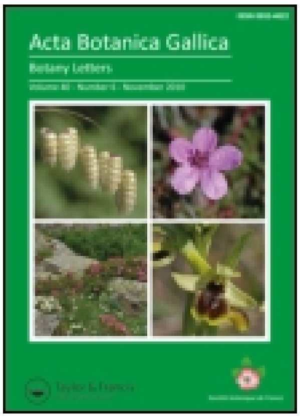

Acta Botanica Gallica
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tabg20

The Algarve climatophilous vegetation series-Portugal: a base document to the planning, management and nature conservation Les séries de végètation climatophiles de l'Algarve - Portugal: un document de base pour la planification, gestion et conservation de la nature

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To cite this article: Ricardo Quinto-Canas , Carlos Vila-Viçosa , Rodrigo Paiva-Ferreira , Ana Cano-Ortiz & Carlos Pinto-Gomes (2012): The Algarve climatophilous vegetation series-Portugal: a base document to the planning, management and nature conservation Les séries de végètation climatophiles de l'Algarve - Portugal: un document de base pour la planification, gestion et conservation de la nature, Acta Botanica Gallica, 159:3, 289-298

To link to this article: http://dx.doi.org/10.1080/12538078.2012.737150

Acta Botanica Gallica: Botany Letters
Vol. 159, No. 3, September 2012, 289–298

Taylor & Francis
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The Algarve climatophilous vegetation series – Portugal: a base document to the planning, management and nature conservation

Les séries de végètation climatophiles de l'Algarve - Portugal: un document de base pour la planification, gestion et conservation de la nature

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Abstract: This work was developed as part of PhD research devoted to the flora and vegetation of the Caldeirão and Monchique mountains that aims to identify the vegetation climatophilous series and use them as an environmental diagnosis of Algarve administrative province phyto-ecological subregions. Biogeographic and bioclimatic considerations are presented, as well as the study area pedological and lithological characterization. For each of the seven climatophilous series the dynamic and catenal behaviours, as well as the main characteristic plants that constitute the successional stages, are given. The corresponding patrimonial value is studied.

Keywords: Algarve; climatophilous series; land use planning; phytosociology.

Resumé: Ce travail a été élaboré dans le cadre de recherches d'un doctorat consacré à la flore et végétation des montagnes de Monchique et Caldeirão, ayant pour objectif d'identifier et d'utiliser les séries de végétation climatophiles comme un diagnostic environnemental des sous-régions phyto-écologiques de la province administrative de l'Algarve. Nous présentons d'abord des considérations biogegraphiques et bioclimatiques, ainsi que les caractérisations pédologiques et lithologiques de la zone d'étude. Pour chacune des sept séries climatophiles sont évalués les comportements dynamique et caténale, ainsi que les principales plantes caractéristiques qui en constituent les étapes de succession, et la valeur patrimoniale correspondante.

Mots clés: Algarve; Série climatophile; Aménagement du territoire; Phytosociologie.

Introduction

The landscape as a dynamic system gives a particular configuration and unity to the Algarve region. Within this region three landscape subunits of distinct character and identity can be recognized: (1) *Faixa Litoral*; (2) *Barrocal*; and (3) *Serra Algarvia*.

The study area covers the southernmost territorial unit of mainland Portugal, and represents about 10% of the country's main area. It is bordered in the north by the rolling topography of Alentejo and in the south by the *Faixa Litoral* lowlands. To the east it is delimited by the Guadiana valley and to the west by the littoral oceanic platform. Algarve is dominated by low, gently hilly lands, but includes two mountainous systems – Monchique (in the west) and Caldeirão (in the east) – separated by the Hercynian, north-west to south-east oriented depression of S. Marcos-Quarteira (Feio 1951). These mountain systems contact in the south with a thin strip of gres, ophites, basalt and dolerite rocks dating from the Triassic, where the transition to the *Barrocal*, also known as limestone Algarve, takes place (Gouveia 1938). The latter is delimited to the south by the Algarve coastal plain.

The *Serra Algarvia* pedology, with the exception of the syenitic soils (Psn, Mns) of the Serra de Monchique massif, is characterized by the predominance of incipient soils (Ex) resulting from schists and greywackes. In contrast, the limestone formation of *Barrocal* is dominated by the marly alkaline soils (Vc, Pc), red and yellow mediterranean soils (Vcd) typically associated with limestone outcroppings (Arc), and clay-rich marly vertic soils. Finally, along the *Faixa Litoral*, by fluvial sedimentation, there are red and grey litholic soils (Vtc) and red and yellow mediterranean soils (Vtc). Following

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ISSN 1253-8078 print/ISSN 2166-3408 online

http://dx.doi.org/10.1080/12538078.2012.737150
http://www.tandfonline.com

the last holozonal regression, dunes have formed close to the coast, covered with a layer of sand (Rg) with varying thickness. In the west coast, these sands are highly acidified and podzolic (Pz) (Kopp et al. 1989).

In a biogeographical context and following Rivas-Martínez (2005, 2007) and Costa et al. (1998), the Algarvian territories include the "Monchiquense" Districts which belong to the Marianic-Monchiquensean Sector, Lusitan-Extremadurean Subprovince, Mediterranean West Iberian Province, and the "Costeiro Altoalgárbico", "Promontório Vicentino" and "Algárbico" Districts which belong to the Algarvian Sector, Gaditan-Algarvian Subprovince, Coastal Lusitan-Andalusian Province (Figure 1).

Bioclimatically (Table 1), the study area has a strong oceanic influence, dominating the thermomediterranean thermotype. However, in Foia (Monchique mountains) and Ameixial (Caldeirão mountains) the bioclimate is mainly upper and lower mesomediterranean, respectively.

Currently, the occurrence of such mature grove formations is becoming exceptionally rare, which can be attributed to the long-lasting impact of human agroforestry and grazing land-use practices (Quinto-Canas et al. 2010).

Flora and vegetation studies by Pinto-Gomes and Paiva-Ferreira (2005a) have included areas belonging to the Algarve territory. However, a comprehensive study concerning the climatophilous series of vegetation present in the administrative region of Algarve is still lacking.

For the correct management and conservation of biodiversity it is imperative to diagnose the climatophilous series of vegetation in Algarve, as well as their dynamics and respective successional stages and catenal relationships, which possesses a considerable number of habitats and species of great patrimonial value and conservational status.

Methods

Taxa identification was made following Coutinho (1939), Tutin et al. (1964–1980), Franco (1971–84), Castroviejo (1986–2010), Aedo and Herrero (2005), Valdés, Talavera, and Fernández-Galiano (1987) and Franco and Rocha Afonso (1994–2003). Taxonomical and sintaxonomical nomenclature followed Rivas-Martínez et al. (2001, 2002). The climatophilous vegetation series study followed the phytosociological approach (Braun-Blanquet 1965; Géhu and Rivas-Martínez 1981) and its diagnosis followed past works from Braun-Blanquet, Silva, and Rozeira (1964), Rivas Goday and Rivas Martínez (1967), Malato-Beliz (1982, 1986), Lousã et al. (1989), Rivas-Martínez et al. (1980, 1990), Rivas-Martínez (1979, 2011), Capelo (1996), Capelo (1996), Costa (1991), Costa et al. (1998), Pinto-Gomes and Paiva-Ferreira (2005a, b), Pinto-Gomes, Paiva-Ferreira, and Meireles (2007, 2010), Pinto-Gomes et al. (2008, 2012) and Quinto-Canas et al. (2010).

