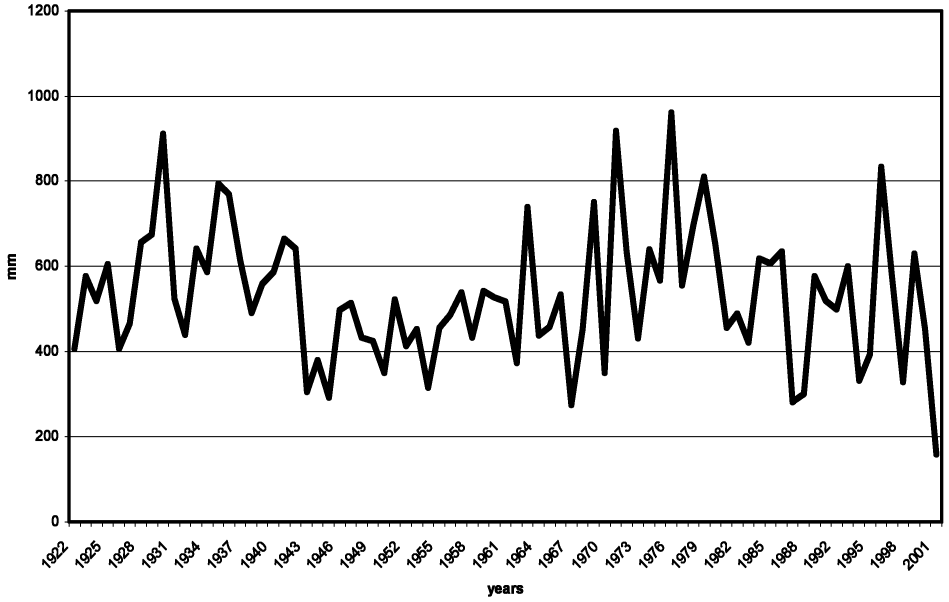


Fig. 3. Trends in precipitations for the period 1922-2001 taken from the Nuraminis station.

Table 2. List of localities.

Locality	Reference number
Cortis Giovanni Caria	1
Costa Faccia a Bidda	2
Domus is Abis	3
Funtana Basilio Tocco	4
Funtana Siutas	5
Genna Carrus	6
Genna Siutas	7
Grutta Arrubia	8
Gutturu Droxiu	9
Monte Atziaddei	10
Monte Coa Margine	11
Monte Coronas Arrubias	12
Monte Fenu	13
Monte Ollastu	14
Monte Perdosu	15
Nuraghe di Samatzai	16
Punta Manna	17
Santa Maria	18
Serra Cannigas	19
Serra Sa Corona	20

of the localities in which the species was observed and/or collected. Abundance is indicated by the following abbreviations: ww = very widespread; w = widespread; c = common; s = sporadic; r = rare; rr = extremely rare.

Alien and cultivated species are identified respectively using ([A]) and ([C]) preceding the specific binomial at the apex. For cultivated species we refer to those present as isolated naturalised exemplars or as remains of cultivated areas nowadays abandoned. For flora analysis we also drew up a biological spectrum utilising the forms suggested by Raunkiaer (1934), the chorological spectrum based mainly on data reported by Pignatti (1982) and Grime's Diagram or CSR Model (Grime 1974) subsequently revised and extended (Grime & al. 1988).

List of vascular flora

PTERIDOPHYTA

Selaginellaceae

Selaginella denticulata (L.) Spring - Ch rept - Steno-Medit.- Rocky crevices – s (12).

Aspleniaceae

Ceterach officinarum Willd. - H ros - Euras.-Temp. – Rocks – s (8).

Polypodiaceae

Polypodium cambricum L. - H ros - Euri-Medit. – Cliffs – s (2; 11).

SPERMATHOPHYTA - GYMNOSPERMAE

Cupressaceae

Juniperus oxycedrus L. subsp. *oxycedrus* - P caesp - Euri-Medit. – Brush growth – rr (11; 12).

ANGIOSPERMAE - DYCOTYLEDONES

Fagaceae

Quercus ilex L. - P scap - Steno-Medit. – Brush and wood growth – s (2; 12; 17).
Quercus virgiliana (Ten.) Ten. – P scap – SE-Europ. – Woods - rr (2).

Moraceae

Ficus carica L. - P scap - Medit.-Turan. – Cliffs and rocky crevices – s (11).

Urticaceae

Parietaria lusitanica L. - T rept - Steno-Medit. – Cliffs – s (12).
Urtica membranacea Poir. ex Savigny - T scap - S-Medit. – Amongst the brush growth - c.
Urtica pilulifera L. – T scap – S-Medit. – Ruderal environments - c.

Santalaceae

Osyris alba L. - NP - Euri-Medit. – Low brush growth – w.

Aristolochiaceae

Aristolochia navicularis E. Nardi - G bulb – Endem. – Amongst the brush growth – r (7; 11).

Refflesiaceae

Cytinus hypocistis (L.) L. – G rad – Medit.-Macarones. – Low brush growth – s (14).

Polygonaceae

Polygonum scoparium Req. ex Loisel. - Ch suffr - Endem. – Cliffs – s (11).
Rumex bucephalophorus L. - T scap - Medit.-Macarones. - Meadows - ww.
Rumex obtusifolius L. - H scap - Subcosmop. – Damp meadows – s (19).

Chenopodiaceae

Chenopodium album L. - T scap - Subcosmop.- Pastureland meadows - s.
Chenopodium murale L. – T scap – Subcosmop. – Ruderal environments – c.

Amaranthaceae

[A] *Amaranthus retroflexus* L. – T scap – Cosmopol. – Small meadows alongside the pathways – c.

Portulacaceae

Portulaca oleracea L. – T scap – Subcosmop. – Clearings - w.

Caryophyllaceae

Cerastium glomeratum Thuill. – T scap – Subcosmop. – Pastureland meadows – c.
Minuartia hybrida (Vill.) Shischk. – T scap – Paleotemp. – Cliffs – r (15; 20).
Petrorhagia prolifera (L.) P.W. Ball & Heywood - T scap - Euri-Medit. – On stony soils – c.
Polycarpon tetraphyllum (L.) L. – T scap – Euri-Medit. – Pastureland meadows - s (8).
Silene gallica L. - T scap - Euri-Medit. – Arid meadows among the rocks – w.
Silene latifolia Poir. - H bienn – Steno-Medit. – Amongst the brush growth – s (2).
Spergularia rubra (L.) J. & C. Presl - T scap - Subcosmop.-temp. – Pastureland meadows – c.
Spergula arvensis L. – T scap – Subcosmop. – Small meadows – s (2).
Stellaria media (L.) Vill. - T rept - Cosmop. – Pastureland meadows - w.

