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Variation in the riparian landscape of the Segura River Basin, SE Spain

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Abstract. The woody and shrubby riparian vegetation of the Mediterranean Region of Spain shows a progressive displacement from the *Querco-Fagetea*, typical of Central Europe, towards the *Nerio-Tamaricetea*, which has its maximum expression in North Africa. We studied the occurrence of 107 riparian plant communities on 52 locations in the Segura River Basin (SE Spain) and their presumed relation to variation in rainfall and temperature. On the basis of agglomerative clustering and Redundancy Analysis (RDA) three riparian vegetation complexes were identified and characterized by (a) Central European-related temperate communities, (b) predominantly North African riparian communities and (c) a combination of both community types, respectively. North African communities predominated in the lower stretches of the Segura Basin, probably due to the prevailing semi-arid bioclimate.

Keywords: Classification; Mediterranean region; Ordination; Riparian vegetation.

Nomenclature: Ríos (1996) for syntaxa.

Introduction

River valleys are one of the principal connections between Central and Western Europe and Mediterranean Europe as far as the distribution of the plant communities of the temperate *Querco-Fagetea* forests are concerned (e.g. Tchou 1951; Braun-Blanquet & Bolòs 1958; see also Moreno et al. 1990). The warm and arid riparian habitats of North Africa support the woody vegetation of the *Nerio-Tamaricetea* (Quézel 1965; Zohary 1973; Alcaraz et al. 1989). Both types of riparian woody vegetation co-occur along the lower and middle stretches of many Spanish rivers (Braun-Blanquet & Bolòs 1958; Ríos 1996). Communities of the *Nerio-Tamaricetea* may replace *Querco-Fagetea* forests as a result of disturbances in the river basins. They may also occur naturally on gravel beds of seasonal streams (*Rubo-Nerion oleandri*) or in habitats with a medium to high degree of salinity (*Tamaricion africanae* and *Tamaricion boveano-canariensis*), habitats which are alien to temperate broadleaved forests.

The semi-arid region of SE Spain is climatically unusual and supports many plant communities and species of North-African origin (Alcaraz & Peinado 1987; Alcaraz et al. 1989; Alcaraz 1996). Of all the river basins of SE Spain the Segura River shows the greatest diversity of riparian plant communities because of a great variation in bioclimate and altitudinal range (Alcaraz et al. 1989; Rivas-Martínez 1987; Ríos 1996).

The purpose of this paper is to describe and ecologically interpret riparian landscapes in the Segura Basin on the basis of combinations of riparian plant communities, with special attention to the gradual substitution of temperate communities by those typical of the Saharo-Arabian Region as well as of the southern Mediterranean.

Study area

The Segura River Basin, extends from Pontones, Jaén (38° 13' N, 2° 40'W) to Guardamar, Alicante (38° 10’ N, 0° 38' W) and represents a large part of the southeastern Iberian Peninsula (Fig. 1). The basin itself covers 19 525 km^2 and spans an altitudinal range from 0 to 2100 m. The macrobioclimate of the area is Mediterranean (Walter 1984; Moreno et al. 1990); the regional bioclimate ranges from xeric-oceanic along the low river stretches to mesic-oceanic along the middle and upper stretches (Ríos & Alcaraz 1996). The annual rainfall varies from 250 to 1300 mm; it is very seasonal with a pronounced summer minimum.

The geology of the area is homogeneous, with a predominance of calcareous rocks. Soils are chiefly alluvial, poorly developed calcareous fluvisols, dystrict fluvisols and eutric gleysols (Anon. 1988).

There is a large increase in sulphate and chloride contents found in the river water from the source to the mouth (Vidal 1985), partly attributable to increased evapotranspiration in the warmer low-altitude parts of the basin.

Methods

The riparian vegetation was studied phytosociologically between 1985 and 1994 following the Braun-Blanquet approach (Westhoff & van der Maarel 1978). Ca. 600 relevés made in 430 locations were classified into 107 community types (Ríos 1996). Occurrence of the plant communities was scored in 0.1-ha plots at 52 selected riparian sites (Fig. 1). 93 plant community types were recorded in the selected sites. A list of the plant community types found in the study area and their syntaxonomical status is available on request from the senior author.

Climatic data from meteorological stations located close to the sampling sites were obtained from the 'Instituto Nacional de Meteorología'. These data include rainfall and temperature, from which we calculated the mean seasonal rainfall in mm and the mean maximum and minimum seasonal temperatures in °C.

The plant-community presence/absence data matrix was classified by Average Linkage Clustering with the Jaccard similarity index, using the package SYNTAX 5.0 by Podani (1992). Redundancy analysis on Euclidean Distance (with standardization by species) was performed using the programme CANOCO (ter Braak 1990).

