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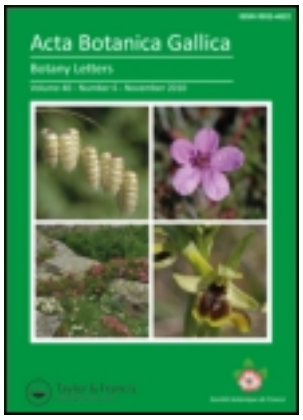

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Approach to climatophilous vegetation series of Serra da Estrela (Portugal)

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Approach to climatophilous vegetation series of *Serra da Estrela* (Portugal)

Approche des séries de végétation climatophiles de la Serra da Estrela (Portugal)

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Abstract: This work contains the study results of climatophilous vegetation series from Serra da Estrela, the highest mountain on the Portuguese mainland. Located in central-northern Portugal in the Estrelensean Sector (Carpetan-Leonese Subprovince), the Serra da Estrela has several bioclimatic stages, mainly resulting from slope and altitude ranges: mesomediterranean, submediterranean mesotemperate, supramediterranean, submediterranean supratemperate, and submediterranean orotemperate. In each of these belts are observed changes in plant communities that determine variations in terms of the vegetation series. The methodology was based on Dynamic-Catenal Phytosociology. The results show the presence of five climatophilous series; their structural characteristics and dynamics are described in this paper: 1. *Lycopodio clavati–Junipereto nani* S.; 2. *Saxifrago spathularis–Betuleto celtibericae* S.; 3. *Holco mollis–Querco pyrenaicae* S.; 4. *Arbuto–Querco pyrenaicae cytisetoso grandiflori* S.; e 5. *Viburno tini–Querco roboris* S.

Keywords: Estrelensean Sector; phytosociology; Serra da Estrela; vegetation series

Resumé: Dans ce travail sont décrits les résultats de l'étude des séries de végétation climatophiles de la*Serra da* Estrela, le point culminant du Portugal. Situé dans le centre-nord du Portugal, le secteur « Estrelense » (sub-province de «Carpétano-leonesa»), *laSerra da Estrela* présente plusieurs étages bioclimatiques distincts, résultant principalement de l'exposition des versants et de l'altitude: mesoméditerranéen, mesotempéré sous-méditerranéen, supraméditerranéen, supratempéré sous-méditerranéen, orotempéré et subméditerranéen. Dans chacun de ces étages, on observe des changements dans la végétation qui déterminent différentes séries de végétation. La méthodologie suivie est celle de la phytosociologie dynamico-caténale. Les résultats montrent la présence de cinq séries, dont les caractéristiques structurelles et la dynamique sont décrites dans le présent document: 1. *Lycopodio clavati–Junipereto nani* S.; 2. *Saxifrago spathularis–Betuleto celtibericae* S.; 3. *Holco mollis–Querco pyrenaicae* S.; 4. *Arbuto–Querco pyrenaicae cytisetoso grandiflori* S.; e 5. *Viburno tini–Querco roboris* S.

Mots-clés: phytosociologie; Secteur « Estrelense »; séries de végétation; Serra da Estrela

Introduction

The Serra da Estrela, 1993 m, is the highest mountain on the Portuguese mainland and is covered by a biogeographical unit known as the Estrelensean Sector (Carpetan-Leonese Subprovince). Being part of the Central Iberian System, on its most oceanic segment, it is dominated by siliceous substrates, mainly granite and schist, and is a landscape marked by the last major glaciation (Ferreira 1993; Vieira and Ferreira 1998; Ferreira and Vieira 1999; Vieira 2004, 2005).

Its very particular geographical position, mainly in the transition areas between mediterranean and temperate bioclimates, in conjunction with the territory orography, influences the local climate characteristics and makes possible the existence of the following bioclimatic stages: mesomediterranean, submediterranean mesotemperate, supramediterranean, submediterranean supratemperate, and submediterranean orotemperate. In each of these belts vegetation changes are observed that determine variations at the respective series level.

