7TH INTERNATIONAL CONFERENCE ON

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PROMOTING AWARENESS OF SERPENTINE BIODIVERSITY

Flora and Vegetation of Iberian Ultramafics

Excursion Guide

A. Asensi, C. Aguiar, D. Sánchez-Mata& T. Monteiro-Henriques (eds.)

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Instituto Politécnico de Bragança

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I. Mid-conference field trip: NE Portugal ultramafic outcrops

Carlos Aguiar (coord.)

Figure 13. *Armeria langei* subsp. *marizii* (*Plumbaginaceae*) (left), *Avenula lusitanica* (*Poaceae*) (right)

Figure 14. *Festuca brigantina* subsp. *brigantina* (*Poaceae*) (left), *Anthyllis sampaioana* (*Fabaceae*) (right)

7. Vegetation

(by Carlos Aguiar, Tiago Monteiro-Henriques & D. Sánchez-Mata)

Introduction

Due to their complexity, vegetation phenomena are not understandable without a consistent conceptual framework. A few indispensable concepts to explore the northeastern Portuguese ultramafic vegetation are set out in Tables 9 and 10.

Table 9. Vegetation science concepts used in the text

Association. The Phytosociology fundamental abstract unit is the association or *associatio*. The concept of association comprises an ecological-taxonomic model of the reality. Therefore, the association includes the notion of a plant **community** (biological information: floristic, physiognomic etc.) that occupies a particular **biotope** (chorologic information) where a specific set of environmental conditions can be found, i.e. the **habitat** (environmental information). The taxonomic element is mainly supported on the floristic composition, which is characteristic and statistically constant between associations. The development of a hierarchical syntaxonomic system (synsystem) is based above all on floristic, but also on environmental, biogeographic and physiognomic characters. Although the association concept is not a true synonym of phytocoenosis the two terms are often used interchangeably, which may result abusive.

Climax vegetation. Stage of maximum structural complexity that culminates successional processes. Stability is not a prerequisite of climax vegetation.

Cover-abundance scale of Braun-Blanquet (1979). r: rare individuals, very small cover; +: sparse individuals, very small cover; 1: many individuals, 1-5% cover; 2: individuals very numerous, 5-25% cover; 3: any number of individuals, 25-50% cover; 4: any number of individuals, 50-75% cover; 5: any number of individuals, 75-100% cover.

Permasigmetum. Is a special kind of vegetation series from extreme environments, where a perennial climactic stage is present, but no substitution perennial stages exist (Rivas-Martínez et al., 2007).

Phytocoenotic diversity. Is the number of phytocoenosis present, for example, in a vegetation series or in a certain territory.

Potential domain. Territory actually or potentially occupied by the same climax vegetation and, consequently, by the same vegetation series (= holotessella or macrotessella).

Potential natural vegetation. "Imagined natural state of vegetation (...) that could be outlined for the present time or for a certain earlier period, if human influence on vegetation was removed – the remaining conditions of life presently existing or having existed during those periods still being valid - and the natural vegetation was imagined as switched into the new balance within a split second (...) to exclude the possible effects of climate changes and the consequences thereof" (Tüxen 1956, see Zerbe 1998).

Vegetation series (≈ sigmetum). A set of plant communities composed by a climax association – usually a forest in Mediterranean and temperate macrobioclimates – and its substitution stages (Rivas-Martínez et al., 2007). Vegetation series occupies homogenous biotopes and its components – seral stages – are connected through successional processes. Semi-nitrophilous vegetation, plant communities dependent of microtopographic features (e.g. temporary Mediterranean ponds vegetation) and functionally dependent communities (e.g. scionitrophilous forest vegetation and epiphytic vegetation) are not included in vegetation series descriptions. Successional mosaics phytocoenotic composition and structure are largely governed by stress (inc. nutritional stress), disturbance patterns, and diaspore availability. **Edaphohygrophilous vegetation series**. Vegetation series of water compensated soils. **Edaphoxerophilous vegetation series**. Vegetation series of crests or steep slopes, submitted to higher water deficit in summer. **Climatophilous vegetation series**. Vegetation series of zonal soils (**euclimatopes**).

Table 10. Raunkiaer plant life-forms (Ellenberg & Mueller-Dombois 1967)

Therophytes. Annual plants.
Chamaephytes. Plants whose mature aerial system remains within the 50 cm above soil surface during the period of growth interruption (winter in non-tropical territories). **Low chamaephytes**, less than 10 cm height. **Tall chamaephytes**, more than 30 cm height.
Hemicryptophytes. Perennial herbaceous plants that display a periodic shoot reduction which remnants rest on the ground surface.
Lianas: Plants that grow supporting themselves on other plants or inanimate supports.
Phanerophytes. Plants, usually woody, with resting buds above 50 cm.
Nanophanerophytes. Plants with resting buds between 0.5 and 2 m height during the period of growth interruption.
Microphanerophytes. Resting buds between 2 and 5 m height.
Mesophanerophytes. Resting buds between 5 and 50 m height.