Results and Discussion

Three groups of communities (Types 1, 2 and 3) can be recognized from the cluster dendrogram (not shown here) at the 0.6 dissimilarity level. Two subgroups are distinguished within Type 2. The RDA diagram (Fig. 2) shows a similar clustering to that shown by the cluster analysis, with a horseshoe distribution of sample sites from the right (Type 1) to the left side (Type 3) of the diagram. Type 1 includes community types with a high-altitude distribution, bound to higher precipitation, both winter and summer and low seasonal temperatures. As Table 1 shows, the share of temperate community types as well as the total species richness are highest here. The samples situated at the other end of Axis I (Type 3) are from sites with the highest temperatures and lowest rainfall. These sites are all lowland sites. Here the share of temperate communities is much lower and the share of North-African and also exotic elements largest. Type 2 includes communities of medium altitude. The type 2 samples take an intermediate position from a climatic point of view. Both the dendrogram and the RDA diagram (Fig. 2) show that type 2 is divided into two subtypes; type 2A resembles type 1 and subtype 2B resembles type 3.

Looking at the data set as a whole (Table 1), we note the gradual decrease of Central-European floristic ele-

Fig. 1. Study area showing the location of the 52 sample sites and the distribution of three types of riparian landscape (see text).

Table 1. Characteristics of the three site types, based on plant community composition.

Type	1	2	3
Thermo-climatic type	Oromediterranean	Mesomediterranean	Thermomediterranean
Ombro-climatic type	Subhumid, Humid	Semi-arid to Subhumid	Semi-arid
Water chemistry	Carbonated	Carbonated, Sulphated or high content in chloride	Sulphated, high content in chloride or equilibrium
Water-biotic quality	High	High/medium	Medium/low
Number of riparian taxa	662	562	384
Number of differential taxa	290	54	68
Percentage of exotic elements	1%	7%	14%
Percentage of Central-European elements	21%	12%	5%
Percentage of Mediterranean elements	41%	41%	39%
Temperate component (Querco-Fagetea)	5	4	0
North-African component (Nerio-Tamaricetea)	0	3	5

ments from Types 1 to 3, the increasing importance of exotic plants (possibly connected with growing human influences as one approaches the mouth of the river) and the decrease in river water quality, which can also be partially attributed to human activities and/or to the higher evapotranspiration and water salinity. With regard to the vegetation, similar variations to those observed for the floristic elements, occurred. The *Querco-Fagetea* types were only found in types 1 and 2, where some communities represent the potential natural riparian vegetation. This class is not represented in type 3, in which the potential vegetation is represented by associations of the herbaceous *Phragmito-Magnocaricetea* or the frutescent *Nerio-Tamaricetea*. These classes are represented by permanent community types or as stages of degradation of *Querco-Fagetea* communities.

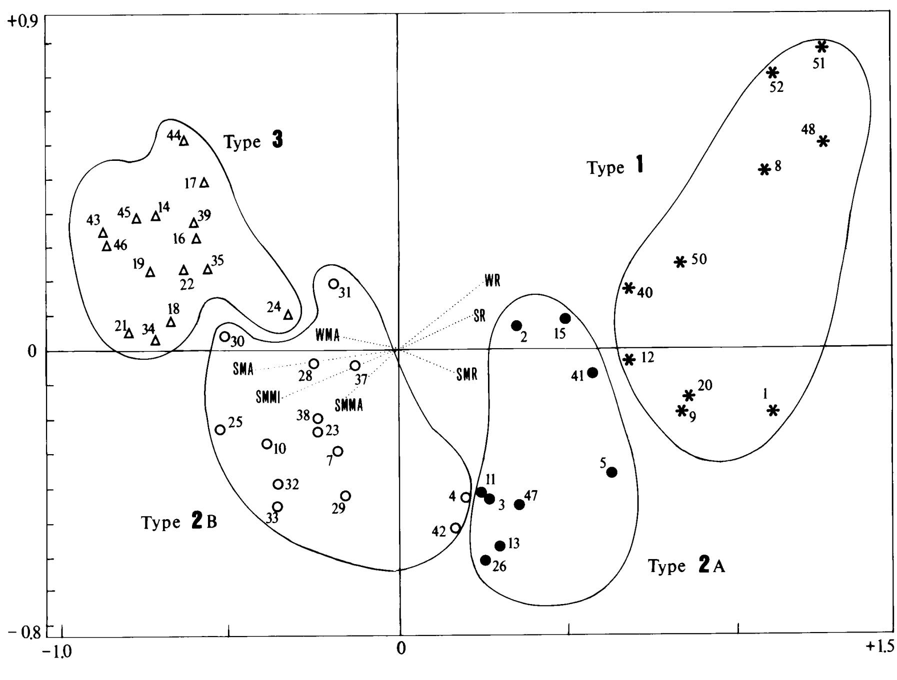

Fig. 2. Diagram of axes 1 and 2 of the Redundancy Analysis with the position of the 52 samples. Also indicated the strength and direction of correlation between the axes and the following environmental variables: WR = Winter rainfall; SR = Spring rainfall; SMR = Summer rainfall; WMA = Winter mean maximum temperature; SMA = Spring mean maximum temperature; SMMI = Summer mean minimum temperature; SMMA = Summer mean maximum temperature.