Ranunculaceae

Adonis annua L. - T scap - Europ. Occid. – Clearings and meadows - s.
Anemone hortensis L. - G bulb - N-Medit. – Meadows – s (2; 7).
Anemone coronaria L. – G bulb – Steno-Medit. – Clearings and meadows – rr (19).
Clematis cirrhosa L. - P lian - Steno-Medit.- Turan. – Amongst the brush growth and in the rock formations - w.
Nigella damascena L. - T scap - Euri-Medit. - Clearings alongside the pathways – c.
Ranunculus bullatus L. - H ros - Steno-Medit. - Clearings amongst the rocks - c.
Ranunculus paludosus Poir. - H scap - Steno-Medit.- Turan. – Clearings – s (4).

Papaveraceae

Fumaria capreolata L. - T scap - Euri-Medit. - Clearings and cliffs - w.

Glaucium corniculatum (L.) Rudolph – T scap – S-Medit. – On gravelly soils and heaps of gravel – s (20).
Papaver hybridum L. - T scap - Medit-Turan. – Pastureland meadows, clearings – s (19).
Papaver rhoeas L. - T scap – E-Medit. – Clearings and meadows - c.

Brassicaceae

Diplotaxis erucoides (L.) DC. – T scap – W-Medit. - Meadows – s (19).
Lobularia maritima (L.) Desv. - H scap - Steno-Medit. – Cliffs, amongst the brush growth - c.
Raphanus raphanistrum L. - T scap - Circumbor. - Meadows – s (19).
Sisymbrium irio L. - T scap - Paleotemp. - Clearings - c.

Resedaceae

Reseda alba L. - T scap - Steno-Medit. - Clearings – s (11).

Crassulaceae

Phedimus stellatus (L.) Raf. - T scap - Steno-Medit. – Meadows among the rocks - c.
Sedum andegavense (DC.) Desv. - T scap - W-Medit. - Cliffs – r (19).
Sedum caeruleum L. - T scap - SW-Medit. – Meadows on stony soils - ww.
Sedum sediforme (Jacq.) Pau - Ch succ - Steno-Medit. - Cliffs - c.
Umbilicus rupestris (Salisb.) Dandy - G bulb - Medit.-Atl. – Cliffs - s (11; 15).
Umbilicus gaditanus Boiss. – G bulb – Steno-Medit. – Cliffs – r (12).

Saxifragaceae

Saxifraga tridactylites L. - T scap - Euri-Medit. - Damp meadows – r (7; 11).

Rosaceae

Crataegus monogyna Jacq. - P caesp - Paleotemp. - Brush growth – s (11; 12).
[C] *Prunus dulcis* (Mill.) D.A.Webb – P scap – S-Medit.(?) - Some exemplars among the bushes.
Prunus spinosa L. - P caesp - Europeo-Caucas. – Brush growth – s (1; 7; 11).
Pyrus spinosa Forssk. - P caesp - Steno-Medit. – Amongst the brush growth – r (11; 12).
Rubus ulmifolius Schott - NP - Euri-Medit. – Damp environments - c.
Sanguisorba minor Scop. – H scap – Subcosmop. – Cliff environments – c.

Fabaceae

Anagyris foetida L. - P caesp - S-Medit. – Brush growth - c.
Astralagus hamosus L. - T scap - Medit.-Turan. – Pastureland clearings - w.
Calicotome villosa (Poir.) Link – P caesp – Steno-Medit. – Brush growth – s (12; 14).
Coronilla scorpioides (L.) W.D.J. Koch - T scap - Euri-Medit. – Pastureland meadows - w.
Dorycnium pentaphyllum Scop. - H scap - SE-Europ.- Brush growth and clearings – s (7; 19).
Genista corsica (Loisel.) DC. - NP – Endem. – Brush growth – rr (17).
Hippocrepis biflora Spreng. - T scap - Euri-Medit.- Pastureland meadows - ww.
Hymenocarpos circinnatus (L.) Savi - H scap - Steno-Medit.- Clearings – s (19).
Lathyrus annuus L. - T scap - Euri-Medit. - Meadows and clearings - s (20).
Lathyrus clymenum L. - T scap - Steno-Medit. - Meadows and clearings - d.
Lens nigricans (M. Bieb.) Godron - T scap - Steno-Medit. – Brush growth - c.

Lotus corniculatus L. group - H scap - Cosmop.- Meadows - c.
Lotus edulis L. - T scap - Steno-Medit.- Pastureland meadows - c.
Ononis viscosa subsp. breviflora (DC.) Nyman - T scap - W-Medit. – Meadows – s (19).
Pisum sativum subsp. *biflorum* (Raf.) Soldano - T scap - Steno-Medit. – Brush growth – s (11).
Scorpiurus muricatus L. - T scap - Euri-Medit. – Clearings - w.
Sulla capitata (Desf.) B.H. Choiet & H. Ohashi - T scap - W-Medit. - Meadows – s (19).
Tetragonolobus purpureus Moench - T scap - Steno-Medit. – Meadows - w.
Trifolium angustifolium L. – T scap – Euri-Medit. – Along the pathways – s (20).
Trifolium arvense L. – T scap – Paleotemp. – Meadows – c.
Trifolium campestre Schreb. - T scap - W-Paleotemp. - Pastureland meadows - w.
Trifolium cherleri L. - T scap - Euri-Medit. - Clearings - c.
Trifolium lappaceum L. – T scap – Euri-Medit. – Clearings – c.
Trifolium nigrescens Viv. - T scap - Euri-Medit. - Meadows - c.
Trifolium spumosum L. – T scap – Steno-Medit. – Pasturelands – c.
Trifolium stellatum L. - T scap - Euri-Medit. - Clearings - c.
Tripodion tetraphyllum (L.) Fourr. - T scap - Steno-Medit.- Meadows – s (19).
Vicia bithynica (L.) L. - T scap - Euri-Medit. - Meadows - s.
Vicia hirsuta (L.) Gray - T scap - Subcosmop. – Amongst the brush growth - c.
Vicia narbonensis L. - T scap - Euri-Medit. – Pasturelands – s (17; 15).
Vicia villosa Roth - T scap - Euri-Medit. - Meadows and clearings - c.

Oxalidaceae

[A] *Oxalis pes-caprae* L. - G bulb - Sudafr. – Ruderal environments, along the pathways – c.

Geraniaceae

Erodium botrys (Cav.) Bertol. - T scap - Steno-Medit. – Pasturelands - c.
Erodium cicutarium (L.) L' Hér. - T scap - Subcosmop. - Clearings - w.
Erodium malacoides (L.) L' Hér. - T scap - Medit.-Macarones. - Meadows - c.
Geranium molle L. - T scap - Subcosmop. - Pastureland meadows - ww.
Geranium robertianum L. - T scap - Subcosmop. - Cliffs – r (11).
Geranium rotundifolium L. - T scap - Paleotemp. - Meadows - c.

Linaceae

Linum strictum L. - T scap - Steno-Medit.- Meadows – s (19).