The purpose of this study was to establish a local vegetation series model, like those existing in other mountain systems of Central and Northern Portugal (Aguiar 2000, Pinto-Gomes et al. 2002; Honrado 2003). This follows previous research performed under a wider phytosociological study of the flora and vegetation of the southern slope of the Serra da Estrela (Meireles 2010).

In this context, Rivas-Martínez et al. (2000) made a first approach to the Estrelensean vegetation series,

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referring the presence of the following series: *Arbuto unedonis–Querco pyrenaicae* Sigmetum, up to about 850 m; *Holco mollis–Querco pyrenaicae* Sigmetum, between 850 m and 1200 m; *Saxifrago spathularidis–Betuleto celtibericae* Sigmetum, from 1200 m to 1700 m, and *Lycopodio clavati–Junipereto nanae* Sigmetum, from 1700 m to the top.

Material and methods

The vegetation series analysis followed the dynamic-catenal phytosociological method (Rivas-Martínez 2007), which is based on existing plant communities, as well as on ecologically homogeneous territories (teselas). For this purpose, in a previous study, a phytosociological plant communities inventory was performed (Meireles 2010), using the method proposed by the Zurich-Montpellier school (Braun-Blanquet 1979; Rivas-Martínez and Géhu and Rivas-Martínez 1981), with the subsequent sinphytosociological analysis.

Results and Discussion

In this work, five climatophilous series have been identified in the territory: *Lycopodio clavati–Junipereto nani* S.; *Saxifrago spathularis–Betuleto celtibericae* S.; *Holco mollis–Querco pyrenaicae* S.; *Arbuto–Querco pyrenaicae* S.; and *Viburno tini–Querco roboris* S.

The results confirm the great extent of the Pyrenean oak (*Quercus pyrenaica*) series, even in the thermophilous areas of lower elevation (mesomediterranean stages). In the particular case of slopes facing south, in upper supramediterranean, the *Holco mollis–Querco pyrenaicae* S. can reach great heights, even establishing contact with the orotemperate submediterranean common juniper (*Juniperus nana*) series.

The presence of upper supratemperate territories with submediterranean nature, where the Birch series of *Saxifrago spathularis–Betuleto celtibericae* S. are dominating, was confirmed.

The results also show that, at great altitude, the *Genista cinerascens* and *Genista florida* subsp. *polygaliphylla* communities are, respectively, excellent bioindicators to differentiate the series of *Holco mollis–Querco pyrenaicae* S. and *Saxifrago spathularis–Betuleto celtibericae* S.

The observed series are described below in their structural, dynamic and chorological aspects.

Lycopodio clavati–Junipereto nanae *Sigmetum* – *Submediterranean orotemperate Estrelensean, Common Juniper (*Juniperus communis *subsp.* alpina*) series, ultrahyperhumid, silicicolous*

This is a climatophilous series, typical of the top of Serra da Estrela (between 1700 and 1993 m), under an ultrahyperhumid submediterranean orotemperate environment, and above siliceous materials of granitic origin. Two variants of pedological origin can be found here, differing especially in perennial grasslands: (1) a gravel and shallow soils variant, with *Festuca summilusitana* communities; and (2) a variant on deep soils, with *Calluna vulgaris* heathlands.

Climactic stage

The climactic community corresponds to a common juniper of *Lycopodio clavati–Juniperetum nanae*, dominated by a small group of bushes where we can highlight the presence of *Juniperus communis* subsp. *alpina*, *Erica arborea* and *Cytisus oromediterraneus*. Currently, this community distribution area is very small in the territory, as a result of the rarity of its habitat and human activities.

Serial stages

Shallow soils variant: Perennial grassland of *Arenario querioidis–Festucetum summilusitanae; Agrostis truncatula* subsp. *commista* community.

Deep soils variant: Heathland of *Potentillo herminii–Callunetum* (slightly drained soils); *Nardus* grassland of *Galio saxatilis–Nardetum strictae* (slightly drained soils), or *Nardus* grassland of *Campanulo herminii–Festucetum henriquesii* (well-drained soils).