The biogeographical and bioclimatic information followed Costa et al. (1998), Rivas-Martínez (2005, 2007), Pinto-Gomes and Paiva-Ferreira (2005a).

Results and Discussion

Each series dynamics identified in the study area is presented briefly, highlighting the main characteristics of its successional stages, as well as the natural or semi-natural habitats that it may incorporate and its asset value. Considering the phytosociological studies developed in Algarve, seven vegetation climatophilous series were diagnosed, distributed in two distinct biogeographic sectors.

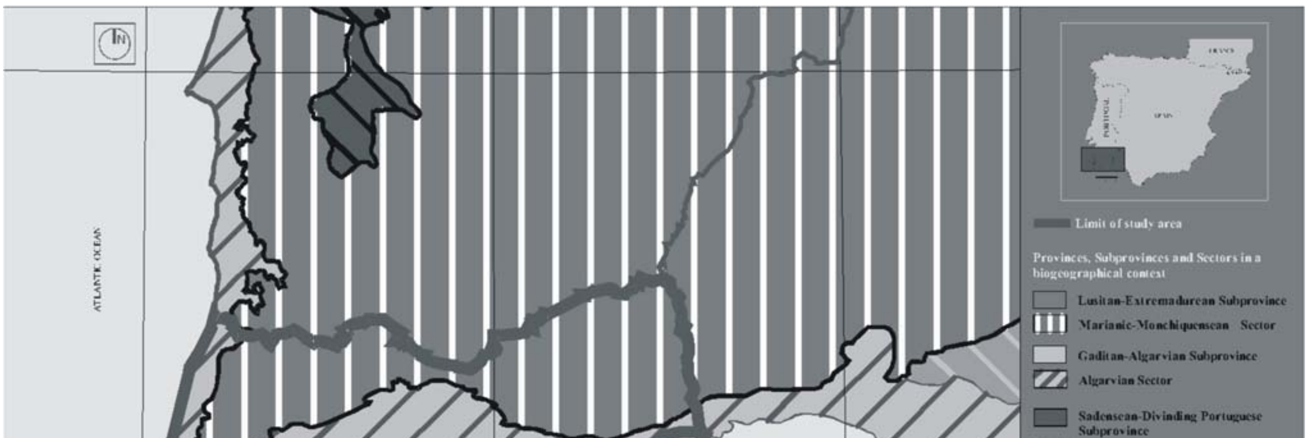

Figure 1. Biogeography of study area (Costa et al. 1998; Rivas-Martínez 2005; Pinto-Gomes and Paiva-Ferreira 2005a).
Figure 1. Biogéographie de la zone d'étude (Costa et al. 1998; Rivas-Martínez 2005; Pinto-Gomes et Paiva-Ferreira 2005a).

Table 1. Climatic variables and bioclimatic parameters of the region (Pinto-Gomes and Paiva-Ferreira 2005a, 2005b; Rivas-Martínez 2005; Quinto-Canas et al. 2010).
Tableau 1. Variables climatiques et índices bioclimatiques de la région (Pinto-Gomes and Paiva-Ferreira 2005a, 2005b; Rivas-Martínez 2005; Quinto-Canas et al. 2010).

Station	Alt	T	M	m	Tp	It/Itc	Ic	Io	Pp	Bioclimatic diagnosis
Faro	8	17.0	16.1	7.9	204.0	410	11.2	2.52	514.0	Mediterranean, Pluvistational, Semihyperoceanic, Lower thermomediterranean, Lower dry
Quarteira	4	16.6	14.4	7.8	198.8	387	11.7	2.27	450.0	Mediterranean, Pluvistational, Semihyperoceanic, Upper thermomediterranean, Lower dry
Tavira	25	16.9	15.4	7.3	203.0	396	12.3	2.89	587.0	Mediterranean, Pluvistational, Semihyperoceanic, Upper thermomediterranean, Upper dry
S. Brás de Alportel	240	15.9	13.8	6.2	190.9	359	13.2	4.58	874.0	Mediterranean, Pluvistational, Euoceanic, Upper thermomediterranean, Lower subhumid
Ameixial	260	16.9	13.0	4.7	202.8	346	14.8	2.40	488.0	Mediterranean, Pluvistational, Euoceanic, Lower mesomediterranean, Lower dry
Caldas de Monchique	–	17.0	15.2	7.5	204.0	397	12.8	5.3	1076.9	Mediterranean, Pluvistational, Semihyperoceanic, Lower thermomediterranean, Upper subhumid
Fóia	–	12.2	9.1	4.5	146.4	258	12.7	10.4	1526.1	Mediterranean, Pluvistational, Semihyperoceanic, Upper mesomediterranean, Upper humid
Monchique	–	15.2	12.9	7.0	182.4	351	12.0	7.1	1300.9	Mediterranean, Pluvistational, Semihyperoceanic, Lower thermomediterranean, Lower humid
Praia da Rocha	–	16.9	15.5	8.0	202.4	404	11.3	2.2	454.6	Mediterranean, Pluvistational, Semihyperoceanic, Lower thermomediterranean, Lower dry
Sagres	–	16.3	15.5	10.3	195.6	421/ 414 (C=7)	7.3	2.5	483.2	Mediterranean, Pluvistational, Euhyperoceanic, Lower thermomediterranean, Lower dry
Vila do Bispo	–	16.2	15.1	9.3	194.4	406	8.5	2.9	560.0	Mediterranean, Pluvistational, Subhyperoceanic, Lower thermomediterranean, Lower dry
V. R. S. António	7	17.1	16.6	6.2	205.3	399	13.2	2.4	488.2	Mediterranean, Pluvistational, Semihyperoceanic, Upper thermomediterranean, Lower dry

Climatophilous relictual series, algarvian, thermomediterranean, subhumid to humid, from Portuguese Oak* (Quercus faginea *subsp.* alpestris)*:* Querco alpestris–broteroi *sigmetum

Serial dynamics

Relictual series from marcescent oak, typical from marly limestones of Algarvian *Barrocal*, thermomediterranean, subhumid to humid bioclimatic stage, exclusive to the Algarve (Pinto-Gomes and Paiva-Ferreira 2005a).

The mature stage corresponds to a Portuguese oak woodland dominated by *Quercus faginea* subsp. *alpestris*, in a dense and pluri-stratified canopy, containing such species as *Quercus faginea* subsp. *broteroi*, *Clematis flammula*, *Hedera maderensis* subsp. *iberica*, *Aristolochia baetica* and *Smilax aspera* var. *altissima* (Table 2). As fringe and first substitution step, there is mesophytic strawberry tree scrubland from *Aristolochio baeticae–Arbutetum unedonis*, dominated by *Arbutus unedo* and *Bupleurum fruticosum*. With the elimination of tree and shrub cover, the maquis yields, in the active lime-rich soils, to thyme and gorse scrublands *Thymo lotocephali–Coridothymetum capitati* and *Siderito lusitanicae–Genistetum algarbiensis*, respectively. In this stage we can separate the occurrence of typical species, such as *Genista hirsuta* subsp. *algarbiensis*, *Sideritis arborescens* subsp. *lusitanica*, *Thymus lotocephalus*, *Serratula baetica* subsp. *lusitanica* and *Bellevalia hackelii*. In decarbonated soils,

Table 2. *Querco alpestris–broteroi* sigmetum dynamics (Pinto-Gomes and Paiva-Ferreira 2005a).
Tableau 2. Dynamique du *Querco alpestris–broteroi* sigmetum (Pinto-Gomes et Paiva-Ferreira 2005a).