Euphorbiaceae

Chamaesyce canescens (L.) Prokh. - T rept - Euri-Medit. - Small meadows among the rocks - c.
Euphorbia characias L. - NP - Steno-Medit. - Cliffs - s (11; 19).
Euphorbia dendroides L. - NP – Steno-Medit. Macarones – Cliffs – s (12).
Euphorbia exigua L. - T scap - Euri-Medit. – Pastureland meadows - c.
Euphorbia peplus L. - T scap - Cosmop. – Meadows on stony soils - c.
Euphorbia pithyusa subsp. *cupanii* (Guss.ex Bertol.) Radcl.-Sm. - Ch suffr - Endem. - Clearings – r (11).
Mercurialis annua L. - T scap - Paleotemp. – Rocky environments – s (20).

Rutaceae

Ruta chalepensis L. - Ch suffr - S-Medit. – Brush growth – s (1).

Anacardiaceae

Pistacia lentiscus L. - P caesp - Steno-Medit. - Brush growth - ww.

Malvaceae

Althaea hirsuta L. - T scap - Euri-Medit. - Meadows on stony soils - w.
Lavatera olbia L. - P caesp - Steno-Medit. – Brush growth – c.
Malva sylvestris L. - H scap - Subcosmop. - Clearings - c.

Thymelaeaceae

Daphne gnidium L. - P caesp - Steno-Medit. Macarones. – Clearings – s (7).
Thymelaea hirsuta (L.) Endl. - NP - S-Medit.-W-Asiat. – Clearings, clumps of brush - w.

Guttiferae

Hypericum perforatum L. - H scap - Subcosmop. - Meadows and clearings - w.

Cistaceae

Cistus creticus subsp. *eriocephalus* (Viv.) Greuter & Burdet - NP - Steno-Medit. – Brush growth – s (7).
Cistus salviifolius L. - NP – Steno-Medit. – Brush growth – c.
Cistus monspeliensis L. - NP – Steno-Medit. Macarones. – Brush growth – r (12).
Fumana thymifolia (L.) Spach *ex* Webb - Ch suffr - Steno-Medit. – Clearings - s (9).
Tuberaria guttata (L.) Fourr. – T scap – Euri-Medit. – Clearings – rr (20).

Cucurbitaceae

Ecballium elaterium (L.) A. Rich. - G bulb - Euri-Medit. – Clearings - c.

Cactaceae

[A] *Opuntia ficus-indica* (L.) Mill. - P succ - Neotropic. – Some exemplars in the vicinity of the cave.
[A] *Opuntia cylindrica* (Lam.) DC.- P succ – Neotropic. - Some exemplars.

Myrtaceae

Myrtus communis L. – P caesp – Steno-Medit. – Brush growth – r (20).

Theligonaceae

Theligonum cynocrambe L. - T scap - Steno-Medit. - Clearings and cliffs – c.

Apiaceae

Daucus carota L. - H bienn - Subcosmop. – Ruderal environments - c.
Eryngium campestre L. - H scap - Euri-Medit. - Meadows - c.
Ferula communis L. - H scap - S-Medit. - Clearings – s (19).
Foeniculum vulgare Mill. - H scap - S-Medit. – Meadows alongside the pathways - ww.

Magydaris pastinacea (Lam.) Paol. - H scap - Steno-Medit. – Amongst the brush growth – s (19).
Scandix pecten-veneris L. - T scap - Subcosmop. - Meadows – s (10; 11).
Smyrnium olusatrum L. - H bienn - Medit.-Atl. - Ruderal environments - c.
Thapsia garganica L. - H scap - S-Medit. – Amongst the brush growth - w.
Tordylium apulum L. - T scap - Steno-Medit. – Clearings - c.

PRIMULACEAE

Anagallis arvensis L. - T rept - Subcosmop. – Clearings - c.
Cyclamen repandum Sm. - G bulb - N-Medit. – Woods – s (2; 17).

PLUMBAGINACEAE

Plumbago europaea L. - Ch frut - Steno-Medit. – Clearings and cliffs – s (11; 13).

OLEACEAE

[C] *Olea europaea* L. – P caesp – Steno-Medit. – Some exemplars.
Olea europaea var. *sylvestris* Brot. - P caesp - Steno-Medit. – Woods and brush growth - ww.
Phillyrea angustifolia L. - P caesp - Steno-W-Medit. - Woods - w.
Phillyrea latifolia L. - P caesp - Steno-Medit. - Brush growth – s (11).

GENTIANACEAE

Blackstonia perfoliata (L.) Huds. – T scap – Euri-Medit. – Clearings – r (12).
Centaurium erythraea Raf. - H bienn - Paleotemp. - Meadows and clearings - s (19).

CONVOLVULACEAE

Convolvulus althaeoides L. - H scand - Steno-Medit. - Meadows on stony soils – s (7).
Convolvulus arvensis L. - G rhiz - Cosmop. - Clearings - c.

BORAGINACEAE

Borago officinalis L. - T scap - Euri-Medit. – Ruderal environments - c.
Cynoglossum creticum Mill. - H bienn - Euri-Medit. – Pasturelands - c.
Echium italicum L. - H bienn - Euri-Medit. – Pasturelands - w.
Echium parviflorum Moench - T scap - Steno-Medit. – Cliffs – s (11).
Echium vulgare L. - H bienn – Europ. – Pasturelands - ww.

CALLITRICHACEAE

Callitriche stagnalis Scop. - I rad - Euriasiat. - Damp rocky environments – r (11).

LABIATAE

Ajuga iva subsp. *pseudoiva* (DC.) Briq. - Ch suffr - Steno-Medit. – Clearings - c.
Lamium amplexicaule L. - T scap - Paleotemp. - Clearings and meadows – s (5).
Micromeria graeca (L.) Benth. ex Rchb. - Ch suffr - Steno-Medit. – Cliffs – s (19).
Prasium majus L. - Ch frut - Steno-Medit. – Brush growth, rocky crevices - w.
Salvia verbenaca L. - H scap - Medit-Atl. – Pastureland clearings - c.
Sideritis romana L. - T scap - Steno-Medit. – Clearings amongst the rocks - c.

Stachys arvensis (L.) L. - T scap - Subcosmop. - Clearings - c.
Stachys glutinosa L. - Ch frut - Endem. – Brush growth – s (13; 19).
Teucrium marum L. - Ch frut - Endem. - Cliffs - w.
Teucrium capitatum L. - Ch suffr - Steno-Medit. – Cliffs and clearings – s (19).

Solanaceae

Solanum nigrum L. - T scap - Cosmop.-Sinantrop. – Ruderal environments - c.

Scrophulariaceae

Bartsia trixago L. - T scap - Euri-Medit. - Pastureland clearings - c.
Verbascum creticum (L.) Kuntze - H bienn - SW-Medit. – Meadows and clearings - c.
Verbascum sinuatum L. - H bienn - Euri-Medit. - Clearings - w.
Veronica cymbalaria Bodard - T scap - Euri-Medit. - Cliffs - w.
Veronica persica Poir. - T scap - Subcosmop. – Clearings – s (11).

Orobancaceae

Orobanche lutea Baumg. - T par - S-Europ. – Amongst the brush growth – r (19).
Orobanche ramosa L. - T par - Paleotemp. - Meadows – s (9).

