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Patterns of plant diversity and endemicity in the vegetation of North-East Alicante (E Spain)

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Abstract
A study of the floristic and vegetational diversity in the North-East of Alicante (region of La Marina Alta, Eastern Spain) has been carried out. The catalogue of the vascular flora was analyzed according to species attributes related to life form and distribution ranges. The relevé data set was analyzed by clustering techniques to obtain floristically homogeneous habitat types and the corresponding character species with significant indicator values. The results of these analyses show the patterns of distribution among habitats of different plant species groups relevant for conservation purposes.

Key words: Iberian endemics, indicator value analysis, plant diversity.

Resumen
Se estudia la diversidad florística y de vegetación en la comarca de La Marina Alta (noreste de la provincia de Alicante, este de la Península Ibérica). El catálogo de la flora vascular se ha analizado según atributos referidos a los biotipos y a las áreas de distribución de las especies. Las comunidades vegetales, estudiadas a partir de inventarios fitosociológicos, se han analizado mediante técnicas de clasificación que han permitido separar los distintos tipos de hábitats presentes en el territorio y las especies indicadoras de cada tipo de hábitat obtenido. Los resultados muestran los patrones de distribución de distintos grupos de especies de plantas entre los hábitats y pueden utilizarse para argumentar propuestas para la gestión y conservación de estos hábitats.

Palabras clave: análisis del valor indicador, diversidad florística, endemismos ibéricos.

Introduction

The outstanding floristic diversity of Mediterranean areas within the European Union needs an special effort of analysis concerning its patterns to properly establish conservation priorities and measures. We present a study of some aspects of the floristic and vegetational diversity in the North-East of Alicante (region of La Marina Alta, Eastern Spain), a small area included among the Mediterranean hotspots of plant diversity (Médail & Quézel, 1997). Our study is based on a complete catalogue of the vascular flora of this area, and a phytosociological survey comprising more than 1000 relevés ascribed to 34 classes and 114 associations. 42 habitat types of the Directive 92/43/CEE, 10 of them considered as priority habitats, are included among these vegetation units.

Phytosociological studies like this may be useful in the measure that are comprehensive of the whole habitat diversity of a territory. In this way, the information coming from a phytosociological survey can be applied to the assessment of the distribution among different habitats of those components of plant diversity relevant for conservation purposes.

Study area

The region of La Marina Alta is a small territory (736 km^2) located in eastern Spain. It belongs to the Baetic-Rifan complex, and is composed of Triassic and Quaternary geological materials, with a predominance of Cretaceous limestones. Climate is Mediterranean; average temperature ranges between 14.5-17.5 ºC and annual precipitation between 500-900 mm. According to the bioclimatic classification of Rivas-Martínez (*in* Rivas-Martínez & Loidi, 1999), two thermotypes of the mediterranean oceanic pluviseasonal bioclimate are represented in the territory: thermo and mesomediterranean. The subhumid ombrotype occupies most of the territory, the dry ombrotype is restricted to its southeast corner. Biogeographically the territory belongs to the Valenciano-Catalano-Provenzal subprovince, Setabense sector and Diánico district. Four climatophilous series of vegetation have been recognized and described, as well as four edapho-hygrophilous series, the geoseries of marshes and salt-marshes, and the edapho-xerophilous geoseries of sand dunes and sea-cliffs (Pérez Badia, 1997).

Methods

The complete floristic catalogue was characterized according to several attributes of the species: families, life forms an distribution range -native, endemics (Pérez-Badia, 1997) and xenophytes (Bolós *et al.*, 1990). The relevé data set was analyzed by clustering techniques in several steps to obtain floristically homogeneous, main groups. First, a clustering with all the relevés (not showed) was carried out to check for the homogeneity of the relevés belonging to the same association table. 82 sufficiently homogeneous clusters were identified and synthetized in two matrices of 1020 species x 82 relevé groups containing the relative frequency or the average abundance of each species in every group. New clustering procedures (Sorensen distance, complete linkage) were performed on these matrices to reveal the higher structure of the vegetation units. Two splitting levels were accepted, the first comprising 11 clusters and the second one 20. A third splitting level (115 groups) was reserved for the individual associations with a representative number of relevés.

Indicator species analysis (Dufrêne & Legendre, 1997) was carried out on these 3 levels of classification using PC-ORD package (McCune & Mefford, 1999). This method is based on the calculation of the indicator value *(IV)* for each species in each group. *IV* formulation combines information on the concentration of species abundance in a particular group and the faithfulness of occurrence of the species in the same group. *IV* can be tested for statistical significance using a Monte Carlo permutation technique. In this way, the species set statistically linked to a relevé group (the character species) can be extracted. Working with several classification levels makes also possible to extract succesively more indicator species whose *IV* are significant at different levels of detail.

The set of indicator species extracted from the relevé matrix was analysed considering again their life forms an distribution ranges.