Vegetation physiognomy	Associations	Bioindicators
Portuguese Oak grove	*Quercetum alpestris–broteroi*	*Quercus faginea* subsp. *alpestris; Quercus canariensis; Quercus faginea* subsp. *broteroi; Clematis flammula; Aristolochia baetica*
Machis scrubland	*Aristolochio baeticae–Arbutetum unedonis*	*Arbutus unedo; Bupleurum fruticosum.*
Gorse scrubland	*Siderito lusitanicae–Genistetum algarbiensis*	*Genista hirsuta* subsp. *algarbiensis; Sideritis arborescens* subsp. *lusitanica; Staehelina dubia*
Perennial grasslands	*Galio concatenati–Brachypodietum phoenicoidis*	*Brachypodium phoenicoidis; Eryngium dilatatum; Galium concatenatum; Serratula baetica* subsp. *lusitanica* var. *lusitanica*
Thyme shrublands	*Thymo lotocephali–Coridothymetum capitati*	*Thymus lotocephalus; Thymbra capitata; Fumana thymifolia*
Annual grasslands	*Velezio rigidae–Astericetum aquaticae*	*Asteriscus aquaticus; Cleonia lusitanica*

these scrublands give place to *Phlomido purpureae–Cistetum albidi*, dominated by *Cistus albidus*, *Cistus monspeliensis* and *Phlomis purpurea*.

In the shrubland clearings, there are therophytic communities from a *Velezio rigidae–Astericetum aquaticae* association (*Asteriscus aquaticus* and *Cleonia lusitanica*), which evolves under grazing pressure to *Medicagini rigidulae–Aegilopetum geniculatae* grasslands or, in trampled soils, to the *Trifolio subterranei–Plantaginetum serrariae* communities. Grazing also promotes perennial grasslands dominated by hemicryptophytes such as *Brachypodium phoenicoides*, belonging to the *Galio concatenati–Brachypodietum phoenicoidis* association. Where grazing is not fully implemented and periodic soil mobilizations are present, the *Thymo lotocephali–Coridothymetum capitati* (Pinto-Gomes and Paiva-Ferreira 2005a) communities appear. Above this, we can find on rocky outcrops of dolomitic limestones, cosmophytic vegetation with very rare plants such as *Asplenium petrarchae* and *Narcisso calcicolae-gaditani* communities, typical of limestone fissures dominated by geophytes such as *Narcissus calcicola*, *Narcissus gaditanus* and *Narcissus obesus* (Pinto-Gomes and Paiva-Ferreira 2005a).

Natural and semi-natural habitats and patrimonial value

5330 – Thermo-Mediterranean and pre-desert scrub; *6220 – Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* (*priority habitat); 9240 – *Quercus faginea* and *Quercus canariensis* Iberian woods.

Exoseral complex

6210 – Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco–Brometalia*) (*important orchid sites); 8210 – Calcareous rocky slopes with chasmophytic vegetation; 9340 – *Quercus ilex* and *Quercus rotundifolia* forests. Among the endemic or conservational relevant, we highlight the presence of *Quercus faginea* subsp. *alpestris*, *Genista hirsuta* subsp. *algarbiensis*, *Sideritis arborescens* subsp. *lusitanica*, *Thymus lotocephalus* (priority species from Annex II of Council Directive 92/43/EEC), *Serratula baetica* subsp. *lusitanica* var. *lusitanica*, *Bellevalia hackelii* (Annex IV of Council Directive 92/43/EEC), *Ophrys vernixia*, *Plantago algarbiensis* (Annex II of Council Directive 92/43/EEC), *Asplenium petrarchae*, *Narcissus obesus*, *Narcissus gaditanus*, *Narcissus calcicola* (Annex II of Council Directive 92/43/EEC).

Climatophilous series Araceno-Monchiquensean, mesomediterranean humid, mesophytic, silicicolous from Mirbeck's Oak* (Quercus canariensis)*:* Euphorbio monchiquensis–Querco canarienis *sigmetum

Serial dynamics

Relictual Mirbeck's Oak grove Iberian Southwest. The mature stage corresponds to a *Euphorbio monchiquensis–Quercetum canariensis* woodland, dominated by *Quercus canariensis* and normally accompanied by *Euphorbia paniculata* subsp. *monchiquensis*, *Paeonia broteroi*, *Quercus faginea* subsp. *broteroi*, among others (Table 3).

Its fringe and first substitution step belongs to the strawberry tree maquis from *Cisto populifolii–Arbutetum unedonis*. Nevertheless, with the removal of tree and shrub cover, the maquis gives place, on deep soils, to the *Adenocarpo anisochili–Cytisetum scoparii* broomland. In contrast, with soil alteration and in relatively humid areas, scrubs from *Centaureo crocatae–Quercetum lusitanicae* develop. With more soil alteration and following the regressive dynamic, an *Erico australis–Cistetum populifolii* heathland follows and a gorse scrubland of *Cisto–Ulicetum minoris*, this last exclusive to the Monchiquensean territories. In woodland clearings, the perennial grasslands dominated by *Brachypodium phoenicoides* frequently occur whereas ground clearance leads to the successive appearance of therophytic grasslands from *Tuberarion guttatae*.

Natural and semi-natural habitats and patrimonial value

4030 – European dry heaths; 5330 – Thermo-Mediterranean and pre-desert scrub; *6220 – Pseudo-

Table 3. *Euphorbio monchiquensis–Querco canarienis* sigmetum dynamics.
Tableau 3. Dynamique du *Euphorbio monchiquensis–Querco canarienis* sigmetum.

Vegetation physiognomy	Associations	Bioindicators
Mirbeck's Oak woodland	*Euphorbio monchiquensis–Quercetum canariensis*	*Quercus canariensis; Quercus faginea* subsp. *broteroi; Euphorbia paniculata* subsp. *monchiquensis; Clematis flammula; Aristolochia baetica*
Maquis scrubland	*Cisto popullifolii–Arbutetum unedonis*	*Arbutus unedo; Cistus populifolius; Erica arborea; Paeonia broteroi; Quercus lusitanica*
Broomland	*Adenocarpo anisochili–Cytisetum scoparii*	*Cytisus scoparius* var. *oxyphyllus; Adenocarpus anisochilus*
Scrubs	*Centaureo crocatae-Quercetum lusitanicae*	*Centaurea crocata; Quercus lusitanica*
Heathland	*Erico australis–Cistetum populifolii*	*Erica australis; Cistus populifolius*
Gorse scrubland	*Cisto–Ulicetum minoris*	*Ulex minor; Cistus crispus*
Perennial grassland	*Brachypodium phoenicoides* community	*Brachypodium phoenicoidis*
Annual grassland	Therophytic grassland from *Tuberarion guttatae*	*Evax ramosissima; Tolpis barbata; Tuberaria guttata; Briza maxima; Aira coryophiylea; Paronychia cymosa*

steppe with grasses and annuals of the *Thero-Brachypodietea* (*priority habitat); 9240 – *Quercus faginea* and *Quercus canariensis* Iberian woods. As higher floristic originality of this syenitic cover we can detach the occurrence of the following taxa: *Centaurea crocata*, *Rhododendrum ponticum* subsp. *baeticum*, *Campanula primulifolia*, *Senecio lopezii*, *Quercus canariensis*, *Euphorbia paniculata* subsp. *monchiquensis*, *Ilex aquifolium* (protected by national laws: Decreto-Lei number 423/89, from 4 December), *Spiranthes aestivalis* (Annex IV of Council Directive 92/43/EEC).