Rubiaceae

Galium verrucosum Huds. - T scap - Steno-Medit. - Meadows and cliffs - w.
Gallium murale (L.) All. - T scap - Steno-Medit. - Cliffs - c.
Rubia peregrina L. - P lian - Steno-Medit. – Brush growth – s (11).
Sherardia arvensis L. - T scap - Subcosmop. – Pastureland clearings - c.
Valantia muralis L. - T scap - Steno-Medit. - Rock crevices - c.

Plantaginaceae

Plantago afra L. - T scap - Steno-Medit. - Clearings - c.
Plantago coronopus L. - T scap - Euri-Medit. - Meadows - c.
Plantago lagopus L. - T scap - Steno-Medit. – Meadows and along the pathways - c.
Plantago lanceolata L. - H ros - Cosmop. - Meadows and among the rocks – s (20).
Plantago weldenii Rchb. – T scap - Euri-Medit. - Meadows – s (10; 20).

Caprifoliaceae

Lonicera implexa Aiton - P lian - Steno-Medit. – Cliffs – s (1; 7).

Valerianaceae

Centranthus calcitrapae (L.) Dufr. - T scap - Steno-Medit. - Meadows and clearings - c.
Valerianella microcarpa Loisel. - T scap - Steno-Medit. – Clearings amongst the rocks - c.

Dipsacaceae

Sixalix atroporpurea subsp. *grandiflora* (Scop.) Soldano & F. Conti - H bienn - Steno-Medit. - Meadows on stony soils – s (19).

CAMPANULACEAE

Campanula erinus L. - T scap - Steno-Medit. - Meadows – s (11).

ASTERACEAE

Aetheorhiza bulbosa (L.) Cass - G bulb - Steno-Medit. – Meadows on stony soils - c.
Anthemis arvensis L. - T scap - Subcosmop. – Meadows - c.
Artemisia arborescens L. - NP - S-Medit. – Brush growth - c.
Atractylis gummifera L. – H ros – S-Medit. – Clearings – c.
Bellis annua L. - T scap - Steno-Medit.-Macarones. - Clearings - c.
Bellis perennis L. - H ros - Circumbor. – Pastureland meadows, alongside the pathways - c.
Calendula arvensis L. - T scap - Euri-Medit. – Pastureland clearings - w.
Carduus tenuiflorus Curtis - H bienn - W-Europ. - Meadows – s (19).
Carlina corymbosa L. - H scap - Steno-Medit. – Pastureland clearings - w.
Carlina racemosa L. - T scap - SW-Medit. - Meadows – s (1).
Carthamus caeruleus L. - H scap - S-Medit. – Clearings – r (19).
Carthamus lanatus L. - T scap - Euri-Medit. - Pastureland clearings - c.
Cichorium intybus L. - H scap - Cosmop. - Meadows and clearings - w.
Crupina crupinastrum (Moris) Vis. - T scap - Steno-Medit. – Meadows - w.
Cyanus segetum Hill - T scap - Subcosmop. – Ruderal environments – r (7).
Cynara cardunculus L. - H scap - Steno-Medit. - Meadows and clearings - w.
Dittrichia graveolens (L.) Greuter – T scap – Medit.-Turan. – Ruderal environments – w.
Dittrichia viscosa (L.) Greuter - H scap - Euri-Medit. – Meadows and clearings - ww.
[A] *Erigeron sumatrensis* Retz. - T scap – America trop. – Meadows on stony soils.
[A] *Erigeron bonariensis* L. - T scap – America trop. – Ruderal environments.
Filago pyramidata L. - T scap - Euri-Medit. - Meadows – s (19).
Galactites elegans (All.) Soldano - H bienn - Steno-Medit. – Pastureland clearings - w.
Glebionis coronaria (L.) Spach - T scap - Steno-Medit. – Degraded meadows and pasturelands - c.
Hedypnois cretica (L.) Dum. Cours. - T scap - Steno-Medit. - Meadows - c.
Helichrysum microphyllum subsp. *tyrrhenicum* Bacch., Brullo & Giusso - Ch suffr - Endem. – Low brush growth in rocky crevices – rr (6).
Hyoseris scabra L. - T ros - Steno-Medit. - Meadows - c.
Hypochaeris achyrophorus L. - T scap - Steno-Medit. - Meadows among the rocks - c.
Leontodon tuberosus L. - H ros - Steno-Medit. – Clearings and clumps of brush - w.
Pallenis spinosa (L.) Cass. - T scap - Euri-Medit. - Meadows – s (19).
Phagnalon saxatile (L.) Cass. - Ch suffr - W-Medit. – Cliffs - w.
Phagnalon sordidum (L.) Rchb. - Ch suffr - W-Medit. - Cliffs – s (11).
Reichardia picroides (L.) Roth - H scap - Steno-Medit. – Arid meadows among the rocks - c.
Senecio delphinifolius Vahl - T scap - SW-Medit. - Meadows - c.
Senecio lividus L. - T scap - Steno-Medit. – Clearings and cliffs - c.
Senecio vulgaris L. - T scap - Cosmop. - Meadows and clearings - w.
Silybum marianum (L.) Gaertn. - H bienn - Medit.-Turan. - Meadows - c.
Sonchus asper (L.) Hill - T scap - Subcosmop. – Clearings and pastureland meadows - c.
Sonchus oleraceus L. – T scap – Subcosmop. – Cliffs, clearings and alongside the pathways – ww.

Sonchus tenerrimus L. - T scap - Steno-Medit. - Cliffs - w.
[A] *Symphyotrichum squamatum* (Spreng.) G.L. Nesom - T scap – Neotrop. – Ruderal environments – c.
Urospermum dalechampii (L.) F.W. Schmidt - H scap - Euri-Medit. - Meadows – s (6; 15).
Urospermum picroides (L.) Scop. *ex* F.W. Schmidt - T scap - Euri-Medit. - Meadows - c.

ANGIOSPERMAE –MONOCOTYLEDONES

Liliaceae

Allium roseum L. - G bulb - Steno-Medit. – Clearings and cliffs - c.
Allium subhirsutum L. - G bulb - Steno-Medit. – Meadows and rocky areas – w.
Allium triquetrum L. - G bulb - Steno-Medit. – Cliffs and damp meadows - c.
Asparagus acutifolius L. - G rhiz - Steno-Medit. - Low brush growth - c.
Asparagus albus L. - Ch frut - Steno-Medit.- Clearings – s (11).
Asphodelus fistulosus L. - H scap – Paleo-Subtrop. - Cliffs – r (11).
Asphodelus aestivus Brot. - G rhiz - Steno-Medit. - Degraded meadows and pasturelands - ww.
Loncomelos narbonensis (Torn. *in* L.) Raf. - G bulb – Euri-Medit. – Clearings – r (17).
Muscari comosum (L.) Mill. - G bulb - Euri-Medit. – Meadows – s (5).
Ruscus aculeatus L. - G rhiz - Euri-Medit. - Brush and wood growth –s (11; 12).
Prospero autumnale (L.) Speta - G bulb - Euri-Medit. – Clearings and cliffs - c.
Prospero obtusifolia (Poir.) Speta – G bulb – Endem. – Clearings – r (20).
Smilax aspera L. - NP – Paleo-Subtrop. – Brush growth - w.
Charybdis maritima (L.) Speta – G bulb – Steno-Medit.-Macarones. – Clearings – r (20; 6).
Charybdis undulata (Desf.) Speta - G bulb - S-Medit. – Meadows and rocky areas – s (19).

