Vegetation series as a basis for habitats and species conservation: methodological aspects

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Abstract: Vegetation series, defined as the sequence of stages in a succession, and known as *sigmetum* (synassociation), describes the set of plant communities or stages that can be found in similar tesselar spaces as a result of the succession process. This establishes the concept of vegetation series; a climatophilous series is one that depends on the climate, whereas an edaphoxerophilous series depends on the dryness of the soil, and is found on crests, spurs, ledges and limestone and siliceous rock fields. Edaphohygrophilous series are located in valleys, dry water courses and river terraces, and depend on the water present in the soil, which may become temporarily flooded and thus condition the temporihygrophilous series; they represent the transition between the clearly edaphohygrophilous and climatophilous series. The vegetation permaseries represents the perennial communities of *permatesselae* or similar permatesselar complexes, as occurs in polar territories, hyperdesert, high-mountain peaks, and non-stratified communities lacking in serial communities.

The edaphoxerophilous series may include –in addition to the series head– permaseries (permanent communities) and other habitats, such as annual and crevice habitats. A territory behaves differently in the same climate depending on the nature of the substrate. If a climatophilous substrate undergoes soil-loss phenomena it may become an edaphoseries, if the loss of the soil factor produces a situation of rocky crest. Thus the edaphoseries may act as dynamic transitional stage between the climatophilous series and the permaseries.

Key-words: conservation, methodology, series, vegetation.

INTRODUCTION

From a conceptual point of view it is worth reviewing some basic concepts. Edaphophilous. Depending on or conditioned by the soil. Describes vegetation series or permaseries and series of any type of potential vegetation which, instead of being governed by and in harmony with the mesoclimate (climatophilous), are linked to and dependent on soil factors (Rivas-Martínez *et al*., 2011). Edaphoxerophilous. Requiring or supporting the xericity of the soil. Describes vegetation series or plant communities that grow in coenotopes that for soil-related reasons are dryer than would normally correspond to the territory according to its ombroclimate; this is the case of rocky spurs and steep suntraps, among others. Edaphohygrophilous. Requiring humidity or swamping of the soil. Describes vegetation series, plant communities or plants that grow on soils which for topographical reasons have greater humidity than would normally correspond according to their ombroclimate (Rivas-Martínez *et al*., 2007).

The territories in the southern Iberian Peninsula are part of the biogeographical provinces of Lusitano-Andaluza-Litoral, Mediterránea-Ibérica Occidental and Bética (Rivas-Martínez *et al*., 2011). Although they have a marked Mediterranean character, the oceanic influence of the Atlantic can be observed throughout the whole territory, with a greater gradient of oceaneity towards the west and continentality moving further towards the interior of the peninsula. There is therefore a wide range of plant ecosystems, all of which can be included in either the large sclerophyllous or deciduous formations that appear in the rainier areas or on Atlantic islands.

Although numerous studies have been published on the southern Iberian Peninsula –Rivas Goday (1964), Belmonte (1986), Laorga (1986), Ruiz Tellez (1986), Cano (1988), Sánchez Pascual (1994), Melendo (1998), Pinto Gomes (1998), Rivas-Martínez *et al*. (1990), Cano *et al*. (2002), Amaral Franco (1990), and Rivas-Martínez & Saénz (1991) among others– there are relatively few studies on the climatophilous and edaphoxerophilous character of the forests of *Quercus*. Pinto Gomes *et al*. (2011) and Cano *et al*. (2012) describe two types of *Quercus* forests in the southern Iberian Peninsula, with a considerable predominance of climatophilous and a lesser representation of edaphoxerophilous forests. They are located in subhumid-humid ombroclimates in both limestone and siliceous

rocky areas and crests obtained through erosive phenomena due to fires and deforestation. Similarly, edaphoxerophilous communities of *Juniperus* appear in areas in the dry ombroclimate when the previously dominant *Quercus rotundifolia* forests disappear and soil is lost. These formations are currently undergoing expansion (Cano *et al*., 2007).

MATERIAL AND METHODS

Various communities of *Quercus* are studied in rainy environments in the southern Iberian Peninsula as a continuation of the previous studies conducted by ourselves (Pinto Gomes *et al*., 2011), together with another group of communities dominated by some of the following species: *Juniperus oxycedrus* subsp. *lagunae, Juniperus phoenicea, Pistacia terebinthus*, growing in humid-subhumid rocky environments in the thermo-, meso- and supramediterranean. To establish a relationship between the ombroclimate and thermocline and the existing plant community type, we apply the bioclimatic indices proposed by Rivas-Martínez (2004) to around one hundred meteorological stations (Cano *et al*., 2005 ; Cano *et al.*, 2009). The study area is part of the Bético province, specifically in the Subbético and Rondeño biogeographical sectors, and the luso-extremadurense territories (Mariánico-Monchiquense sector).