Climatophilous series Araceno-Monchiquensean, thermomediterranean subhumid to humid, silicicolous from cork oak* (Quercus suber)*:* Lavandulo viridis–Querco suberis *sigmetum

Serial dynamics

The mature stage is characterized by the dominance of *Quercus suber* and the constant presence of *Lavandula viridis*, a southwestern Iberian endemic, considered a characteristic species of this association (Table 4). The presence of differential plants such as *Cytisus striatus*, *Stauracanthus boivinii*, *Ulex argenteus*, *Genista triacanthos*, *Cistus populifolius* and *Deschampsia stricta* among others, segregates chorologically this association from the others, exclusive from Aracenean and Monchiquensean territories (Quinto-Canas et al. 2010). At its fringe and at first, the strawberry tree maquis from *Cisto popullifolii–Arbutetum unedonis* occurs, dominated by *Arbutus unedo*, *Cistus populifolius*, *Phillyrea angustifolia*, *Daphne gnidium*, *Erica arborea*, *Viburnum tinus*, *Paeonia broteroi*, *Quercus lusitanica*, among others. With the removal of tree and shrub cover, the maquis gives place to *Lavandulo viridis–Cytisetum striati* broomlands. Soil degradation promotes the development of the *Querco lusitanicae–Stauracanthetum boivinii*, community, dominated by *Stauracanthus boivinii*, *Thymelaea villosa* and *Quercus lusitanica*. Following the regressive dynamics, we can detach the *Erico australis–Cistetum populifolii* heathland and the *Cisto ladaniferi–Ulicetum argentei* gorse scrubland. In the woodland clearings, perennial grasslands dominated by *Dactylis lusitanica* frequently occur. Finally, regarding the last stages from climactic groves, therophytic grasslands of *Tuberarion guttatae* appear.

Natural and semi-natural habitats and patrimonial value

4030 – European dry heaths; 5330 – Thermomediterranean and pre-desert scrub; *6220 – Pseudo-steppe with grasses and annuals of the *Thero–Brachypodietea* (*priority habitat); 6310 – Dehesas with evergreen *Quercus* spp.; 9330 – *Quercus suber* forests.

Exoseral complex

8220 – Siliceous rocky slopes with chasmophytic vegetation. Beside these habitats we can detach the exclusive presence of taxa from the Peninsular Southwest such as *Stauracanthus boivinii*, *Ulex argenteus*, *Lavandula viridis* and *Cynara algarbiensis*.

Climatophilous series Tingitanian and Coastal Lusitan–Andalusian, thermomediterranean dry to subhumid, psammophilous from cork oak* (Quercus suber)*:* Aro neglecti–Querco suberis *sigmetum

Serial dynamics

Vegetation series occurring along the Algarve coastline have as the climactic stage of cork oak woodland of Coastal Lusitan–Andalusian and Tingitanian, the thermomediterranean dry to subhumid, psammophilous form *Oleo sylvestris–Quercetum suberis* (Table 5). This grove is dominated by *Quercus suber* and normally accompanied by *Arum italicum* subsp. *neglectum, Pistacia lentiscus and Stauracanthus genistoides* (Rivas-Martínez et al. 2011). The pre-forest stage is rich in thermophilous elements such as *Smilax aspera*, *Asparagus aphyllus*, *Rubia longifolia* and *Hedera maderensis* subsp. *iberica*.

Table 4. *Lavandulo viridis–Querco suberis* sigmetum dynamics.
Tableau 4. Dynamique du *Lavandulo viridis–Querco suberis* sigmetum.

Vegetation physiognomy	Associations	Bioindicators
Cork oak woodland	*Lavandulo viridis–Quercetum suberis*	*Quercus suber; Quercus faginea subsp.* broteroi; *Lavandula viridis; Smilax aspera* var. *altissima; Rubia peregrina* subsp. *longifolia; Deschampsia stricta*
Maquis scrubland	*Cisto popullifolii–Arbutetum unedonis*	*Arbutus unedo; Cistus populifolius; Erica arborea; Viburnum tinus; Phillyrea angustifolia; Daphne gnidium*
Broomland	*Lavandulo viridis–Cytisetum striati*	*Cytisus striatus; Lavandula viridis*
Shrubland	*Querco lusitanicae–Stauracanthetum boivinii*	*Stauracanthus boivinii; Quercus lusitanica; Thymelaea villosa*
Heathland	*Erico australis–Cistetum populifolii*	*Erica australis; Cistus populifolius*
Gorse scrubland	*Cisto ladaniferi–Ulicetum argentei*	*Ulex argenteus; Cistus ladanifer; Lavandula luisieri; Lithodora lusitanica*
Perennial grasslands	*Dactylis lusitanica* community	*Dactylis lusitanica*
Annual grasslands	Therophytic grassland from *Tuberarion guttatae*	*Evax ramosissima; Tolpis barbata; Tuberaria guttata; Briza maxima; Aira coryophiylea; Paronychia cymosa*

Table 5. *Aro neglecti–Querco suberis* sigmetum dynamics.
Tableau 5. Dynamique de l'*Aro neglecti–Querco suberis* sigmetum.

Vegetation physiognomy	Associations	Bioindicators
Cork oak woodland	*Aro neglecti–Quercetum suberis*	*Quercus suber; Olea europaea* var. *sylvestris; Smilax aspera var. altissima; Arum italicum* subsp. *neglectum Rubia peregrina* subsp. *longifolia; Asparagus aphyllus*
Maquis scrubland	*Phillyreo angustifoliae–Arbutetum unedonis*	*Arbutus unedo; Erica arborea; Erica scoparia; Viburnum tinus; Phillyrea angustifolia; Pistacia lentiscus*
Broomland	*Cytisetum cabezudoi*	*Cytisus grandiflorus* subsp. *cabezudoi*
Perennial grassland	*Avenulo hackelii–Celticetum sterilis*	*Celtica gigantea* subsp. *sterilis; Avenula hackelii* subsp. *hackelii; Avenula hackelii* subsp. *stenophylla; Hyacinthoides vicentina*
	Armerio macrophyllae–Celticetum giganteae	*Celtica gigantea; Armeria macrophylla; Asphodelus aestivus; Scilla odorata*
Gorse scrubland	*Erico umbellatae–Ulicetum welwitschiani*	*Erica umbellata; Ulex australis* subsp. *welwitschianus; Calluna vulgaris; Erica australis; Lavandula luisieri*
	Halimio halimifolii–Stauracanthetum genistoidis	*Halimium halimifolium; Stauracanthus genistoides; Armeria velutina; Thymus albicans* subsp. *donyanae; Ulex australis* subsp. *australis*
	Genisto triacanthi–Stauracanthetum vicentini	*Stauracanthus spectabilis* subsp. *vicentinus*
	Tuberario majoris–Stauracanthetum boivinii	*Stauracanthus boivinii; Tuberaria major*
	Thymo camphorati–Stauracanthetum spectabilis	*Thymus camphoratus; Stauracanthus spectabilis*
Cistaceous scrubland	*Cistetum bourgaeani (libanotidis)*	*Cistus libanotis; Thymus albicans* subsp. *albicans; Ulex argenteus* subsp. *subsericeus; Armeria macrophylla; Dianthus broteri* subsp. *hinoxianus*
Perennial grasslands	*Herniario maritimae–Corynephoretum maritimi*	*Corynephorus canescens* var. *maritimus; Sedum sediformis; Sesamoides spathulifolia; Herniaria maritima; Iberis ciliata* subsp. *welwitschii; Anagallis monelli* var. *microphylla*
Annual grasslands	*Tolpido barbatae–Tuberarietum bupleurifoliae*	*Tuberaria bupleurifolia; Arenaria algarbiensis; Tolpis barbata; Tuberaria guttata; Scilla odorata*