Dioscoreaceae

Tamus communis L. - G rad - Euri-Medit. - Rocky crevices amongst the brush growth - c.

Iridaceae

Gladiolus communis L. - G bulb - N-Medit.-W.-Asiat. - Meadows and rocky areas – s (9).
Gynandriris sisyrinchium (L.) Parl. - G bulb - Steno-Medit. – Pastureland meadows - c.
Romulea ramiflora Ten. subsp. *ramiflora* - G bulb - Steno-Medit.-Macarones.- Clearings alongside the pathways - c.
Romulea ligustica Parl. – G bulb – Steno-Medit. – Clearings on stony soils – s (12).

Poaceae

Agrostis stolonifera L. - H rept - Circumbor. - Meadows - c.
Ampelodesmos mauritanicus (Poir.) T. Durand & Schinz - H caesp - Steno-Medit. - Clearings and cliffs - ww.
Avena barbata Pott *ex* Link - T scap - Euri-Medit.-Turan. – Clearings - w.
Avena fatua L. - T scap - Euriasiat. – Clearings - c.
Brachypodium retusum (Pers.) P. Beauv. – H caesp – W-Steno-Medit. – Cliffs - c.
Briza maxima L. - T scap - Paleosubtrop. – Clearings - c.
Briza media L. - H caesp - Euro-Sib. - Meadows – s (19).
Bromus hordeaceus L. - T scap - Subcosmop. - Pastureland clearings - c.

Bromus intermedius Guss. - T scap - Euri-Medit. - Meadows - w.
Bromus madritensis L. - T scap - Euri-Medit. - Clearings - c.
Bromus sterilis L. - T scap - Euri-Medit.-Turan. – Clearings – s (6).
Catapodium rigidum (L.) C.E. Hubb. *ex* Dony - T scap - Euri-Medit. - Meadows - c.
Dactylis glomerata L. - H caesp - Paleotemp. – Clearings and rocky crevices - w.
Dasypyrum villosum (L.) P. Candargy - T scap - Euri-Medit.-Turan. - Meadows - c.
Hordeum murinum L. - T scap - Circumbor. – Pastureland clearings - w.
Hyparrhenia hirta (L.) Stapf - H caesp - Paleotrop. - Clearings - c.
Lagurus ovatus L. - T scap - Euri-Medit. – Pastureland clearings - c.
Lamarckia aurea (L.) Moench - T scap – Steno-Medit.-Turan. – Meadows – c.
Lolium rigidum Gaudin - T scap - Paleosubtrop. - Clearings on stony soils - c.
Melica ciliata L. - H caesp - Euri-Medit.-Turan. - Cliffs - c.
Melica minuta L. - H caesp - Steno-Medit. - Cliffs – s (20).
Phalaris paradoxa L. - T scap - Steno-Medit. - Meadows and clearings - c.
Piptatherum miliaceum (L.) Cosson - H caesp - Steno-Medit.- Turan. – Meadows - ww.
Poa bulbosa L. - H caesp - Paleotemp. – Cliffs – rr (10; 12).
Triticum ovatum (L.) Raspail - T scap - Steno-Medit.- Turan. – Pastureland clearings - c.
Vulpia ligustica (All.) Link - T caesp - Steno-Medit. - Meadows and clearings - c.

Araceae

Arisarum vulgare Targ. Tozz. - G rhiz - Steno-Medit. – brush growth, meadows and cliffs - w.
Arum pictum L. f.- G rhiz - Endem. – Cliffs, amongst the brush growth – c.
Arum italicum Mill. – G rhiz – Euri-Medit. – Woods – s (2).
Biarum dispar (Schott) Talavera – G rhiz – Endem. – Clearings and clumps of brush – rr (16; 3).

Cyperaceae

Carex distachya Desf. – H caesp – Steno-Medit. – Woods – s (2; 17).
Carex divisa Huds. - G rhiz - Euri-Medit.-Atlant. - Damp meadows – s (9).
Carex flacca subsp. *serrulata* (Biv.) Greuter - G rhiz - Europ. - Clearings - c.

Orchidaceae

Himantoglossum robertianum (Loisel.) P. Delforge – G bulb – Steno-Medit. – Clearings – rr (3).
Ophrys apifera Huds. – G bulb – Euri-Medit. – Brush growth – r (2; 12).
Ophrys bombyliflora Link - G bulb - Steno-Medit. - Meadows – s (20).
Ophrys eleonorae J. Devillers-Terschuren & P. Devillers [= *Ophrys iricolor* subsp. *maxima* (A. Terrac.) Paulus & Gack] – G bulb – Endem. – Clearings – r (12).
Ophrys holoserica (N.L. Burm.) W. Greuter - G bulb - Euri-Medit. - Meadows – s (19).
Ophrys lutea Cav. - G bulb - Steno-Medit. – Pastureland clearings - c.
Ophrys tenthredinifera Willd. - G bulb - Steno-Medit. - Meadows – s (11).
Ophrys speculum Link - G bulb - Steno-Medit. - Clearings - c.
Ophrys x sommieri E.G. Camus *ex* Cortesi - G bulb - Steno-Medit. - Meadows – r (20).
Orchis anthropophora (L.) All. – G bulb – Medit.-Atl. – Clearings – r (20).
Orchis collina Banks & Sol. ex Russell - G bulb - Steno-Medit. - Meadows – r (11; 19).
Orchis longicornu Poir. – G bulb – W-Steno-Medit. – Clearings and brush growth - w.

Orchis papilionacea L. – G bulb – W-Medit. – Clearings amongst the brush growth - c.
Serapias lingua L. – G bulb – Steno-Medit. – Meadows – s (14).
Serapias parviflora Parl. - G bulb - Steno-Medit. - Clearings – s (11).

Results and discussion

Our research made it possible to identify 291 taxonomic units, of which 282 spontaneous, 7 alien and 2 cultivated, which, overall are included in 63 families and 204 genera, values which vary when excluding alien and cultivated plants, as shown in Table 3. The most numerous families (Tab. 4) are *Asteraceae* (42) followed by *Fabaceae* (31) and *Poaceae* (26). Floristic characteristics of the area under study have been summarised in Table 5 which shows flora composition divided by systematic groups.