RESULTS AND DISCUSSION

Vegetation series

The bioclimate in the southern Iberian Peninsula has been the subject of previous studies by ourselves where we established the values of Io, It/Itc and Ic for the various meteorological stations. The subhumid-humid ombrotype and mesosupramediterranean thermotype is frequent in the Cazorla mountains, with values of Io = 4.7-7.2, Itc = 263-161, Ic = 19.6-17 in Cazorla-Icona and Pontones respectively. The subhumid and humid ombrotype is also common in the Rondeño territory –with an intermittent presence of the hyperhumid ombrotype–, and predominantly thermo- and mesomediterranean thermotypes, with values of Io = 10.9, Itc = 304, Ic = 17.7 for Grazalema. These bioclimatic values, in conjunction with the knowledge of the soil, served to establish the different climatophilous vegetation series. These series are derived from the set of stages or plant communities that can be found in similar tesselar spaces as a result of the succession. This implies a vertical dynamic in which certain communities are substituted by others due to succession; as a result the tessela may contain both the mature stage and its substitution stages. This set of plant communities, related in terms of their dynamic, is known by the name of *sigmetum* or synassociation (set of associations) (Fig. 1).

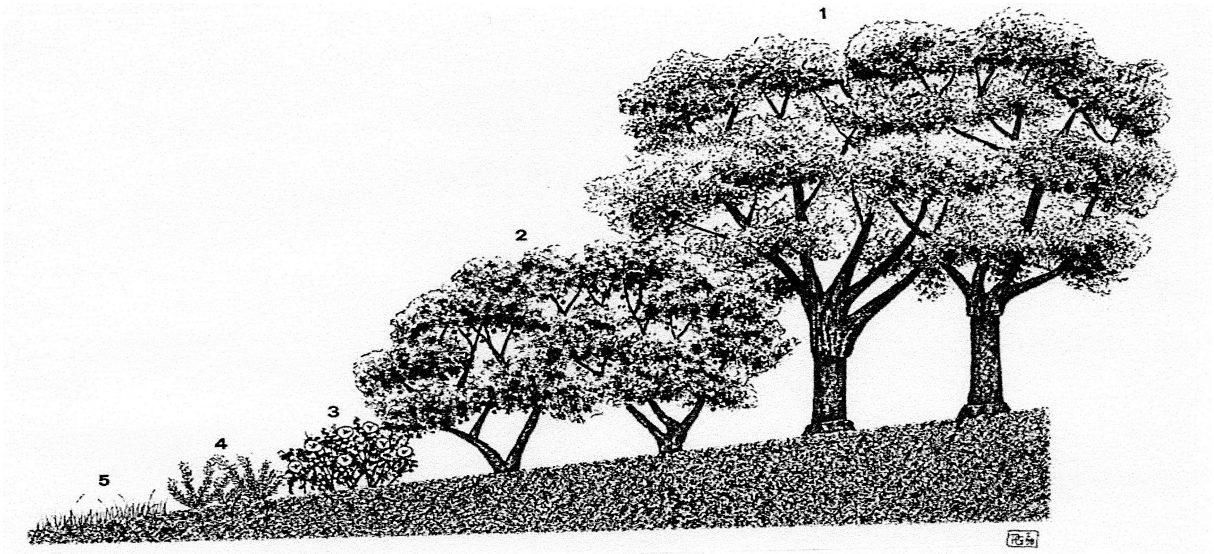

Figure 1 - Climatophilous vegetation series. Mariánico-Monchiquense sector (eastern Marianense district). *Sanguisorbo agrimonioidis-Querco suberis sigmetum*. 1.- *Sanguisorbo agrimonioidis-Quercetum suberis*. 2.- *Phillyreo angustifoliae-Arbutetum unedonis*. 3.- *Polygalo microphyllae-Cistetum populifolii*. 4.- *Halimio ocymoidis-Ericetum umbellatae*. 5.- Grasslands of *Trifolio cherleri-Plantaginetum bellardii, Trifolio cherleri-Taeniantheretum capitis-medusae, Poo bulbosae-Trifolietum subterranei*.