The Mediterranean vegetation series can be quite complex (Figure 15), in general substantially more than its Eurosiberian counterparts. The number of vegetation stages in the Portuguese Mediterranean vegetation series generally depends on the biogeographic and bioclimatic contexts. Some of its seral stages have more than one plant community. For example, the mesotrophic perennial grasslands communities are usually distinct in landscapes with a forest or with a low scrub community matrix. The same phenomenon happens with tall shrublands of *Cytisus* and *Genista* species.

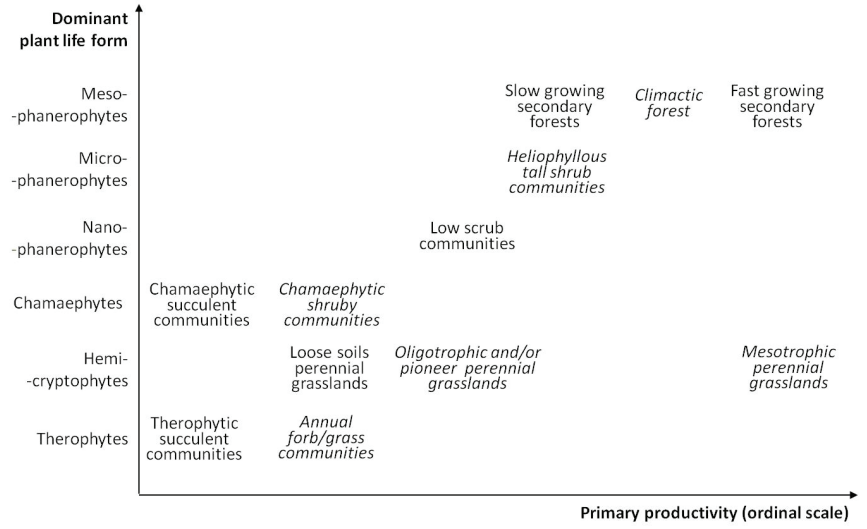

Figure 15. Diagrammatic representation of the Portuguese vegetation series phytocoenotic structure (Aguiar & Capelo ined.). In italics: seral stages present in the climatophilous vegetation series of the ultramafic rocks of northeastern Portugal.

Climatophilous vegetation series

The vegetation of the ultramafic rocks of northeastern Portugal was originally studied by Pinto da Silva (1970). Substantial progress has been achieved over the past twenty five years with new interpretations of the ecology of *Alyssum serpyllifolium* subsp. *lusitanicum* shrublands, the description of annual grasslands and, more recently, with the full understanding of the successional meaning of *Avenula lusitanica* communities and other perennial grasslands.

There is one unique climatophilous vegetation series in the ultramafic rocks of northeastern Portugal – the *Genisto hystricis-Querco rotundifoliae Sigmetum* – lead by forests of *Quercus rotundifolia* (*Genisto-Quercetum rotundifoliae*) (Figure 16 and Table 11). The holm oak (*Quercus rotundifolia*) is the only *Quercus* species that withstands harsh serpentine effects. Although being a colonial species, *Quercus pyrenaica*, the dominant tree of supramediterranean forests in northeastern Portugal, simply doesn't colonize serpentine soils. *Q. suber* and *Q. faginea* subsp. *faginea* can, sometimes, coexist with *Q. rotundifolia* in soils with a mild serpentine effect.

Substratum toxicity has a depressive effect on tree cover, height and productivity, as well as in *Q. rotundifolia* forest resilience and resistance to disturbance. Consequently, heliophilous shrubs like *Cistus ladanifer* and *Genista hystrix* reach a high cover naturally in these forests and increase their proneness to wildfires. The low forest resilience, and the severity and short recurrence cycles of wildfires and herbivory disturbances, through a complex cause-effect chain, increase soil erosion susceptibility and soil toxicity, and slow down pedogenesis. Consequently, ultramafic vegetal landscapes are composed of diversified successional vegetation mosaics (Figure 16) whose interpretation is a source of a grateful ecological and phytosociological experience.