Type 3 is the most homogeneous type; this is probably the result of both the more extreme climatic conditions and the higher human impact which is, for instance, expressed in the predominance of nitrophilous plant communities. Type 1 is still fairly homogeneous, in this case because of a lack of human influences, so that mainly natural and semi-natural communities occur. The intermediate type 2 is the most heterogeneous.

Conclusions

Given the geological homogeneity of the study area, it is most probable that climatic variation recorded along the river is controlling riparian vegetation patterns.

The differences between the riparian vegetation of Central Europe and North Africa are substantial and well-known. However, no mention has so far been made of European river basins which contain an almost exclusively African type of vegetation. In this respect, the extremely low rainfall of the lower parts of the Segura River Basin together with the high temperatures seem to constitute a major climatic limit which halts the advance of *Querco-Fagetea* plant communities and supports those of the *Nerio-Tamaricetea* and *Phragmito-Magnocaricetea*. These more extreme conditions also result in a high degree of water salinity and a high evapotranspiration. Probably, these are the real controlling factors. The difficulty of establishment of the *Querco-Fagetea* species is also indicated by the difficulties in cultivating species from this class, e.g. *Populus nigra*, *Rosa* spp. and *Salix* spp. (Ríos 1996).

Similar climatic conditions to those registered along the lower stretches of the Segura River Basin (type 3) are also found along the rivers of the Almería (Andárax and Almanzora) and Alicante (Vinalopó) Provinces, where the irregular water volume and higher degree of disturbance have been an obstacle for the study of their vegetation.

The present study reveals the exceptional characteristics of the riparian vegetation of the Segura River. Complexes of plant communities as found in the present study point to the existence of a separate landscape type characterized by a combination of abiotic and anthropogenic influences. Hence we speak of three landscape types according to their flora and vegetation. Finally, the Segura river system itself is a very interesting model for understanding the transition between Central-European and North-African riparian landscapes.

References

Anon. 1988. *FAO/UNESCO: Soil Map of the World. Revised legend.* FAO, Rome.

Alcaraz, F. 1996. Fitosociología integrada, paisaje y biogeografía. In: Loidi, J. (ed.) *Avances en fitosociología*, pp. 59-94. Universidad del País Vasco, Bilbao.

Alcaraz, F. & Peinado, M. 1987. El sudeste ibérico semiárido. In: Peinado Lorca, M. & Rivas-Martínez, S. (eds.) *La vegetación de España*, pp. 257-281. Publ. Univ. Alcalá de Henares, Alcalá de Henares.

Alcaraz, F., Díaz, T.E., Rivas-Martínez, S. & Sánchez-Gómez, P. 1989. Datos sobre la vegetación del Sureste de España: provincia biogeográfica Murciano-Almeriense. *Itin. Geobot.* 2: 5-133.

Braun-Blanquet, J. & de Bolòs, O. 1958. Les groupements végétaux du bassin moyen de l'Ebre et leur dynamisme. *Anal. Estac. Exp. Aula Dei* 5: 1-266.

Moreno, J.M., Pineda, F.D. & Rivas-Martínez, S. 1990. Climate and vegetation at the Eurosiberian-Mediterranean boundary in the Iberian Peninsula. *J. Veg. Sci.* 1: 233-244.

Podani, J. 1992. *SYN-TAX 5.0. Computer programs for data analysis in ecology and systematics on IBM-PC and Macintosh computers.* U.N.I.D.O, Trieste.

Quézel, P. 1965. *La végétation du Sahara, du Tchad à la Mauritanie*. G. Fischer, Stuttgart.

Ríos, S. 1996. *El paisaje vegetal de las riberas del Río Segura (S.E. de España).* ETD Micropublicaciones, Barcelona.

Ríos, S. & Alcaraz, F. 1996. *Flora de las riberas y zonas húmedas de la cuenca del Río Segura.* Publicaciones Universidad de Murcia, Murcia.

Rivas-Martínez, S. 1987. *Memoria del mapa de series de vegetación de España.* I.C.O.N.A., Madrid.

Tchou, Y.-T. 1951. Études écologiques et phytosociologiques sur les forêts riveraines du Bas-Languedoc. *Vegetatio* 1: 2-28, 93-128, 217-257, 347-383.

ter Braak, C.J.F. 1990. *CANOCO - A FORTRAN program for canonical community ordination by [partial] [detrended] [canonical] correspondence analysis and redundancy analysis (version 3.11).* TNO, Wageningen.

Vidal, M.R. 1985. *Las aguas superficiales de la cuenca del Río Segura (SE de España). Caracterización físico-química en relación con el medio físico y humano.* Ph.D. Thesis, Universidad de Murcia.

Walter, H. 1984. *Vegetation und Klimazonen, 5th ed.* Ulmer, Stuttgart.

Westhoff, V. & van der Maarel, E. 1978. The Braun-Blanquet approach. In: Whittaker, R.H. (ed.) *Classification of communities*, pp. 289-399. Junk, The Hague.

Zohary, M. 1973. *Geobotanical foundations of the Middle East.* G. Fischer, Stuttgart.

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