Vegetation edaphoseries

This describes plant communities located in places where for soil-related reasons the climatophilous communities habitually found in the territory do not occur. In this case the soil is the factor conditioning the vegetation type, and thus the final community towards which the territory moves is known as an edaphoclimax, and depends on the interplay between soil and climate. Its evolution may tend towards the climatophilous or extreme edaphoseries = permaseries. The permaseries is a permanent single-stratum community that is stable in space and time provided the environmental conditions that generated it are maintained. It represents the extreme of the edaphoseries, and all permaseries are therefore edaphoseries if this is their origin, but not the reverse. However they differ in terms of dynamics. The permaseries has no dynamic, but the edaphoseries can have dynamic stages, which will largely depend on the floristic elements in nearby communities, and thus on opportunistic elements. The dynamic in the case of edaphoseries is hence both vertical and horizontal.

Edaphoxerophilous series may also include the head of series, the permaseries (permanent communities) and other habitats such as annual and crevice-growing communities. In the same climate a territory behaves in different ways according to the nature of the substrate, implying that if a climatophilous series is subjected to soil-loss phenomena, it may become an edaphoseries when the loss of the soil factor produces a situation of rocky crests. The edaphoseries may therefore act as a dynamic stage of transition between climatophilous series and permaseries.

Edaphoseries areas may contain a variable number of associations and botanical species of interest, and therein lies their primary importance and their differences with the climatophilous series, which has clear serial stages (vertical dynamic). In the case of stable edaphoseries it is therefore advisable to establish a separation between climatophilous and edaphoxerophilous series. For example, *Berberido hispanicae-Quercetum hispanicae* is the climax of the "climatophilous and edaphoxerophilous calcicolous and calco-dolomitocolous Mediterranean pluviseasonal oceanic supramediterranean dry-humid series of forests of *Quercus rotundifolia* and *Berberis hispanica*". In our opinion this series should be diagnosed solely as climatophilous and not as climatophilous and edaphoxerophilous.

Permaseries

Permaseries is understood as a permanent single-stratum plant community without a dynamic. It represents the perennial communities of permatesselas or similar permatesselar complexes – as occurs in polar territories, hyperdeserts, and on high-mountain summits (Rivas-Martínez *et al.*, 2007) – located in a permatessela that occurs in extreme or exceptional situations in which the conditioning factor endures over time. This implies that no other type of substitution community may exist, although there may be annual communities of a temporal nature that appear due to the microtopography of the soil. These annual communities interspersed among the permanent community (permaseries) occupy an ecologically homogeneous temporal space (microtessela) (Cano, 2007), which can only have a single-stratum association.

Vegetation minoriseries and curtoseries

Vegetation minoriseries (curtaseries) is a term defined by Rivas-Martínez (2014), who says: "this name and its Latinised term – *minorisigmetum* – describe permanent plant communities and their corresponding perennial and annual substitution stages found in tesselar spaces and in their territories of jurisdiction, which for exceptional mesological causes do not ultimately reach the progressive mature stage of the head of the climatophilous or edaphophilous series habitually corresponding to their biogeographic and bioclimatic environment".

It can be defined as a vegetation series that has been conditioned by some environmental factor of a permanent nature which prevents the final evolution to the mature stage of the surrounding areas. This series may undergo various dynamic substitution stages typical of the succession, but which due to the exceptional nature of the environment, do not culminate in the final stage of succession habitually seen in the territory in the surrounding area. The set of associations in this tesselar or minoritesselar space is called a minoriseries or minorisynassociation.

As described by Lazare (2009) for curtaseries, there do not appear to be many differences between curtaseries and minoriseries, as both arise due to the presence of some exceptional environmental factor. However this environmental factor may be temporary, and herein lies the fundamental difference between minoriseries and curtaseries: the former occurs due to the presence of some permanent environmental factor, while in the second, this factor is temporary. We could therefore say that minoriseries present a spatial occupation, and this will be permanent. In contrast the curtaseries or truncated series may evolve until the initial situation from which it originated in response to the appearance of the environmental factor. Its duration over time and its spatial occupation may therefore be ephemeral. Minoriseries and curtaseries are terms deriving from the series in exceptional situations, and thus they may both have their origin in the climatophilous, edaphoxerophilous and edaphohygrophilous series. Fig. 2 contains a vegetation profile of the Maginense district of the Subbético sector showing the topographic situations of edaphoseries, minoriseries, climatophilous series and permaseries, which –as can be seen– are located on a vertical rock face, where only perennial communities can survive.