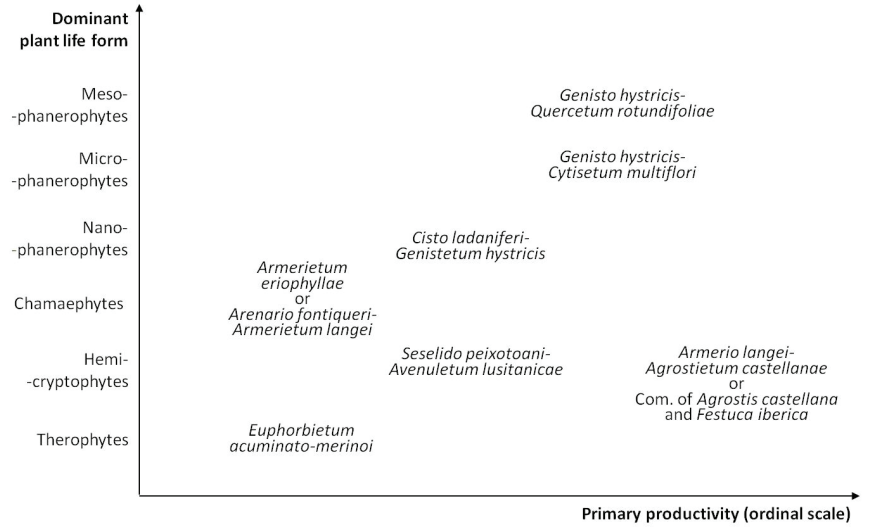

Figure 16. A diagrammatic representation of the *Genisto hystricis-Querco rotundifoliae Sigmetum*, the climatophilous vegetation series of the ultramafic rocks of northeastern Portugal.

The most conspicuous seral substitution stage of the ultramafic *Q. rotundifolia* forests is a shrub formation of *Cistus ladanifer* (*Cisto ladaniferi-Genistetum hystricis*, Table 11, Figure 17). This heliophilous, aromatic and highly inflammable vegetation is poor in shrub species. In addition to *C. ladanifer* (*Cistaceae*) there are common *Helichrysum stoechas* (*Asteraceae*) and a few *Lamiaceae* like *Lavandula pedunculata* and *Thymus mastichina*. Deeper soils derived from ultramafic rocks, chiefly in concave physiographies in the midst of forest dominated seral mosaics, under low disturbance regimes, are more suitable to tall shrub communities composed of nanophanerophytes of *Genisteae* tribe (family *Fabaceae*, e.g. *Cytisus scoparius* e *C. multiflorus*), of the *Genisto hystricis-Cytisetum multiflori* (Table 11, Figure 17).

Figure 17. *Cistus ladanifer* (*Cistaceae*) (left), *Cytisus scoparius* (*Fabaceae*) (right)

Large areas of rocky soil surfaces stripped of large biomass vegetation is a common characteristic of many serpentine areas around the world. In northeastern Portugal these soils – leptosols – harbour two important endemics rich vegetation types: the pioneer tall perennial grasslands of the *Seselido-Avenuletum lusitanicae* (Figure 20), and the chamaephytic shrubby communities of the *Armerietum eriophyllae* (Figure 18) in the Bragança ultramafic outcrops, or of the *Arenario fontiqueri-Armerietum langei* in the Morais massif (Table 6). An immediate conclusion of this empirical observation is that successional progression, achieved through fire and herbivory suppression, endangers endemic plant populations.

Chamaephytic shrubby communities have a low plant cover and are composed of prostrate perennial plants adapted to colonize small soil pockets in near horizontal, thin, rocky soils. These plants usually have a strong root system, capable of resisting the effects of sheet erosion. The chamaephytic shrubby communities coexist with highly diverse annual oligotrophic forb/grass communities like the *Euphorbietum acuminato-merinoi* described in Table 11, Figure 19.

Figure 18. *Armerietum eriophyllae* (*Armerion eriophyllae*), punctuated by the flowering *Alyssum serpyllifolium* subsp. *lusitanicum* (with yellow flowers)

Figure 19. *Tuberaria guttata* (*Cistaceae*) (left), *Euphorbia falcata* (*Euphorbiaceae*) (right)

The dominant plants of tall pioneer perennial grasslands (*Seselido-Avenuletum lusitanicae*) – e.g. *Koeleria crassipes* and the endemic *Avenula lusitanica* – display a phalanx strategy in colonial growth (Figure 20). The tightly packed colonial ramets spread slowly from putative seed growths, conquering space and gathering soil around them brought from above by rainwater superficial flow. With time, these small fertility islands coalesce and appear to have a facilitating effect on the species of other successional stages (e.g. mesotrophic perennial grasslands). This slow (secular?) course leads to the exclusion of chamaephytic shrubby community species, unless herbivore, fire or landslide disturbance resets the process.

Figure 20. Pioneer tall perennial grasslands (*Seselido-Avenuletum lusitanicae, Potentillo montanae-Brachypodion rupestris*) (above). *Armerio daveaui-Agrostietum castellanae* (*Armerion eriophyllae*) (below). *Nota bene* the dry silver capitula of *Armeria langei* subsp. *daveaui*

Mesotrophic perennial grassland species are much more productive and palatable to mammal herbivores than pioneer communities' characteristic plants.There frequently occur in forest clearings the *Armerio daveaui-Agrostietum castellanae*, a grassland of *Armeria langei* subsp. *daveaui*, *Agrostis castellana* and *Centaurea langei* (Table 11, Figure 20). The *Festuca iberica* and *Agrostis castellana* community develops in coluvial soils (regosols), in open, forest free, ultramafic landscapes.