The fringe and first substitution step, which occurs above sandy accumulations, belongs to the strawberry tree from *Phillyreo angustifoliae–Arbutetum unedonis* (*Arbutus unedo*, *Phillyrea angustifolia*, *Viburnum tinus*, *Erica arborea*, *Erica scoparia*). The elimination of arboreal and shrubby strata leads to the psammophilous broomland from *Cytisetum cabezudoi*, dominated by *Cytisus grandiflorus* subsp. *cabezudoi*. Shifting to deeper soils, these communities are backed by perennial grasslands from *Avenulo hackelii–Celticetum sterilis* and *Armerio macrophyllae–Celticetum giganteae* (Pinto-Gomes, Paiva-Ferreira, and Meireles 2007, 2010). In the regressive dynamic, the domain is separate from *Erico umbellatae–Ulicetum welwitschiani* heathlands, and a psammophilous community of *Halimio halimifolii–Stauracanthetum genistoidis*. For the "Costeiro Vicentinos" territories, also on sandy or loamy soils, the gorse scrublands of *Genisto triacanthi–Stauracanthetum vicentini* are seen, with *Stauracanthus spectabilis* subsp. *vicentinus* as an important endemic element. In sandy soils with clay we observe the gorse scrubland from *Tuberario majoris–Stauracanthetum boivinii*, mainly in palaeopodzolic ferruginous lithosols, subject to waterlogging. Through its shift, in the districts of "Promontório Vicentino" and "Costeiro Altoalgárbico", in sandy soils without the ferruginous horizon, coastal gorse scrublands of *Thymo camphorati–Stauracanthetum spectabilis* emerge and also the algarvian psammophilous community of *Cistetum bourgaeani* (*libanotidis*). With more degradation, the perennial grassland of *Herniario maritimae–Corynephoretum maritimi* (Pinto-Gomes et al. 2006), and the therophytic communities of *Tolpido barbatae–Tuberarietum bupleurifoliae* occur.

Natural and semi-natural habitats and patrimonial value

*2150 – Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (*priority habitat); 2230 – *Malcolmietalia* dune grasslands; 2260 – *Cisto–Lavenduletalia* dune sclerophyllous scrubs; 2330 – Inland dunes with open *Corynephorus* and *Agrostis* grasslands; 4030 – European dry heaths; 5330 – Thermo-Mediterranean and pre-desert scrub; *6220 – Pseudo-steppe with grasses and annuals of the *Thero–Brachypodietea* (*priority habitat); 9330 – *Quercus suber* forests.

Exoseral complex

2190 – Humid dune slacks; *2270 – Wooded dunes with *Pinus pinea* and/or *Pinus pinaster* (*priority habitat); 6310 – Dehesas with evergreen *Quercus* spp.

To characterize the flora specificities, we identified some characteristic taxa from these territories: *Stauracanthus boivinii*; *Stauracanthus genistoides*, *Stauracanthus spectabilis*; **Tuberaria major* (*priority species, from Annex II of Council Directive 92/43/EEC);

Thymus camphoratus (*priority species, from Annex II of Council Directive 92/43/EEC); *Armeria velutina* (Annex II of Council Directive 92/43/EEC); *Thymus albicans* subsp. *albicans*; *Thymus albicans* subsp. *donyanae*; *Cistus libanotis*; *Ulex argenteus* subsp. *subsericeus*; *Armeria macrophylla*; *Dianthus broteri* subsp. *hinoxianus*; *Malcolmia lacera* subsp. *gracillima* (Annex V of Council Directive 92/43/EEC); *Narcissus bulbocodium* (Annex V of Council Directive 92/43/EEC). In terms of vegetal communities, the following are characteristic examples from the studied territory: *Avenulo hackelii–Celticetum sterilis*; *Armeriomacrophyllae–Celticetum giganteae*; *Halimio halimifolii–Stauracanthetum genistoidis*; *Genisto triacanthi–Stauracanthetum vicentini*; *Tuberario majoris–Stauracanthetum boivinii*; *Thymo camphorati–Stauracanthetum spectabilis*; *Cistetum bourgaeani* (*libanotidis*).

***Climatophilous series Betic and Algarvian, thermomediterranean dry to subhumid, calcicolous and calco-dolomiticolous from round-leaf oak* (Quercus rotundifolia)*:* Rhamno oleoidis–Querco rotundifoliae *sigmetum, Algarvian faciation with* Juniperus turbinata**

Serial dynamics

Climatophilous series from round-leaf oak thermomediterranean woodlands on marly and dolomitic limestones from *Barrocal Algarvio*, mainly in calcic cambisols, with dry to subhumid ombrotype (Pinto-Gomes et al. 2008) (Table 6). The climactic grove in this area corresponds to the *Rhamno oleoidis–Quercetum rotundifoliae juniperetosum turbinatae* woodlands, dominated by round-leaf oak (*Quercus rotundifolia*) and rich in climbing taxa and thermophilous elements, such as *Aristolochia baetica*, *Juniperus turbinata*, *Ceratonia siliqua*, *Asparagus albus*, *Chamaerops humilis*, *Pistacia terebinthus*, *Rubia peregrina* subsp. *longifolia, Olea europaea* var. *sylvestris*, *Clematis flammula* and *Smilax aspera* var. *altissima*. The destruction of the arboreal layer leads to a maquis from *Asparago albi–Rhamnetum oleoidis*, which represents the fringe and first substitution layer, dominated by *Quercus coccifera*, *Pistacia lentiscus*, *Rhamnus oleoides*, *Lonicera implexa*, *Smilax aspera* var. *aspera*, among others. As this scrubland regresses, in active lime-rich soils the gorse scrublands from *Siderito lusitanicae–Genistetum algarbiensis* and the thyme scrublands from *Thymo lotocephali–Coridothymetum capitati* emerge, whereas, in decarbonated soils, the *Phlomido purpureae–Cistetum albidi* scrublands appear. In contrast, the elimination of the shrubby communities leads to *Velezio–Astericetum* grasslands, which, through trampling, produce *Poo bulbosae–Astragalion sesamei* or, on moderately grazed soils, *Medicagini rigidulae–Aegilopetum geniculatae*. The grazing maintenance favours the implementation of *Galio concatenati–Brachypodietum phoenicoidis* association, mainly in marly soils, rich in active lime, dominated by the hemicryptophyte *Brachypodium phoenicoides*. Particularly in decarbonated calcareous soils, and generally in less evolved soils where the rocky outcrops of dolomitic limestone are abundant, exoseral therophytic communities develop with spring phenology – the *Hornungio petraeae–Linarietum haenseleri* (Pinto-Gomes and Paiva-Ferreira 2005a) association.