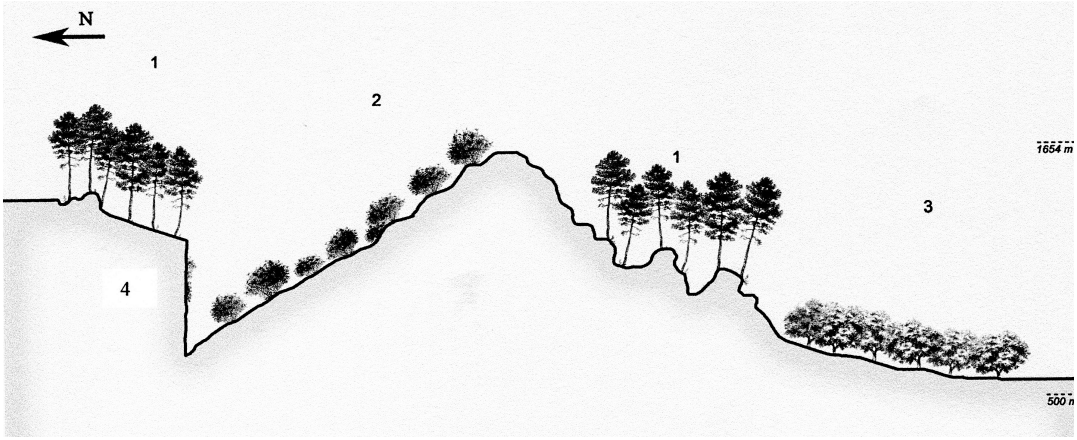

Figure 2 - Vegetation profile. Subbético sector (Maginense district).- 1. Edaphoseries (*Rhamno lycioidis-Pino halepensis sigmetum*). 2.- Minoriseries (Co. of *Pistacia terebinthus*). 3.- Climatophilous series (*Paeonio coriaceae-Querco rotundifoliae sigmetum*). 4.- Permaseries (*Seseli granatenis-Festuco hystricis sigmetum*).

When the conditioning factors are exceptional microtopographical or soil situations (rock walls, rock fields, marine cliffs, salt flats), a certain connection can be observed between the edaphoseries, permaseries, minoriseries and curtaseries, where the intensity and duration of the limiting factor conditions the existence of one or another type of series. However the origin of these types of series may be diverse; a climatophilous series may be transformed into an edaphoxerophilous series due to human activity in the form of burning, deforestation and soil loss. The territory may therefore present a certain climatophilous series owing to the existence of particular climate factors, with edaphoxerophilous communities appearing in microtopographical islands (rock walls, rock fields) even in locations with a high ombroclimate. This is the case of the presence of communities of *Quercus rotundifolia* and *Juniperus oxycedrus* in rainy sites, as occurs in the Subbético, Rondeño and Marianense territories. Places which frequently have a dry, subhumid and humid ombrotype may contain a predominance of climatophilous forests of *Quercus rotundifolia, Quercus suber, Quercus pyrenaica, Quercus marianica, Quercus broteroi, Quercus canariensis*, among others. (Fig. 3).

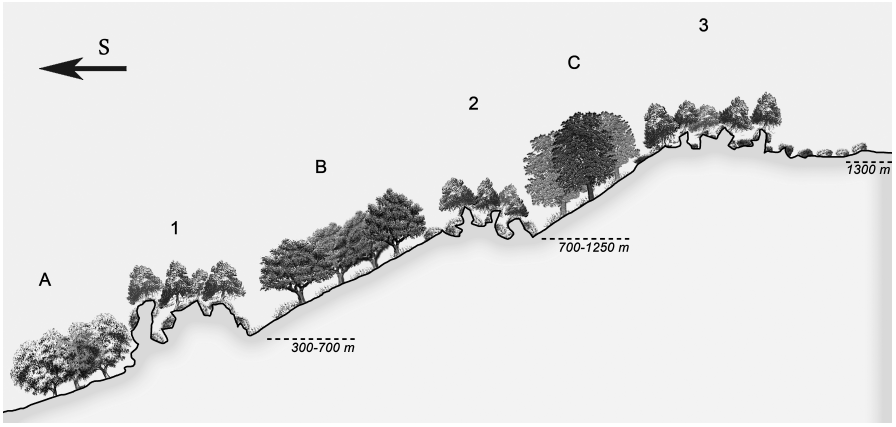

Figure 3 - Idealised profile of Sierra Morena: A, B and C. Climatophilous vegetation . A. Holm oak forests; B. Cork oak forests; C. *Quercus* oak forests. 1, 2, and 3 edaphoseries vegetation. 1.- Co. *Myrtus communis* et *Juniperus lagunae*. 2.- Co. *Genista polyanthos* et *Juniperus lagunae*. 3.- *Echinosparto iberici-Junipero lagunae sigmetum* (Cano *et al*., 2007).