Figure 21. *Seseli montanum* subsp. *peixotoanum* (*Apiaceae*) (left), *Reseda virgata* (*Resedaceae*) (right)

Table 11. Successional stages of the *Genisto hystricis-Querco rotundifoliae Sigmetum* in the ultramafic rocks of northeastern Portugal

Climactic forest

***Genisto-Quercetum rotundifoliae*. Representative relevé:** Mesophanerophytes (trees): *Quercus rotundifolia* 5. Microphanerophytes (tall shrubs): *Erica arborea* +, *Arbutus unedo* +. Nanophanerophytes: *Genista hystrix* 2, *Cistus ladanifer* 1, *Alyssum serpyllifolium* subsp. *lusitanicum* +. Lianas: *Rubia peregrina* 1. Ferns: *Asplenium adiantum-nigrum* subsp. *corunnense* +, *A. onopteris* 1. Hemicryptophytic forbs: *Acinos meridionalis* +, *Anarrhinum bellidifolium* +, *Anthyllis sampaiana* +, *Arabis stenocarpa* r, *Arenaria montana* 1, *Biscutella valentina* +, *Campanula rapunculus* +, *Clinopodium arundanum* +, *Digitalis purpurea* r, *Galium mollugo* +, *Galium papillosum* 1, *Filipendula vulgaris* 1, *Luzula forsteri* r, *Sanguisorba verrucosa* +, *Sedum forsterianum* 1, *Silene nutans* +. Hemicryptophytic grasses: *Anthoxanthum odoratum* 1, *Brachypodium rupestre* 1, *Dactylis hispanica* 1. Therophytic forbs: *Geranium purpureum* +, *Jasione montana* var. *montana* + [Vinhais: Soeira, just in front of the trout farm; Aguiar 2002]

Heliophilous tall shrub communities

***Genisto hystricis-Cytisetum multiflori*. Representative relevé**: Microphanerophytes (tall shrubs): *Cytisus scoparius* 4. Nanophanerophytes: *Cytisus multiflorus* +, *Genista hystrix* 2, *Lavandula pedunculata* 2. Tall chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* +, *Thymus mastichina* 2. Hemicryptophytic forbs: *Sedum forsterianum* +, *Centaurea langei* +. Hemicryptophytic grasses: *Agrostis castellana*. Therophytic forbs: *Centaurium erythraea* 1. [Bragança: Alimonde, road to Vila Boa de Ousilhão; Aguiar 2002].

Scrub communities

***Cisto ladaniferi-Genistetum hystricis*. Representative relevé:** Mesophanerophytes (trees): *Quercus rotundifolia* +. Nanophanerophytes: *Cistus ladanifer* 3, *Genista hystrix* +, *Lavandula pedunculata* var. *pedunculata* 2, *Doronicum pentaphyllum* +. Tall chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* +, *Helichrysum stoechas* 2, *Thymus mastichina* +, *Santolina semidentata* +. Small chamaephytes: *Jasione crispa* subsp. *sessiliflora* +, *Thymus zygis* +. Hemicryptophytic forbs: *Pilosella pseudopilosella* +, *Sanguisorba verrucosa* +. Hemicryptophytic grasses: *Avenula sulcata* +. Annual forbs:

Tuberaria guttata +, *Lathyrus angulatus* +, *Leontodon longirostris* +, *Trifolium campestre* +, *Orobanche gracilis* +, *Vicia disperma* r [Bragança, Moinho dos Padres; Aguiar 2002]

Chamaephytic shrubby communities

***Armerietum eriophyllae*. Representative relevé:** Small chamaephytes: *Armeria eriophylla* 1, *Arenaria querioides* subsp. *fontiqueri* 1, *Dianthus laricifolius* subsp. *marizii* +, *Plantago holosteum* 2. Hemicryptophytic forbs: *Seseli montanum* subsp. *peixotoanum* +. Hemicryptophytic grasses: Koeleria crassipes +, *Poa bulbosa* 2. Cryptophytes: *Allium vineale* +, *Ornithogalum concinnum* +. Therophytic forbs: *Logfia minima* +, *Moenchia erecta* 1, *Scleranthus polycarpos* 1, *Sedum lagascae* 1, *Spergula morisonii* +, *Teesdalia coronopifolia* +. Therophytic grasses: *Anthoxanthum aristatum* 1, *Micropyrum tenellum* +, *Molineriella laevis* 1 [Bragança, between Grandais and Portela, Monte Ladeiro; Pinto da Silva 1970]