Natural and semi-natural habitats and patrimonial value

5330 – Thermo-Mediterranean and pre-desert scrub; *6220 – Pseudo-steppe with grasses and annuals of the *Thero–Brachypodietea* (*priority habitat); 9340 – *Quercus ilex* and *Quercus rotundifolia* forests.

Exoseral complex

8210 – Calcareous rocky slopes with chasmophytic vegetation; *6210 – Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites); *9560 – Endemic

Table 6. *Rhamno oleoidis–Querco rotundifoliae* sigmetum dynamics (Pinto-Gomes and Paiva-Ferreira 2005a).
Tableau 6. Dynamique du *Rhamno oleoidis–Querco rotundifoliae* sigmetum (Pinto-Gomes et Paiva-Ferreira 2005a).

Vegetation physiognomy	Associations	Bioindicators
Round-leaf oak woodland	*Rhamno oleoidis–Quercetum rotundifoliae juniperetosum turbinatae*	*Quercus rotundifolia; Juniperus turbinata; Aristolochia baetica; Smilax aspera* var. *altissima; Olea europaea* var. *sylvestris; Clematis flammula*
Maquis scrubland	*Asparago albi–Rhamnetum oleoides*	*Asparagus albus; Rhamnus alaternus; Quercus coccifera; Ceratonia siliqua; Chamaerops humilis; Lonicera implexa; Rhamnus oleoides*
Gorse scrubland	*Siderito lusitanicae–Genistetum algarbiensis*	*Genista hirsuta* subsp. *algarbiensis; Sideritis arborescens* subsp. *lusitanica; Staehelina dubia*
Perennial grassland	*Galio concatenati–Brachypodietum phoenicoidis*	*Brachypodium phoenicoidis; Eryngium dilatatum; Galium concatenatum; Serratula baetica* subsp. *lusitanica* var. *lusitanica*
Thyme scrubland	*Thymo lotocephali–Coridothymetum capitati*	*Thymus lotocephalus; Thymbra capitata; Fumana thymifolia*
Cistaceous scrubland	*Phlomido purpureae–Cistetum albidi*	*Rosmarinus officinalis; Cistus albidus; Cistus monspeliensis*
Annual grassland	*Velezio rigidae–Astericetum aquaticae*	*Asteriscus aquaticus; Cleonia lusitanica*

forests with *Juniperus* spp. (*priority habitat). Considering rare vegetal species, or those with greater conservational status: *Genista hirsuta* subsp. *algarbiensi*s, *Juniperus turbinata*, *Sideritis arborescens* subsp. *lusitanica*, *Thymus lotocephalus* (priority species from Annex II of Council Directive 92/43/EEC), *Serratula baetica* subsp. *lusitanica* var. *lusitanica*, *Bellevalia hackelii* (Annex IV of Council Directive 92/43/EEC), *Plantago algarbiensis* (Annex II of Council Directive 92/43/EEC), *Ophrys vernixia*, *Doronicum plantagineum* subsp. *tournefortii* (Annex V from Council Directive 92/43/EEC), *Asplenium petrarchae*, *Narcissus obesus*, *Narcissus gaditanus*, *Narcissus calcicola* (Annex II from Council Directive 92/43/EEC), among others.

Climatophilous series Rifenian, Betic and Marianic-Monchiquensean, thermomediterranean dry to subhumid, silicicolous from round-leaf oak* (Quercus rotundifolia)*:* Myrto communis–Querco rotundifoliae *sigmetum

Serial dynamics

The climactic stage of this vegetation series corresponds to the round-leaf oak silicicolous woodlands from *Myrto communis–Quercetum rotundifoliae*, dominated by *Quercus rotundifolia* (Table 7). Besides this Fagaceae, these groves are rich in thermophilous plants, including *Ceratonia siliqua*, *Osyris lanceolata*, *Aristolochia baetica*, *Olea europaea* var. *sylvestris*. As fringe and first substitution stage, the maquis emerges comprising *Asparago albi–Rhamnetum oleoidis*, where *Rhamnus oleoides*, *Asparagus albus*, *Phlomis purpurea*, among others, dominate. In siliceous rocky soils, the maquis gives way to the *Genistetum polyanthi* broomlands. However, the arboreal and shrubby cover elimination promotes the Cistaceous scrublands with *Cistus ladanifer*, *Ulex eriocladus* and *Genista hirsuta*, reliable in the *Genisto hirsutae–Cistetum ladaniferi* association. At greater degradation stages an annual grassland develops with *Tuberarion guttatae*.

Natural and semi-natural habitats and patrimonial value

4030 – European dry heaths; 5330 – Thermo-Mediterranean and pre-desert scrub; 9340 – *Quercus ilex* and *Quercus rotundifolia* forests.

Exoseral complex

*3170 – Mediterranean temporary ponds (*priority habitat); 6310 – Dehesas with evergreen *Quercus spp.*; 8220 – Siliceous rocky slopes with chasmophytic vegetation. Among the species of conservational interest, we detach the presence of *Genista polyanthos*, *Juniperus turbinata*, *Cosentinia vellea*, *Armeria linkiana*.

Climatophilous series Betic and Gaditan-Algarvian, meso-thermomediterranean dry to humid, from vertisoils of wild olive* (Olea europaea *var.* sylvestris)*:* Aro neglecti–Oleo sylvestris *sigmetum.

Serial dynamics

It corresponds to the vegetation series characteristic for marly soils with vertic properties under a subhumid to humid ombrotype, with the mature stage corresponding to a wild olive woodland belonging to the *Aro neglecti–Oleetum sylvestris* association (Table 8). It consists of a grove dominated by *Olea europaea* var. *sylvestris* (wild olive) and normally accompanied by *Ceratonia siliqua*, which occurs on thermophilous slopes, above clay-rich, neutro-basic soils, expanding in winter (Pinto-Gomes and Paiva-Ferreira 2005a). The pre-forestall stage is dominated by thermophilous climbing taxa, such as *Smilax aspera* var. *altissima*, *Rubia peregrina*, *Clematis flammula*, *Aristolochia baetica*, *Iris foetidissima*, *Arum italicum*. As the first substitution stage, the *Asparago albi–Rhamnetum oleoidis* maquis occurs, where we can observe *Pistacia lentiscus*, *Myrtus communis*, *Rhamnus alaternus*, *Chamaerops humilis* and *Juniperus turbinata*.

As in *Quercetum alpestris–broteroi* Portuguese oak woodlands and *Rhamno oleoidis–Quercetum rotundifoliae* round-leaf woodlands, gorse scrublands develop from *Saturejo–Coridothymenion*, dominated by *Genista hirsuta* subsp. *algarbiensis, Sideritis arborescens* subsp. *lusitanica*, *Staehelina dubia*. In these grove clearings, perennial grasslands frequently occur from *Galio concatenati–Brachypodietum phoenicoidis*, although if soil mobilization is current, thyme scrubland from Thymo *lotocephali–Coridothymetum* capitati emerges, where the Algarvian endemic *Thymus lotocephalus* is found.