Saxifrago spathularidis–Betuleto celtibericae *Sigmetum – Submediterranean upper supratemperate, Galician-Portuguese and Estrelensean Birch series, ultrahyperhumid, silicicolous*

The massive and widespread destruction of the spontaneous forests that grew on this mountain makes it difficult to distinguish between territories with the potential under oak or birch ambit. However, it was found that at higher elevations, especially on northern and western slopes, in deep soils, the territory was under the birch series, and the *Quercus pyrenaica* forests from *Holco mollis–Quercetum pyrenaicae* were the result of secondary settlement.

The greatest bioindicators in this differentiation are *Genista cinerascens* and *Genista florida* subsp. *polygaliphylla*. The communities of *Genista cinerascens* are faithfully associated with the altitudinal Pyrenean oak groves, while the *Genista florida* subsp. *polygaliphylla* communities are related to the presence of birch woodlands.

In this territory, the birch woodlands usually constitute the altitudinal limit of the forest formations, substituted by the oro-submediterranean common juniper communities at higher altitudes and by the Pyrenean oak forests in inferior supramediterranean territories. Two distinct variants can be found in this territory, according to soil waterlogging: (1) a variation on deep soils without prolonged waterlogging, with *Erica australis* subsp. *aragonensis* heathlands; and (2) a variant on deep soils and prolonged waterlogging, with communities of *Potentillo herminii–Callunetum*.

Climactic stage

The top stage corresponds to a birch grove of *Saxifrago spathularidis–Betuletum celtibericae*, marked by the