***Arenario fontiqueri-Armerietum langei*. Representative relevé:** Small chamaephytes: *Armeria langei* subsp. *marizii* 1, *Plantago holosteum* 2, *Arenaria querioides* subsp. *fontiqueri* 1, *Dianthus laricifolius* subsp. *marizii* 1. Hemicryptophytic forbs: *Herniaria scabrida* subsp. *scabrida* 1, *Sanguisorba verrucosa* +, *Saxifraga granulata* +, *Seseli montanum* subsp. *peixotoanum* +, *Reseda virgata* +. Hemicryptophytic grasses: *Koeleria crassipes* +, *Poa bulbosa* 2, *Dactylis hispanica* 1. Therophytic forbs: *Tuberaria guttata* 1, *Leontodon longirostris* 1, *Cerastium brachypetalum* 1, *Linaria amethystea* +, *Trifolium campestre* +, *Asterolinon linum-stellatum* +, *Euphorbia falcata* subsp. *falcata* var. *acuminata* 1, *Galium parisiense* +, *Moenchia erecta* +. Therophytic grasses: *Aira cupaniana* +, *Brachypodium distachyon* 1, *Vulpia ciliata* + [Macedo de Cavaleiros: Vinhas, Castro Roupal, Monte de Morais; Aguiar *et al.* 1998]

Mesotrophic perennial grasslands

***Armerio daveaui-Agrostietum castellanae*. Representative relevé: Representative relevé:** Small chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* +. Hemicryptophytic grasses: *Agrostis castellana* 5, *Dactylis hispanica* +. Hemicryptophytic forbs: *Armeria langei* subsp. *daveaui* 1, *Centaurea langei* 1, *Seseli montanum* subsp. *peixotoanum* 1. Cryptophytes: *Allium sphaerocephalon* +. [Bragança: Carrazeda; Aguiar et al., ined]

Community of *Festuca iberica* and *Agrostis castellana*. Representative relevé: Small chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* 2, *Plantago holosteum* 1. Hemicryptophytic grasses: *Agrostis castellana* 5, *Arrhenatherum elatius* subsp. *bulbosum* +, *Brachypodium rupestre* +, *Dactylis hispanica* 1, *Festuca iberica* 2. Hemicryptophytic forbs: *Centaurea langei* 2, *Gladiolus italicus* +, *Seseli montanum* subsp. *peixotoanum* +, *Sanguisorba verrucosa* +. Cryptophytes: *Allium sphaerocephalon* 1, *Allium guttatum* subsp. *sardoum* 1, *Asphodelus serotinus* 1. Therophyts: *Anthoxanthum aristatum* 1, *Leontodon longirostris* + [Bragança: Macedo de Cavaleiros, Talhinhas, Gralhós, próximo da pedreira; Aguiar et al., ined]

Pioneer tall perennial grasslands

***Seselido-Avenuletum lusitanicae*. Representative relevé:** Nanophanerophytes: *Genista hystrix* 1. Tall chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* +, *Helichrysum stoechas* 1, *Santolina semidentata* 1. Small chamaephytes: *Asperula aristata* 1, *Dianthus laricifolius* subsp. *marizii* +, *Plantago holosteum* 1. Hemicryptophytic forbs: *Centaurea langei* 1, *Reseda virgata* 1, *Seseli montanum* subsp. *peixotoanum* 1. Hemicryptophytic grasses: *Avenula lusitanica* 4, *Agrostis castellana* 2, *Koeleria crassipes* 1. Cryptophytes: *Allium guttatum* subsp. *sardoum* + [Macedo de Cavaleiros, Castro Roupal, Monte de Morais; Aguiar *et al*., ined.]

Annual forb/grass communities

***Euphorbietum acuminato-merinoi*. Representative relevé**: Hemicryptophytic forbs: *Sanguisorba verrucosa* +. Therophytic forbs: *Asterolinon linum-stellatum* +, *Brachypodium distachyon* 1, *Euphorbia exigua* subsp. *merinoi* 1, *Euphorbia falcata* subsp. *fal-*

cata var. *acuminata* +, *Galium parisiense* 1, *Leontodon longirostris* 1, *Linum trigynum* 2, *Petrorhagia nanteuilii* +, *Trifolium arvense* 2, *Tuberaria guttata* 2, *Crucianella angustifolia* 1, *Hymenocarpos lotoides* 1, *Hypochaeris glabra* 1, *Lathyrus angulatus* +, *Linaria amethystea* r, *Logfia minima* 1, *Sherardia arvensis* +, *Trifolium bocconei* 1, *T. campestre* 1, *T. striatum* + [Bragança, Grandais; Aguiar 2002]

Legend: Plants cover-abundance evaluated with Braun-Blanquet scale (see Table 10).

Particular vegetation types

Rupicolous vegetation

Exposure to the sun is a major factor in the assembling of rupicolous vegetation. The two most notable rupicolous phytocoenosis of the NE Portugal serpentines, the *Umbilico-Asplenietum corunnensis* and the *Notholaenetum marantae*, are characteristic, respectively, of sciophilous and sun exposed rock crevices (Table 12). The dominant species of the first association, the *Asplenium adiantum-nigrum* subsp. *corunnense* (*Aspleniaceae*), is a serpentinophyte endemic of Iberian Peninsula. *Notholaena marantae* (*Pteridaceae*) is a serpentinicolous relict of a substantial number of European ophiolites.