Velezio rigidae–Astericetum aquaticae emerges at later degradation stages, and then, through moderate grazing, evolves to *Medicagini rigidulae–Aegilopetum*

Table 7. *Myrto communis–Querco rotundifoliae* sigmetum dynamics.
Tableau 7. Dynamique du *Myrto communis-Querco rotundifoliae* sigmetum.

Vegetation physiognomy	Associations	Bioindicators
Round-leaf Oak	*Myrto communis–Quercetum rotundifoliae*	*Quercus rotundifolia; Olea europaea* var. *sylvestris; Aristolochia baetica; Osyris lanceolata*
Maquis scrublands	*Asparago albi–Rhamnetum oleoides*	*Asparagus albus; Rhamnus oleoides; Phlomis purpurea; Aristolochia baetica; Quercus coccifera; Pistacia lentiscus*
Broomlands	*Genistetum polyanthi*	*Genista polyanthos*
Cistaceous scrublands	*Genisto hirsutae–Cistetum ladaniferi*	*Cistus ladanifer; Genista hirsuta*
Perennial grasslands	*Dactylis lusitanica* community	*Dactylis lusitanica*
Annual grasslands	*Tuberarion guttatae* community	*Trifolium arvense*

Table 8. *Aro neglecti–Oleo sylvestris* sigmetum dynamics.
Tableau 8. Dynamique de l'*Aro neglecti–Oleo sylvestris* sigmetum.

Vegetation physiognomy	Associations	Bioindicators
Wild olive woodland	*Aro neglecti–Oleetum sylvestris*	*Olea europaea* var. *sylvestris; Phlomis purpurea; Tamus communis; Arum italicum*
Maquis scrubland	*Asparago albi–Rhamnetum oleoidis*	*Asparagus albus; Ceratonia siliqua; Rhamnus alaternus; Chamaerops humilis*
Corse scrublands	*Siderito lusitanicae–Genistetum algarbiensis*	*Genista hirsuta* subsp. *algarbiensis; Sideritis arborescens* subsp. *lusitanica; Staehelina dubia*
Perennial grassland	*Galio concatenati– Brachypodietum phoenicoidis*	*Brachypodium phoenicoidis; Eryngium dilatatum; Galium concatenatum; Serratula baetica* subsp. *lusitanica* var. *lusitanica*
Thyme scrubland	*Thymo lotocephali–Coridothymetum capitati*	*Thymus lotocephalus; Thymbra capitata; Fumana thymifolia*
Annual grassland	*Velezio rigidae–Astericetum aquaticae*	*Asteriscus aquaticus; Cleonia lusitanica*

geniculatae grasslands or, on trampled soils, to *Trifolio subterranei–Plantaginetum serrariae* (Pinto-Gomes and Paiva-Ferreira 2005a).

Natural and semi-natural habitats and patrimonial value

5330 – Thermo-Mediterranean and pre-desert scrub; *6220 – Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* (*priority habitat); 9320 – *Olea* and *Ceratonia* forests.

Exoseral complex

6210 – Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco–Brometalia*) (*important orchid sites). Among the species of conservational interest, we highlight the presence of *Genista hirsuta* subsp. *algarbiensis*, *Juniperus turbinata*, *Sideritis arborescens* subsp. *lusitanica*, *Thymus lotocephalus* (priority species from Anex II of Council Directive 92/43/CEE), *Serratula baetica* subsp. *lusitanica* var. *lusitanica*.

Conclusion

We have developed this first approach to the climatophilous vegetation series of the Algarve region, through which it was possible to perceive the existence of a large diversity of climatophilous vegetation series. Seven climatophilous vegetation series were identified, displaying great value, with several rare endemic plants that, in Portugal, only appear in the studied area. Therefore, from the phytosociological analysis performed, we could verify the presence of marcescent groves in most humid areas, varying according to the soil characteristics, namely: *Querco alpestris–broteroi* sigmetum over deep marly alkaline soils of the algarvian *Barrocal* and *Euphorbio monchiquensis–Querco canariensis* sigmetum over the syenitic soils of the Monchique mountains. Cork oak stands are found in the presence of *Aro neglecti–Querco suberis* sigmetum over sandy soils of dry to subhumid ombrotype along the Littoral strip, and the presence of *Lavandulo viridis–Querco suberis* sigmetum occurring over schists and greywackes from dry to subhumid Monchiquensean district. In the driest regions the round-leaf oak formations dominate, whereas *Rhamno oleoidis–Querco rotundifoliae* sigmetum dominates over the calcareous and dolomitic soils of the algarvian *Barrocal*, and *Myrto communis–Querco rotundifoliae* sigmetum dominates on the siliceous substrate of the Guadiana valley. Occasionally, the *Aro neglecti–Oleo sylvestris* sigmetum occurs over marly soils of vertic nature, from subhumid to humid ombrotype. Understanding vegetation series is of utmost importance for the diagnosis and determination of the vegetation's current conservation status. This information allows the landscape managers to design intervention plans, promoting those management actions needed to contribute to the upholding and valorisation of biodiversity and, at the same time, accounting for the socio-economic activities that support the sustainable use of the existing natural resources.

Syntaxonomic scheme

Quercetea ilicis Br.-Bl. *ex* A. and O. Bolòs 1950
- + *Quercetalia ilicis* Br.-Bl. *ex* Molinier 1934 em. Rivas-Martínez 1975
  - * *Quercion broteroi* Br.-Bl., P. Silva and Rozeira 1956 *em*. Rivas-Martínez 1975 *corr*. Ladero 1974
    - ** *Quercenion broteroi*
      - 1 – *Quercetum alpestris-broteroi* Pinto Gomes and Paiva Ferreira 2005
      - 2 – *Euphorbio monchiquensis-Quercetum canariensis* Malato-Beliz in Rivas-Martínez, Lousã, T.E. Díaz, Fernández-González and J. C. Costa 1990
  - * *Querco rotundifoliae-Oleion sylvestris* Barbéro, Quézel and Rivas-Martínez in Rivas-Martínez, Costa and Izco 1986
    - ***Querco rotundifoliae-Oleenion sylvestris*
      - 3 – *Aro neglecti-Oleetum sylvestris* Rivas-Martínez and Cantó 2002 corr Rivas-Martínez 2011

4 – *Myrto communis-Quercetum rotundifoliae* Rivas Goday in Rivas Goday, Borja, Esteve, Galiano, Rigual and Rivas-Martínez 1960

5 – *Aro neglecti-Quercetum suberis* Rivas-Martínez and Díez Garretas in Rivas-Martínez 2011

6 – *Rhamno oleoidis-Quercetum rotundifoliae* Rivas-Martínez 1960

** Quercenion rivasmartinezii-suberis Capelo in J.C. Costa et al. ined. unpublished

7 – *Lavandulo viridis-Quercetum suberis* R. Quinto-Canas, C. Vila-Viçosa, C. Meireles, R. Paiva-Ferreira, M. Martínez-Lombardo, A. Cano and C. Pinto-Gomes 2010

References

Aedo, C., and A. Herrero. 2005. *Flora Ibérica. Smilacaceae-Orchidaceae*. Vol. XXI. Madrid: Real Jardín Botánico. CSIC.

Braun-Blanquet, J. 1965. *Plant Sociology. Study of plant communities*. London: Hafner 439 p.

Braun-Blanquet, J., P. Silva, and A. Rozeira. 1964. Resultats de trois excursions géobotaniques à travers le Portugal septentrional et moyen. III. Landes à *Cistes et Ericacees* (*Cisto-Lavanduletea et Calluno-Ulicetea*). *Agronomia Lusitanica* 23, no. 4: 229–313.