Although rainfall is high in the Cazorlense and Rondeño territories, the wild character of the rock fields with limestone and limestone-dolomitic material allows the terrain to behave as dry. We therefore find edaphoxerophilous holm oak forest on rocky crests in both biogeographical sectors with a subhumid-humid ombroclimate, whose catenal contact is Portuguese oak forests of *Quercus broteroi* and fir forests of *Abies pinsapo* in the Rondeño sector. In the Subbético sector the contact of these edaphoxerophilous holm oak forests is a Portuguese oak forest of *Quercus faginea* subsp. *alpestris*. In the Rondeño sector the edaphoxerophilous holm oak forest grows in the thermo-mesomediterranean subhumid-humid on limestone and limestone-dolomitic crests, whose floristic composition is *Quercus rotundifolia, Olea sylvestris, Ceratonia siliqua, Bupleurum gibraltaricum, Aristolochia baetica, Clematis cirrhosa, Hedera hibernica, Hedera madeirensis* (Pinto Gomes *et al*., 2011; Cano *et al*., 2012); and in the Cazorlense territory the holm oak is located in the meso-supramediterranean

subhumid-humid on hard limestone and its floristic composition is *Quercus rotundifolia, Juniperus oxycedrus* subsp. *lagunae, Juniperus phoenicea, Hedera hibernica, Buxus sempervirens, Bupleurum rigidum* (Figs 4-5).

Figure 4 - Subbético sector (Cazorleño district). 1.- Climatophilous series (*Junipero sabinae-Pino latisquamae sigmetum*). 2.- Edaphoseries (*Junipero phoeniceae-Pino latisquamae sigmetum*). 3.- Climatophilous series (*Berberido hispanicae-Querco rotuntidoliae sigmetum*). 4.- Edaphoseries (Co. *Juniperus lagunae* and *Quercus rotundifolia*). 5.- Climatophilous series (*Paeonio coriaceae-Querco rotundifoliae sigmetum*). 6.-Edaphoseries (Co. *Juniperus phoenicea* and *Juniperus lagunae*).

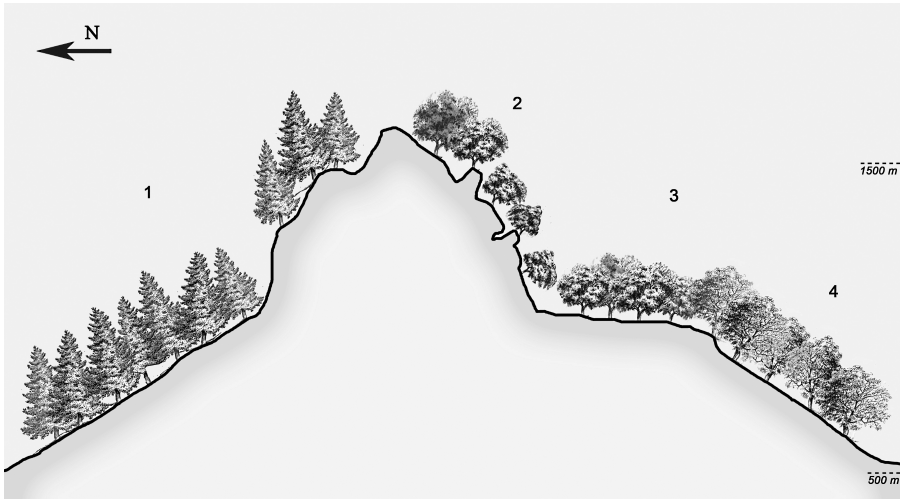

Figure 5 - Rondeño sector (Arundense district). 1.- Climatophilous series (*Paeonio broteri-Abieto pinsapo sigmetum*). 2.- Edaphoseries (*Bupleuro gibraltarici-Querco rotundifoliae sigmetum*). 3.- Climatophilous series (*Paeonio coriaceae-Querco rotundifoliae sigmetum*). 4.- Climatophilous series (*Oleo sylvestris-Querco alpestris sigmetum*).

CONCLUSION

The whole climatophilous series is highly dependent on the ombroclimate and has its own dynamic stages; we therefore recommend defining the ombroclimate for climatophilous forests. In contrast, the edaphoxerophilous series has a high dependence on the soil. Due to its particular topographic and edaphic location it contains a significant number of floristic elements and habitats of great botanical value. For the purposes of territorial management it is useful to decouple the concepts of “edaphoxerophilous” and “climatophilous”, as the vegetation

series forms the basis for forestry and agricultural ordination. The proposed separation between edaphoxerophilous and climatophilous aspects is supported by the fact that the flora, plant communities and the dynamic are different in both situations. Thus a series should be considered climatophilous when certain climatic conditions prevail. If the climate is maintained but the substrate changes, then xericity appears and modifies the floristic composition, the dynamic and the catenal contacts, and it should not therefore be considered the same series.

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