Figure 22. *A) Asplenium adiantum-nigrum* subsp. *corunnense* (*Aspleniaceae*). B) *Notholaena marantae* (*Pteridaceae*)

Table 12. Floristic composition of the main rupicolous associations of NE Portugal ultramafic outcrops

Umbilico-Asplenietum corunnensis. **Representative relevé:** Ferns: *Asplenium adiantum-nigrum* subsp. *corunnense* 2. Small chamaephytes: *Jasione crispa* subsp. *sessiliflora* +, *Saxifraga fragosoi* +, *Umbilicus rupestris* +. Hemicryptophytes: *Silene legionensis* +, *Festuca* sp. 1. Annual forbs: *Asterolinon linum-stellatum* + [Bragança, Carrazedo; Pinto da Silva 1970]

Notholaenetum marantae**. Representative relevé:** Ferns: *Notholaena marantae* 4, *Asplenium ceterach* +. Tall chamaephytes: *Alyssum serpyllifolium* subsp. *lusitanicum* +. Small chamaephytes: *Dianthus laricifolius* subsp. *marizii* +, Hemicryptophytic forbs: *Linaria saxatilis* +, *Herniaria scabrida* subsp. *scabrida* +. Therophytic forbs: *Leontodon longirostris* +, *Teesdalia nudicaulis* +. Therophytic grasses: *Micropyrum tenellum* 2. [Mogadouro, Piçarrão; Pinto da Silva 1970]

Legend: Plants cover-abundance evaluated with Braun-Blanquet scale (see Table 10).

Temporary wet soils

In wet years, in the middle of spring, the small depressionary areas of the habitat of the small rich endemic chamaephytic communities are filled with the lilac flowers of the succulent leaved *Sedum maireanum* (*Crassulaceae*) (Figure 23). This species is generally accompanied by other annuals adapted to temporarily wet soils, like *Spergularia segetalis* (*Caryophyllaceae*) (Figure 23), several species of annual *Juncus* (*Juncaceae*) and *Molineriella laevis* (*Poaceae*) (Table 13). This curious plant community can also be observed in holm oak (*Q. rotundifolia*) clearings, after the disturbance of the bryophyte covering by wild boars, an interesting ecological interaction between wild mammals and vascular plants.

Table 13. Floristic composition of the temporary wet soils phytocoenosis in NE Portugal ultramafic outcrops

***Spergulario segetalis-Sedetum maireani*. Representative relevé:** Succulent therophytes: *Sedum maireanum* 4. Other therophytes: *Rumex bucephalophorus* subsp. *gallicus* 1, *Jonopsidium abulense* 1, *Spergularia segetalis* 2, *Herniaria lusitanica* subsp. *lusitanica* 1, *Spergularia capillacea* 2, *Molineriella laevis* 1, *Mibora minima* +, *Juncus capitatus* 1, *Juncus bufonius* +, *Moenchia erecta* +, *Tuberaria guttata* +, *Logfia minima* +, *Anthoxanthum aristatum* subsp. *aristatum* +, *Leontodon longirostris* +, *Ranunculus paludosus* +. [Aguiar *et al*., ined.]

Legend: Plants cover-abundance evaluated with Braun-Blanquet scale (see Table 10).

Figure 23. *Sedum maireanum* (*Crassulaceae*) (left), *Spergularia segetalis* (*Caryophyllaceae*) (right)

Semi-nitrophilous vegetation

Soil disturbance promotes an immediate influx of semi-nitrophilous species in NE Portugal serpentines. Old cereal fields on coluvial soils, rural roads and quarries are frequent habitats for semi-nitrophilous vegetation. The process of freeze and

thaw, and soil erosion and deposition, apparently also encourage semi-nitrophilous plants. Two associations predominate in regional ultramafic semi-nitrophilous vegetation mosaics: the annual *Trifolio-Taeniatheretum capitis-medusae* (Figure 24), and the shrubby *Alysso lusitanici-Santolinetum semidentatae* (Table 14, Figure 24). The nickel bioaccumulator *Alyssum serpyllifolium* subsp. *lusitanicum* (Figure 25), although omnipresent in almost all the serpentine vegetation types, reaches its phytosociological optimum in disturbed habitats, amid other semi-nitrophilous species.

Figure 24. *A) Taeniatherum caput-medusae* (*Poaceae*) (left), *Santolina semidentata* (*Asteraceae*) (right)

Figure 25. *Alyssum serpyllifolium* subsp. *lusitanicum* (*Brassicaceae*).