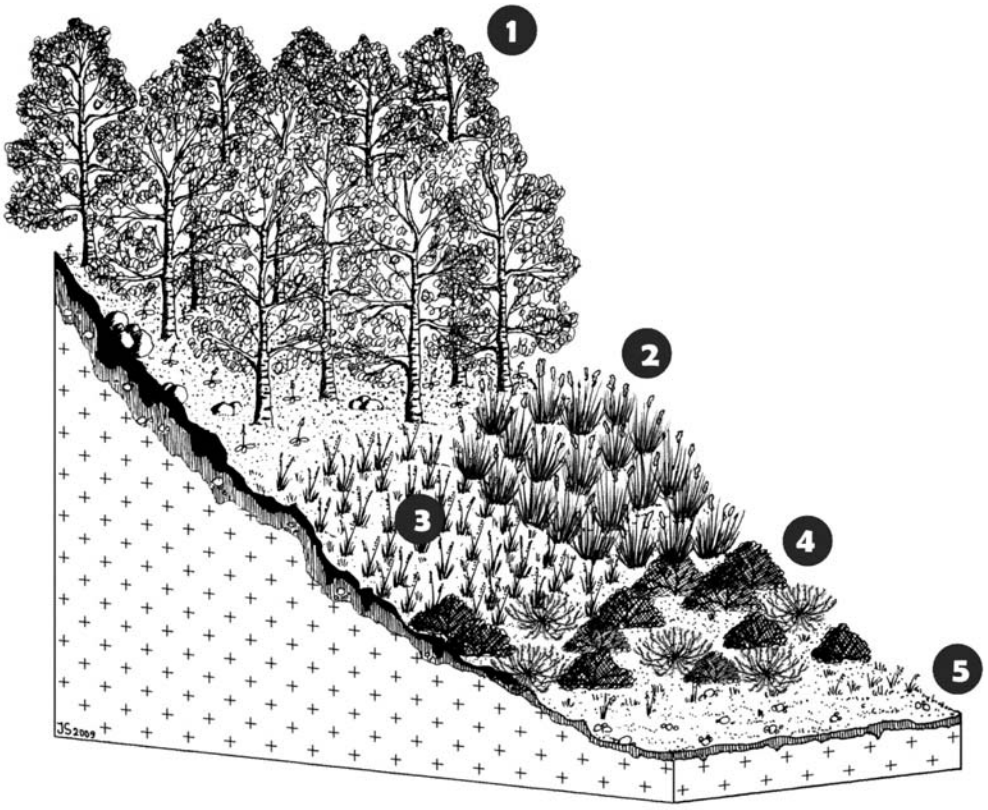

Figure 1. Simplified scheme from *Saxifrago spathularidis–Betuleto celtibericae* S. em solos profundos sem hidromorfia prolongada. 1. *Saxifrago spathularidis–Betuletum celtibericae*; 2. *Cytiso striati–Genistetum polygaliphyllae*; 3. *Phalacrocarpo oppositifolii–Festucetum elegantis*; 4. *Junipero nanae–Ericetum aragonensis*; 5. *Arenario–Cerastietum ramosissimi*.
Figure 1. Schéma simplifié de la série *Saxifraga–spathularidis Betuleto celtibericae* S., sur sols profonds, sans engorgement prolongé: 1. *Saxifrago spathularidis–Betuletum celtibericae*; 2. *Cytiso striati–Genistetum polygaliphyllae*; 3. *Phalacrocarpo oppositifolii–Festucetum elegantis*; 4. *Junipero nanae–Ericetum aragonensis*; 5. *Arenario–Cerastietum ramosissimi*.

presence of *Saxifraga spathularis* and a wide variety of Pteridophytes. In the Serra da Estrela, these woodlands were almost all destroyed, leaving small, highly altered remnants.

Serial stages

Variant on deep soils without *waterlogging* (Figure 1): *Cytiso striati–Genistetum polygaliphyllae* broomland; *Phalacrocarpo oppositifolii–Festucetum elegantis* perennial grassland; *Junipero nanae–Ericetum aragonensis* heathlands; *Arenario–Cerastietum ramosissimi* annual grassland; *Arrhenatherum carpetanum* community (existing only in the serial forward direction).

Variant on deep soils with prolonged waterlogging: Potentillo herminii–Callunetum heathland; *Galio saxatilis–Nardetum strictae Nardus* grassland.

Holco mollis–Querco pyrenaicae *Sigmetum – Submediterranean upper supratemperate series, subhumid, humid and hyperhumid, from western Carpetan and Orensan-Sanabriensean, silicicolous, of Pyrenean Oak* (Quercus pyrenaica)

The supramediterranean and submediterranean supratemperate stages, lying between 800 (1000) and1700 (1800) m, rely on the climatophilous series from the *Holco mollis–Querco pyrenaicae* S. In this territory, it is possible to observe some variations in this series, determined primarily by altitude: (1) a granitic upper supramediterranean territories variant, with *Genista cinerascens* broomland; and (2) a lower suprasubmediterranean territories typical variant, with *Cytisus* spp. broomlands.

Climactic stage

The top stage corresponds to Pyrenean Oak woodland from *Holco mollis–Quercetum pyrenaicae*, whose upper stratum is dominated almost exclusively by Pyrenean Oak. Currently, there are a few patches of these groves, usually very impoverished. However, the best preserved elements are high-species-diversity woodlands, especially by the input of species typical of their natural fringes. These groves, here on the border with the Eurosiberian world, are mostly in submediterranean territories. This makes it possible that, in most oceanic areas, they can present *Quercus robur* in their floristic composition, particularly at lower levels.

Serial stages

Upper supramediterraneanterritories variant: Genista cinerascens broomlands; Arenario querioidis–Festucetum

summilusitanae perennial grasslands; *Arenario–Cerastietum ramosissimi* annual grasslands; *Arrhenatherum carpetanum* community (only in the forward dynamic).