The biological spectrum (Fig. 4) shows significant dominance of therophytes (46.1%) followed in percentage terms by hemicryptophytes (19.9%), geophytes (17.0%), phanerophytes and nanophanerophytes (10.6%), camephytes (6.0%) and hydrophytes (0.4%). Plant geography characteristics expressed in the general chorographical spectrum (Tab. 6) indicate the strong Mediterranean character of the area under study, with 75.5% of plants belonging to Mediterranean chorotypes. Amongst these there is absolute prevalence of steno-Mediterranean species (37.2%) followed by Euro-Mediterranean (21.6%) (Fig. 5). There is also a significant percentage of cosmopolite elements (11.7%) whose presence is related to those areas degraded by animal grazing and human activities which, leading to the disappearance of Mediterranean-based species, have favoured the spread of floristic entities of broad distribution.

The endemic component consists of 11 taxonomic units (3.9 %) which, as demonstrated in Table 7, are found not only in Sardinia but also other islands and coastal territories of the western Mediterranean. Analysis of their distribution area shows that 64% of elements are mainly found in the central northern territories of the western Mediterranean (Corsica, the Tuscan Archipelago, etc.), whereas 36% show phytogeographic relationships with some territories of the south western Mediterranean, in particular Sicily and North Africa. The high percentage of endemic plants shared by Sardinia and Corsica (Bacchetta & al. 2004b) is in the main the result of the granite substrata characteristic of the Sardinian-Corsican batholith. The endemic component found in the area under study is widespread

Table 3. Numerical consistency of taxonomic families, genera and units.

	Spontaneus	Alien	Coltivated	Total
Families	60	3	-	63
Genera	199	5	-	204
Species	272	7	2	281
Subspecies	9	-	-	9
Varieties	1	-	-	1

Table 4. Families most frequently found.

Family	Taxonomic units
Asteraceae	42
Fabaceae	31
Poaceae	26
Liliaceae	15
Orchidaceae	15
Labiatae	10
Apiaceae	9
Caryophyllaceae	9

both in the carbonate and siliceous substrata in Sardinia and no taxonomic units exclusive to Sardinia were observed, which are mainly linked to calcicolous chasmophilous, silicicous orophilous and coastal litophilous plants. In particular, the endemic calcicolous contingent of the central eastern mountains is that which most differentiates Sardinian from Corsican flora (Arrigoni 1983).

The flora of the carbonate formations was examined also through application of the CSR method based on the multiplicity of climatic, soil and human factors, which are connected in the main to stress and disturbance. Grime's strategies (C, CR, SC, S, SR, R, CSR), grouped in three main categories (C, S, R) make it possible to focus better on the factors which have greatest incidence on the development of flora as shown by Médail & Verlaque (1997) and Vidal & al. (1998) for some territories of Corsica and France. Grime's diagram highlights the dominance of the stress-tolerant ruderal strategy (SR) with 40.78% and competive-ruderal (CR) with 21.99% (Fig. 6). From the diagram showing strategies in a broad sense (Fig. 7) we can note dominance of ruderal strategy (R) with 40.87%, followed by stress-tolerant (S) with 37.14% and lastly competitive (C) with 21.99%.

Table 5. Numerical consistency of taxonomic families, genera and units.

	Families	Genera	Taxonomic units
Pteridophyta	3	3	3
Gymnospermae	1	1	1
Dicotyledones	52	158	219
Monocotyledones	7	42	68
Total	63	204	291

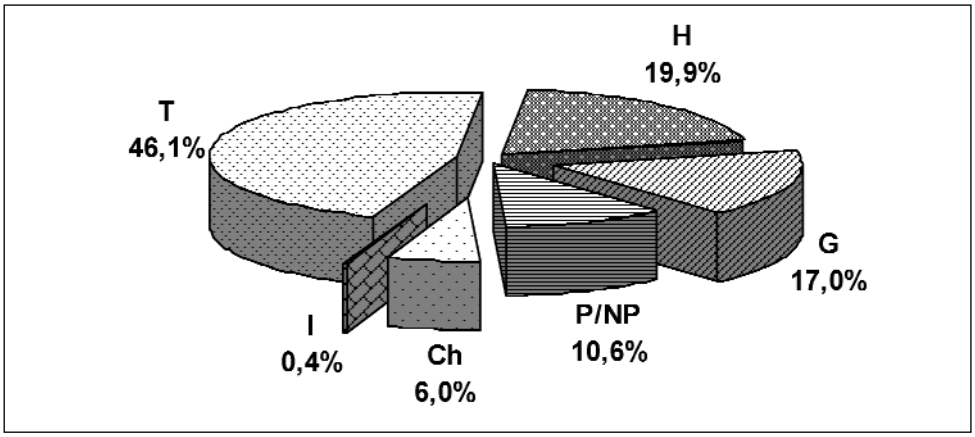


Fig. 4. Biological spectrum.

Observations on flora of the carbonate formations of the central eastern Campidano region show a relationship between the high incidence of human activity in the territory and the disappearance of well-structured forms of vegetation. The territory examined shows high rock content of the soil, a factor which has limited farming activity in the areas round the study area. Farming activity is usually based on cereal and forage crops, vegetable production and almond and olive groves. The meadows and the rocks with carbonate substrata, which cannot be cultivated, are used for grazing and these areas are subject to brush fires. Over and above these forms of disturbance, we must mention quarrying activity present in several areas, one of the main causes of degradation of the flora and ecosystems. These activities are responsible for the reduction of natural environments in favour of highly artificial zones, which favour the spread of wide-distribution floristic elements.

Table 6. General chorological spectrum.

Corologic type	N°	%
Atlantic	6	2.1
Circumboreal	5	1.8
Cosmopolites	33	11.7
Eurasiatic *s.l.*	20	7.1
Mediterranean	213	75.5
Paleotropical *s.l.*	5	1.8
Total	282	100.0

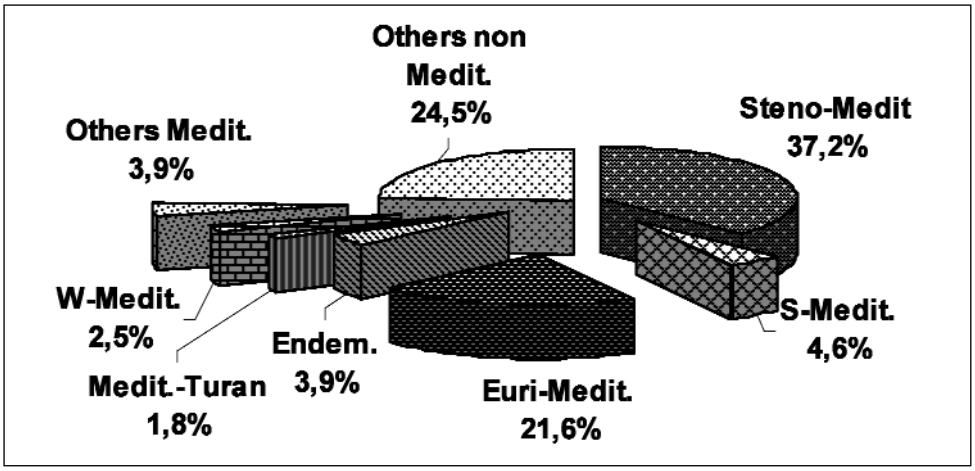


Fig. 5. Chorological spectrum of Mediterranean elements.