Capelo, J. 1996. Esboço da paisagem vegetal da bacia portuguesa do rio Guadiana. *Silva Lusitanica* 4 (special issue): 13–64.

Castroviejo, S. (coord.). 1986–2010. *Flora ibérica*, Vols. I-VIII, X, XIV, XV, XVIII, Madrid: Real Jardín Botánico, CSIC.

Costa, J.C. 1991. *Flora e Vegetação do Parque Natural da Ria Formosa*. Doctoral thesis. Universidade Técnica Lisboa, Lisboa: Instituto Superior Agronomima, 323 p.

Costa, J.C., J.H. Capelo, M. Lousã, and C. Aguiar. 1998. Biogeografia de Portugal Continental. *Quercetea* 0: 5–56.

Coutinho, A.X. 1939. *Flora de Portugal* (*Plantas Vasculares*). 2nd ed. Lisboa: Bertrand. 933 p.

Feio, M. 1951. *A evolução do relevo do Baixo Alentejo e Algarve*. Lisbon: Serviços Geológicos de Portugal, Vol. XXXII (2nd part).

Franco, J.A. 1971–1984. *Nova Flora de Portugal* (*Continente e Açores*). Lisbon: Ed. from Author, 1, 2.

Franco, J.A., and M.L. Rocha-Afonso. 1994–2003. *Nova Flora de Portugal* (*Continente e Açores*). Lisbon: Ed. Escolar, 3 (1)–3(3)

Gouveia, A.M. 1938. *Algarve (aspectos fisiográficos)*. Doctoral thesis. Universidade de Coimbra. Lisbon: Instituto para a Alta Cultura, 160 p.

Géhu, J.M., and S. Rivas-Martínez. 1981. *Notions fondadamentales de phytosociologie*. In: ed. H. Dierschke Synt., *Ber Int. Symp. Int. Vereinigung Vegetatiousk*, 5–33, Vaduz: Cramer.

Kopp, E., M. Sobral, T. Soares and M. Woerner. 1989. *Os solos do Algarve e as suas características. Vista geral*. Faro: DGEA-DRAA-GTZ, 180 p.

Malato-Beliz, J. 1982. *A Serra de Monchique*: Flora e Vegetação. Lisbon: Serviço Nacional de Parques, Reservas e Património Paisagístico, N.° 10, 92 p.

Malato-Beliz, J. 1986. *O Barrocal Algarvio*: Flora e Vegetação. Lisbon: Serviço Nacional de Parques, Reservas e Património Paisagístico, N.° 17, 51 p.

Pinto-Gomes, C., and R. Paiva-Ferreira. 2005a. Flora *e Vegetação do Barrocal Algarvio* (*Tavira-Portimão*). CCDR-Algarve, 350 p.

Pinto-Gomes, C., and R. Paiva-Ferreira. 2005b. Cartografia das Séries de Vegetação da Área de Intervenção da Comissão Regional de Reflorestação do Algarve. Universidade de Évora, *Documento técnico*, D.R.F., Algarve, 57 p.

Pinto-Gomes, C., R. Paiva-Ferreira, E. Cano, and S. Mendes. 2006. Pelouses psammophiles à *Corynephorus canescens var. maritimus* Godr. Du centre et sud Portugal. *Acta Botanica Gallica* 153, no. 3: 341–54.

Pinto-Gomes, C., R. Paiva-Ferreira, and C. Meireles. 2007. New Proposals on Portuguese Vegetation. *Lazaroa* 28: 67–77.

Pinto-Gomes, C., R. Paiva-Ferreira, R. Quinto-Canas, J. Rosa-Pinto, C. Meireles, M.M. Garcia. 2008. Guia Geobotânico ao Barrocal Algarvio. *Quercetea* 8: 3–143.

Pinto-Gomes, C., R. Paiva-Ferreira, and C. Meireles. 2010. New Proposals on Portuguese Vegetation (II). *Lazaroa* 31: 59–65.

Pinto-Gomes, C., A. Cano-Ortiz, R. Quinto-Canas, C. Vila-Viçosa and Mª C. Martínez-Lombardo. 2012. Analysis of the *Cytisetea scopario-striati* scrubs in the south-west-centre of the Iberian Peninsula. *Acta Botanica Gallica* 159, no. 2: 251–66.

Quinto-Canas, R., C. Vila-Viçosa, C. Meireles, R. Paiva-Ferreira, M. Martínez-Lombardo, A. Cano, and C. Pinto-Gomes. 2010. A contribute to the knowledge of the climatophilous cork-oak wood-lands from Iberian Southwest. *Acta Botanica Gallica* 147, no. 4: 627–37.

Lousã, M.F., M. Espírito-Santo, M. Rosa, and P. Luz. 1989. Estevais do Centro e Sul de Portugal (Alguns tipos). *Studia Botica* 8: 67–77.

Rivas-Goday, S., and S. Rivas-Martínez. 1967. Matorrales y tomillares de la Península Ibérica comprendidos en la clase *Ononido-Rosmarinetea* Br.-Bl. 1947. *Anales del Jardin Botanico de Madrid* 25: 7–201.

Rivas-Martínez, S. 1979. Brezales y Jarales de Europa Occidental (Revisión fitosociologica de las clases *Calluno-Ulicetea* y *Cisto-Lavanduletea*). *Lazaroa* 1: 5–127.

Rivas-Martínez, S. 2005. *Avances en Geobotánica*. *Discurso de Apertura del Curso 2005*, Real Acad. Farmacia, Madrid, 142 p.

Rivas-Martínez, S. 2007. Mapa de series, geoseries y geopermaseries de vegetación de España. Part. I. *Itinera Geobotanica* 17: 5–436.

Rivas-Martínez, S. 2011. Mapa de series, geoseries y geopermaseries de vegetación de España. Part. II. *Itinera Geobotanica* 18, no. 1–2: 5–800.

Rivas-Martínez, S., M. Costa, S. Castroviejo, and E. Valdes. 1980. Vegetación de Doñana (Huelva, España). *Lazaroa* 2: 5–190.

Rivas-Martínez, S., T. Díaz, F. Fernández-González, J. Izco, X. Loidi, M. Lousã, and A. Penas. 2002. Vascular Plant Communities of Spain and Portugal: Addenda to the Syntaxonomical Checklist of 2001. *Itinera Geobotanica* 15, no. 1-2: 1–922.

Rivas-Martínez, S., T. Díaz, F. Fernández-González, X. Loidi, M. Lousã, and A. Penas. 2001. Sintaxonomical Checklist of Vascular Plant Communities of Spain and Portugal to Association Level. *Itinera Geobotanica* 14: 5–341.

Rivas-Martínez, S., M. Lousã, T. Díaz, F. Fernández-González, and J. Costa. 1990. La vegetación del sur de Portugal. *Itinera Geobotanica* 3: 5–126.

Tutin, T.G., V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentina, S.M. Walthers and D.A. Webb (eds). 1964–1980. *Flora Europaea*. Cambridge: Cambridge University Press, 1–5.

Vadés, B., S. Talavera, E. Fernández-Galiano. 1987. *Flora Vascular de Andalucía Occidental*. Vols. I–III. Barcelona: Ed. Ketres.