Submediterranean lower supratemperate territories variant:Genisto falcatae–Cytisetum grandiflori broomland; *Phalacrocarpo oppositifolii–Festucetum elegantis* (in wettest territories), *Sedo elegantis–Agrostietum castellanae* (in transition to mesomediterranean territories) or *Festuco amplae–Agrostietum castellanae* (in places of higher waterlogging); *Centaureo–Celticetum gigantea* (only in deep soils that have lost some organic matter in areas of greatest temperate nature); *Lavandulo sampaioanae–Cytisetum multiflori* broomlands; *Hispidello hispanicae–Tuberarietum guttatae* annual grasslands.

Arbuto unedonis–Querco pyrenaicae *Sigmetum* – *Mesomediterranean series, subhumid to humid, silicicolous, of Lusitan-Extremadurean optimum, of Pyrenean Oak* (Quercus pyrenaica)

The lower altitude territories of the southeast belong to the *Arbuto unedonis–Querco pyrenaicae* S. Two variants were identified in the territory, which depend mainly on the lithological origin (granite or schist): (1) Schist variant, with *Erica australis* subsp. *aragonensis* heathlands; and (2) Granitic variant with *Cytisus* spp. broomlands.

Climactic stage

The climactic stage corresponds to Pyrenean Oak woodland of *Arbuto unedonis–Quercetum pyrenaicae cytisetosum grandiflori*, in an occidental upper mesomediterranean subassociation, expressed by a higher oceanic character and marked by the absence of thermophilous elements (Meireles 2010). *Quercus pyrenaica*, *Arbutus unedo*, *Quercus suber* and *Quercus rotundifolia* were typical of these forests, as well as elements of greater oceanic influence like the occasional presence of *Quercus robur* or *Quercus* × *andegavensis*.

Serial stages

Variant on schist: Strawberry tree communities from *Erico scoparii–Arbutetum unedonis; Centaureo coutinhoi–Dactyletum lusitanici* (thermophilous situation) or *Sedo elegantis–Agrostietum castellanae* (less thermophilous and with certain temporal waterlogging) perennial grasslands; *Erica australis* subsp. *aragonensis* upper mesomediterranean heathland; *Euphorbio oxyphyllae–Cistetum ladaniferi* scrubland (in increasing soil erosion); *Galio parisiensis–Logfietum minimae* or *Ornithopo–Plantaginetum bellardii* (xeric positions) annual grasslands.

Variant on granite: Genisto falcatae–Cytisetum grandiflori broomland (Meireles 2010); *Centaureo coutinhoi–Dactyletum lusitanici* (thermophilous situation) or *Sedo elegantis–Agrostietum castellanae* (less thermophilous and with certain temporal waterlogging) perennial grasslands; *Cytisus striatus* broomlands of *Lavandulo sampaioanae–Cytisetum multiflori* in a deeper soils variant; *Cytisus multiflorus* (*Lavandulo sampaioanae–Cytisetum multiflori*) broomland, as typical variant; *Galio parisiensis–Logfietum minimae* annual grassland.

Viburno tini–Querco roboris *S.* – *Thermo-mesotemperate series, humid to hyperhumid, silicicolous, Galician-Portuguese, from English Oak* (Quercus robur)

In southwestern territories, despite the rarity of the local forests, the floristic and phytocoenotic elements indicate the presence of the *Viburno tini–Querco roboris* S.

Climactic stage

The climactic stage corresponds to an English oak (*Quercus robur*) woodland, belonging to the *Viburno tini–Quercetum roboris* association.

Serial stages

Strawberry tree communities from *Erico scoparii–Arbutetum unedonis; Agrostis curtisii* perennial grassland; *Erica australis* subsp. *aragonensis* heathland; *Halimio alyssoidis–Pterospartetum cantabrici* dwarf heathland; *Galio parisiensis–Logfietum minimae* or *Ornithopo–Plantaginetum bellardii* (xeric positions) annual grasslands.

Conclusion

In conclusion, the work developed in recent years by the Universities of Évora (Portugal) and Jaén (Spain) in the Serra da Estrela has helped to increase the existing knowledge about local flora and vegetation. The results have allowed us to identify and represent the local climatophilous vegetation series, both in structural and dynamic terms, providing an important tool for sustainable land management.

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