Indeed, while on the one hand more than 75% of the chorological types show flora of strong Mediterranean characteristics, some 12% is represented by cosmopolitan and subcosmopolitan floristic elements. The relationship between climatic conditions and soil degradation emerges also from the high percentage of therophytes (46.1%) higher by 3.5% than that recently indicated for Sardinian flora by Mossa & al. (2003). The most widespread therophytes belong to *Asteraceae*, *Fabaceae* and *Poaceae* which are also the most numerous families in the area under study. Amongst the *Asteraceae* we find great fre-

Table 7. List and distribution areal of endemisms: AG = Algeria; AT = Tuscan Archipelago; BL = Balearic Islands; CO = Corsica; H = Hyères Islands; LI = Lybia; SA = Sardinia; SI = Sicily; TN = Tunisia.

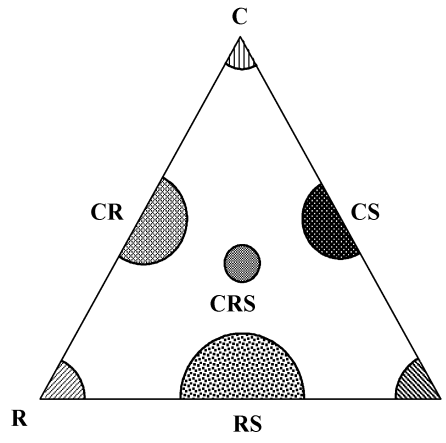
Endemic flora	Distribution area
Arum pictum L. f.	SA-CO
Aristolochia navicularis E. Nardi	SA-SI-TN-AG
Biarum dispar (Schott) Talavera	SA-AG-LI
Euphorbia pithyusa subsp. *cupanii* (Guss. ex Bertol.) Radcl.-Sm.	SA-CO-SI
Genista corsica (Loisel.) DC.	SA-CO
Helichrysum microphyllum subsp. *tyrrhenicum* Bacch., Brullo & Giusso	SA-CO-BL
Ophrys eleonorae J. Devillers-Terschuren & P. Devillers	SA-CO-TN
Polygonum scoparium Req. ex Loisel.	SA-CO
Prospero obtusifolia (Poir.) Speta	SA-AG
Stachys glutinosa L.	SA-CO-AT
Teucrium marum L.	SA-CO-BL-AT-H

quency of *Carlina corymbosa* L., *Calendula arvensis* L., *Glebionis coronaria* (L.) Spach and *Sonchus tenerrimus* L., whereas amongst the *Poaceae* the most widespread belong to the genera *Bromus, Aegilops*, *Dactylis* e *Vulpia*. Coming to the *Fabaceae* the most frequent genera are *Trifolium*, *Vicia*, *Lotus* and *Lathyrus*, while there are extensive populations of *Sulla capitata* (Desf.) B.H. Choiet & H. Ohashi.

Herbaceous plants also include numerous hemicryptophytes and geophytes which taken together represent 36.9% of the flora. Adding together the percentage of therophytes (T), hemicryptophytes (H) and geophytes (G) we find that 83% of the flora is represented by biological forms which structurally make up herbaceous formations. These forms cover almost three quarters of the area under study, whereas only one quarter is occupied by rocks and more evolved plant species. The ruderal character of the flora is highlighted also by Grime's diagrams in which we find dominance of SR and CR strategies typical of areas where disturbance is linked to stress situations (SR) or to local availability of resources (CR). It is moreover clear that stress-associated situations might well depend also on the worsening of adverse meteorological conditions, in particular drought and irregular rainfall.

The species which most marks the plant landscape is *Ampelodesmos mauritanicus* (Poiret.) T. Durand & Schinz, widespread in the meadows, amongst the bush growth, in earth-filled hollows and on the rocks. Amongst its extensive populations there is also a small number of other plants such as *Dorycnium pentaphyllum* Scop., *Sulla capitata* (Desf.) B.H. Choiet & H. Ohashi., *Coronilla scorpioides* (L.) Koch and *Magydaris pastinacea* (Lam.) Paol.

The development of some herbaceous species is linked to grazing and brush fires as is the case with meadows of *Asphodelus aestivus* Brot. where are to be found *Borago officinalis* L., *Leontodon tuberosus* L., *Smyrnium olusatrum* L., *Mercurialis annua* L., *Allium roseum* L., *Gladiolus communis* L., *Ranunculus bullatus* L. and *Centranthus calcitrapae*



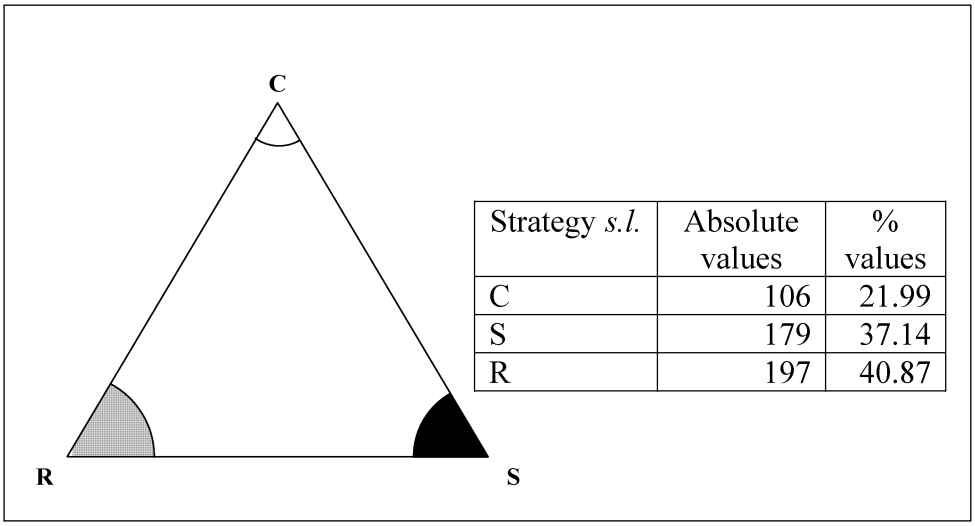
Strategy	Absolute values	% values
C	6	2.13
SC	38	13.48
S	26	9.22
SR	115	40.77
R	20	7,09
CR	62	21.99
CSR	15	5.32

Fig. 6. Grime's Diagram.

(L.) Dufr. The high number of *Orchidaceae*, growing in the clearings, is related to the carbonate nature of the soil, in particular as regards some rare entities such as *Orchis collina* Banks & Sol., not particularly common in Sardinia.