Table 14. Floristic composition of the main semi-nitrophilous vascular plant communities of NE Portugal ultramafic outcrops

***Trifolio cherleri-Taeniatheretum capitis-medusae* Representative relevé:** Tall chamaephytes**:** *Alyssum serpyllifolium* subsp. *lusitanicum* 2, Hemicryptophytic forbs: *Andryala integrifolia* +, *Convolvulus arvensis* 1, *Crepis capillaris* +, *Herniaria scabrida* 1, *Hypochaeris radicata* +, *Scorzonera angustifolia* r. Hemicryptophytic grasses: *Agrostis castellana* 1, *Cynodon dactylon* +. Annual forbs: *Anthemis arvensis* +, *Chondrilla juncea* +, *Eryngium tenue* 1, *Hispidella hispanica* +, *Hymenocarpos lotoides* 1, *Leontodon longirostris* 1, *Logfia minima* +, *Petrorhagia nanteuilii* +, *Rumex gallicus* 1, *Trifolium angustifolium* +, *T. arvense* 2, *T. cherleri* 1, *T. dubium* 1, *T. glomeratum* 1, *T. striatum* 1. Annual grasses: *Aegilops triuncialis* 2, *Bromus tectorum* +, *Lolium rigidum* +, *Taeniatherum caput-medusae* 3, *Vulpia ciliata* +. [Vinhais: Vila Verde, rural road to Monte de Cabrões; Aguiar 2002]

***Alysso lusitanici-Santolinetum semidentatae*. Representative relevé.** Tall chamaephytes**:** *Santolina semidentata* 3, *Alyssum serpyllifolium* subsp. *lusitanicum* 2, *Helichrysum stoechas* 2. Small chamaephytes: *Jasione crispa* subsp. *sessiliflora* +, *Plantago holosteum* 1, *Arenaria querioides* subsp. *fontiqueri* 1. Hemicryptophytic forbs: *Herniaria scabrida* subsp. *scabrida* +. Hemicryptophytic grasses: *Dactylis hispanica* +, *Agrostis castellana* 1, *Poa bulbosa* 2. Annual grasses: *Taeniatherum caput-medusae* +. Annual forbs: *Trifolium arvense* +, *T. cherleri* 1, *T. hirtum* 1 [Bragança: Conlelas, between Conlelas and Alimonde; Aguiar 2002]

Legend: Plants cover-abundance evaluated with Braun-Blanquet scale (see Table 10).

Syntaxonomic scheme

ASPLENIETEA TRICHOMANIS (Br.-Bl. *in* Meier & Br.-Bl. 1934) Oberdorfer 1977

+ Androsacetalia vandellii Br.-Bl. *in* Meier & Br.-Bl. 1934

*** Cheilanthion hispanicae** Rivas Goday 1956

Asplenio billotii-Cheilanthetum hispanicae Rivas Goday in Sáenz & Rivas-Martínez 1979

+ Cheilanthetalia maranto-maderensis Sáenz & Rivas-Martínez 1979

*** Phagnalo saxatilis-Cheilanthion maderensis** Loisel 1970 *corr.* Sáenz & Rivas-Martínez 1979

Umbilico violacei-Asplenietum corunnensis P. Silva 1970 corr. Rivas-Martínez & Izco 2002

Notholaenetum marantae P. Silva 1970 *corr*. Capelo, Aguiar & J. Gomes Pedro 1996

CISTO-LAVANDULETEA Br.-Bl. in Br.-Bl., Molinier & Wagner 1940

+ Lavanduletalia stoechadis Br.-Bl. *in* Br.-Bl., Molinier & Wagner 1940 *em.* Rivas-Martínez 1968

*** Cistion laurifolii** Rivas Goday 1956

Cisto ladaniferi-Genistetum hystricis P. Silva 1970

CYTISETEA SCOPARIO-STRIATI Rivas-Martínez 1975

+ Cytisetalia scopario-striati Rivas-Martínez 1974

*** Genistion polygaliphyllae** Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984

Genisto hystricis-Cytisetum multiflori Rivas-Martínez, T. E. Díaz, F. Prieto, Loidi & Penas 1984

*** Ulici europaei-Cytision striati** Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 1991

Lavandulo sampaianae-Cytisetum multiflori Br.-Bl., P. Silva & Rozeira 1956

FESTUCO-BROMETEA Br.-Bl. & Tüxen ex Br.-Bl. 1949

+ Brometalia erecti Br.-Bl. 1936

*** Potentillo montanae-Brachypodion rupestris** Br.-Bl. 1967 corr.

Seselido peixotoani-Avenuletum lusitanicae Aguiar, Monteiro-Henriques & Sánchez-Mata ass. nova inéd.

FESTUCETEA INDIGESTAE Rivas Goday & Rivas-Martínez 1971

+ Jasiono sessiliflorae-Koelerietalia crassipedis Rivas-Martínez & Cantó 1987

*** Armerion eriophyllae** P. Silva 1970

Armerietum eriophyllae Pinto da Silva 1965

Arenario fontqueri-Armerietum langei Aguiar, Penas & Lousã 1998

HELIANTHEMETEA (Br.-Bl. in Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas-Martínez 1963 *em.* Rivas-Martínez 1978

+ Trachynietalia distachyae Rivas-Martínez 1978

*** Trachynion distachyae** Rivas-Martínez 1978

Euphorbietum acuminato-merinoi Aguiar & Penas 2002

Minuartio hybridae-Saxifragetum tridactylitidis T.E. Díaz & Penas 1984

ISOETO-NANOJUNCETEA Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946

+ Isoetalia Br.-Bl. 1936 *em.* Rivas Goday 1970

*** Cicendion** (Rivas Goday *in* Rivas Goday & Borja 1961) Br.-Bl. 1967

Spergulario segetalis-Sedetum maireani Aguiar, Monteiro-Henriques & Sánchez-Mata ass. nova inéd.

MOLINIO-ARRHENATHERETEA Tüxen 1937

+ Holoschoenetalia Br.-Bl. *ex* Tchou 1948

*** Molinio-Holoschoenion** Br.-Bl. *ex* Tchou 1948

**** Molinio-Holoschoenenion**

Com. de *Scirpus holoschoenus* e *Carex flacca*

PEGANO-SALSOLETEA Br.-Bl. & O. Bolòs 1958

+ Helichryso stoechadis-Santolinetalia squarrosae Peinado & Martínez Parras 1984

*** Artemisio glutinosae-Santolinion rosmarinifoliae** Costa 1975

Alysso lusitanici-Santolinetum semidentatae Aguiar, Penas & Lousã 1999

PHAGNALO-RUMICETEA INDURATI (Rivas Goday & Esteve 1972) Rivas-Martínez, Izco & Costa 1973

+ Phagnalo saxatilis-Rumicetalia indurati Rivas Goday & Esteve 1972

*** Rumici indurati-Dianthion lusitani** Rivas-Martínez, Izco & Costa *ex* V. Fuente 1986

Phagnalo saxatilis-Rumicetum indurati Rivas-Martínez ex F. Navarro & C.J. Valle 1984

*** Saxifragion continentalis** Rivas-Martínez *in* Rivas-Martínez, Fernández-González & Sánchez-Mata 1986

Sedo hirsuti-Saxifragetum continentalis Rivas-Martínez 1963

POETEA BULBOSAE Rivas Goday & Rivas-Martínez in Rivas-Martínez 1978

+ Poetalia bulbosae Rivas Goday & Rivas-Martínez *in* Rivas Goday & Ladero 1970

*** Trifolio subterranei-Periballion** Rivas Goday 1964

Festuco amplae-Poetum bulbosae Rivas-Martínez & Fernández-González in Rivas-Martínez, Fernández-González & Sánchez-Mata 1986

QUERCETEA ILICIS Br.-Bl. ex A. & O. Bolòs 1950

+ Quercetalia ilicis Br.-Bl. ex Molinier 1934 em. Rivas-Martínez 1975

*** Quercion broteroi** Br.-Bl., P. Silva & Rozeira 1956 corr. V. Fuente 1986 em. Rivas-Martínez 1975

**** Paeonio broteroi-Quercenion rotundifoliae** Rivas-Martínez in Rivas-Martínez, Costa & Izco 1986

Genisto hystricis-Quercetum rotundifoliae P. Silva 1975

STELLARIETEA MEDIAE Tüxen, Lohmeyer & Preising *ex* von Rochow 1951

CHENOPODIO-STELLARIENEA Rivas Goday 1956

+ Brometalia rubenti-tectorum Rivas-Martínez & Izco 1977

*** Taeniathero-Aegilopion geniculatae** Rivas-Martínez & Izco 1977

Trifolio cherleri-Taeniatheretum capitis-medusae Rivas-Martínez & Izco 1977

STIPO GIGANTEAE-AGROSTIETEA CASTELLANAE Rivas-Martínez, Fernández-González & Loidi 1999

+ Agrostietalia castellanae Rivas Goday in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980

*** Agrostion castellanae** Rivas Goday 1958 corr. Rivas Goday & Rivas-Martínez 1963

Armerio daveaui-Agrostietum castellanae Aguiar, Monteiro-Henriques & Sánchez-Mata ass. nova inéd.

Com. of *Festuca iberica* and *Agrostis castellana*

8. Excursion

Itinerary

Monte de Morais (Macedo de Cavaleiros)

Monte de Morais emerges in the landscape in the shape of a small dome. Due to the lack of agricultural value in its soil, the Monte de Morais is a communal area, shared by five village communities. The serpentine vegetation of Monte de Morais seems very homogeneous at first glance. However, a more careful analysis reveals that vascular plants appear to be organized in several complex vegetation mosaics.

The scattered trees of holm oak (*Quercus rotundifolia, Fagaceae*) are a testimony to the climactic forests that dominated the regional landscape before the advent of the Neolithic food production modes. A dense tree and shrub cover is incompatible with extensive grazing because the best indigenous fodder plants are heliophilous. Fire was the main tool used in the conversion of the primeval forests into grasslands, and it is still widely used in the control of vegetation progressive succession.