In clearings in the locality Domus is Abis we found the only population of *Biarum dispar* (Schott) Talavera, an Aracea which in Italy is found only in some Sardinian localities. This colony extends round the Nuraghe of Samatzai and its conservation is threatened since an archaeological dig is in progress in the area to bring to light a nuraghic village. Before the start of excavations, to avoid extinction of this colony, some of the plant material was removed by the Biodiversity Conservation Centre (CCB – Centro per la Conservazione della Biodiversità) of the Department of Botanical Sciences of the University of Cagliari. This has made it possible to preserve *ex situ* 200 rhizomes which are at present under cultivation at the the Botanical Gardens in the hope that once excavations are completed it will be possible to replant them in order to protect not only the archaeological, but also the botanical assets.

Cyanus segetum Hill and *Anemone coronaria* L were widespread exclusively in the clearings adjoining cereal fields: these are two species whose distribution in Sardinia is little known. They are often omitted from floristic lists because they grow in environments strongly marked by human activity, namely farming, hence areas that are rarely the subject of botanical investigation. *Cyanus segetum* Hill was observed recently also in the Sinis area, in the northern portion of the Campidano plain, in the cereal crop fields near Capo Mannu (personal observation by the Authors). More widespread is *Anemone coronaria* L. which also grows along the roadside again in farming ecosystems. It is found in the hinterland of Cagliari (*Herbarium CAG*), in the vicinity of the Simbirizzi marsh (Onnis 1964), round the villages of Siliqua and Senorbì (*Herbarium CAG*), in the outskirts of San Sperate and on the banks of the Riu Mannu in the municipality of Decimomannu (personal obser-



Strategy *s.l.*	Absolute values	% values
C	106	21.99
S	179	37.14
R	197	40.87

Fig. 7. Grime's Diagram strategies *s. l.*

vation by the Authors), whereas in northern Sardinia it is to be found round the Baratz lake (*Herbarium SS*). Probably this species has disappeared from other areas since some *exsiccata* refer to botanical field trips carried out at the end of the 19th century in territories which are today urbanised.

The phanerophytes and nanophanerophytes, with 10.6%, are the most evolved plant formations represented mainly by discontinuous woodland stands. Often bushes and trees emerge from the herbaceous formations or on the rocks as isolated individuals. The most widespread type is brush, with *Olea europaea*. L. var. *sylvestris* Brot. associated with *Phillyrea angustifolia* L., *Pyrus spinosa* Forssk., *Pistacia lentiscus* L., *Anagyris foetida* L., *Crataegus monogyna* Jacq., *Smilax aspera* L., *Clematis cirrhosa* L. and *Rubia peregrina* L. Probably in the past these vegetation formations also included *Juniperus oxycedrus* L. subsp. *oxycedrus*, of which at the present time only plantules and immature exemplars are to be observed. Exclusively in the area between Costa Faccia a Bidda and Monte Costas Arrubias, in the municipality of Segariu, did we find stands of *Quercus ilex* L., situated on the slopes with mainly northerly exposure and a more mesophilic climate. Amongst the ilex we found sporadic evidence of *Quercus virgiliana* (Ten.) Ten., a deciduous oak which adapts very well to all types of substratum and bio-climatic conditions. In Sardinia it is to be found from sea level to the mountain areas of the Gennargentu, but its *optimum* habitat is in the hill and sub-mountain stations, where it tends to form pure or mixed woods (Mossa & al. 1998).

The low bush formations consist mainly of *Artemisia arborescens* L., *Asparagus albus* L., *Asparagus acutifolius* L., *Cistus creticus* subsp. *eriocephalus* (Viv.) Greuter & Burdet, *Dittrichia viscosa* (L.) Greuter, *Osyris alba* L., *Thymelaea hirsuta* (L.) Endl., *Plumbago europaea* L. and *Prunus spinosa* L.

In the rupiculous environments, plant formations are marked by camephytes which overall account for 6% of flora and number several species including *Euphorbia characias* L., *Fumana thymifolia* (L.) Spach, *Micromeria graeca* (L.) Bentham, *Phagnalon saxatile* (L.) Cass., *Phagnalon sordidum* (L.) Cass., and *Teucrium capitatum* L. as well as some endemisms. In this habitat there are species of significant naturalistic importance such as *Euphorbia pithyusa* L. subsp. *cupanii* (Guss. *ex* Bertol.) Radcl.-Sm., *Helichrysum microphyllum* subsp. *tyrrhenicum* Bacch., Brullo & Giusso, *Polygonum scoparium* Req., *Stachys glutinosa* L. and *Teucrium marum* L. associated with *Arum pictum* L. f., *Genista corsica* (Loisel.) DC. and *Prospero obtusifolia* (Poir.) Speta. Only in the cliffs of this habitat we found sporadic evidence of *Geranium robertianum* L.

The absence of marshy environments is shown by the presence of only one hydrophyte, *Callitriche stagnalis* Scop., which grows in rock weathering pools in which water collects during the rainy season.

Some floristic aspects of the carbonate formations investigated are to be found on Capo S. Elia and the hills of Cagliari (Martinoli 1950; Biondi & Mossa 1992), made up of similar limestone formations of the Miocene. Differences depend on the more southerly siting of these territories and their vicinity to the coast marked by more pronounced drought conditions. The plant landscape shows some similar typologies such as the formations of *Olea europaea* var. *sylvestris* Brot., *Artemisia arborescens* L., *Euphorbia dendroides* L. and *Anagyris foetida* L. classifiable as *Pistacio lentisci - Rhamnetalia alaterni* Rivas-Martínez 1975, or those with *Ampelodesmos mauritanicus* (Poiret.) T. Durand & Schinz, *Cistus cre-*

ticus subsp. *eriocephalus* (Viv.) Greuter & Burdet, *Thymelaea hirsuta* (L.) Endl. to be referred to *Rosmarinetalia officinalis* Br.-Bl. 1931. Herbaceous formations, especially widespread also at Capo S. Elia and on the hills, can be classified mainly as *Tuberarietea guttate* Br.-Bl. 1952 em. Riv.-Mart. 1978, *Ruderali-Secalietea* Br.-Bl. 1936 and *Lygeo sparti-Stipetea tenacissimae* Riv.-Mart. 1978.

On conclusion of this work and in view of the significant naturalistic value of both botanical and geological aspects, as well as the presence in the area under study of important archaeological sites, it is to be hoped that local authorities will take steps to plan actions targeting conservation of the historical and naturalistic patrimony, with the planning of multi-disciplinary teaching pathways. The production of management models and environmental recovery plans in those areas suffering from significant degradation is the keystone on which to base sustainable development and the conservation of the plant cover, by enhancing especially the endemic and/or rare floristic component. It is moreover to be hoped that before embarking on studies of an archaeological nature, reconnaissance will be carried out to identify any rare or especially important floristic species or those of particular phytogeographic importance as occurred for *Biarum dispar* (Schott) Talavera.

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Address of the authors:
Emanuele Bocchieri & Gianluca Iiriti, Dipartimento di Scienze Botaniche, Università degli Studi di Cagliari, Viale S. Ignazio 13, 09123 Cagliari, Italy. E-mail: bocchi@unica.it; lucaiiriti@tiscali.it.