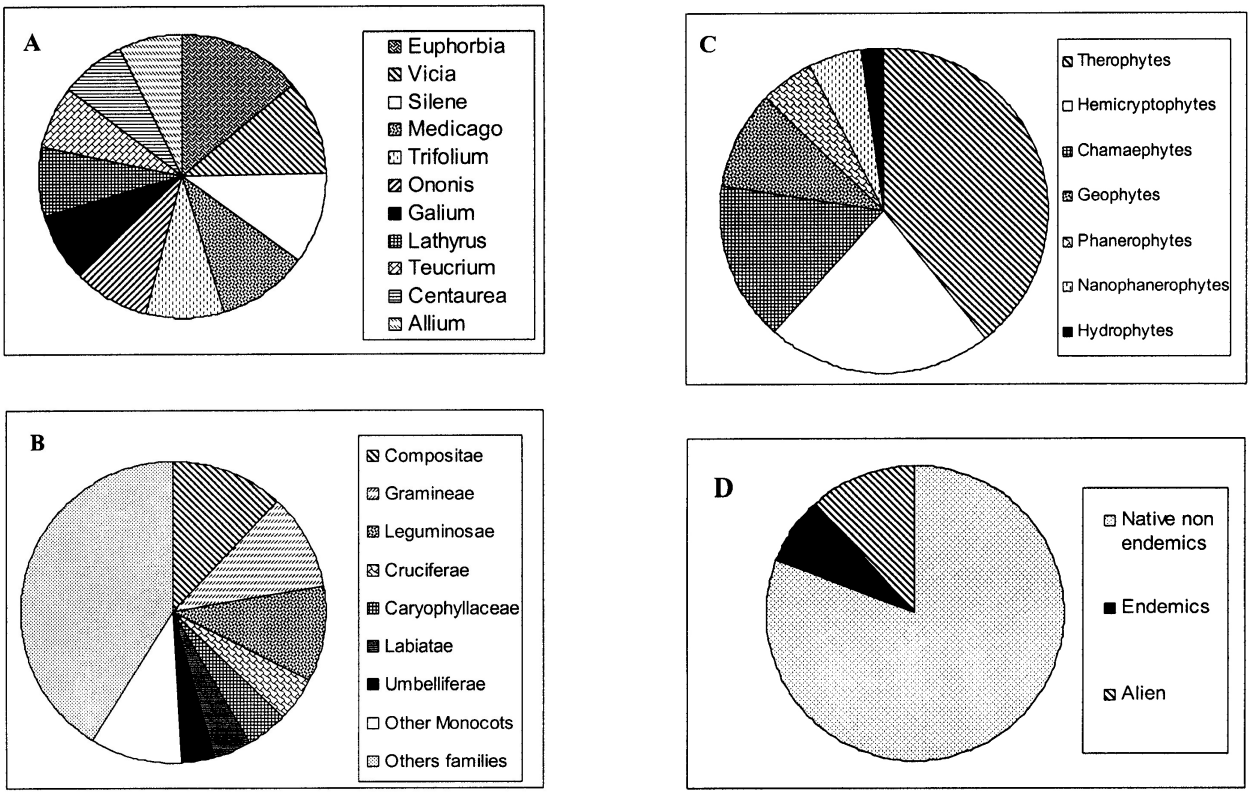

Fig. 1 - Flora of La Marina Alta (NE Alicante). A: Distribution of species among the 11 richest genera. B: Proportion of species richness by families. C: Proportion by life forms. D: Proportion by distribution ranges

Results and Discussion

Catalogue of vascular flora

The vascular flora of La Marina Alta comprises 1489 specific or subespecific taxa belonging to 615 genera and 133 families. It is an important amount taking into account the moderate size of the territory. *Compositae*, *Gramineae* and *Leguminosae* are in this order the richest families; 7 families account for 50% of all species (Fig. 1B). The genera with more species are *Vicia*, *Euphorbia*, *Silene*, *Medicago*, etc. (Fig. 1A). Around 40% of the flora are annuals and 75% belong to herbaceous species (Fig. 1C). Among woody plants the highest species richness deals with low shrubs (chamaephytes) (Fig. 1C). Alien species amount 171 (14.5%), while endemics to Eastern or Southern Spain (Iberolevantine, Murcian-Almeriense and Baetic provinces) amount 111 (7.6%) (Fig. 1D).

Clustering

The initial relevé matrix is composed of 1194 relevés and 1020 species. A chi-square test performed on the proportions of the species of the catalogue and the species represented in relevé matrix did not reveal significant differences among families, life forms or distribution ranges.

The structure of the groups of relevés in the second step of clustering is showed in Fig. 2. Tab. 1 contains an explanation of the habitats represented in the groups. Clustering based on species frequencies (after arcsine transformation; Fig.2) were in general more efficient in recovering the habitat relationships between vegetation units, although the relative position of some units changed when average abundances were used, as in the case of the groups Rs and Gm-Gw for which we took their position in the later clustering (not showed). The clustering structure relies on habitat affinities apart

Tab. 1 - Main groups from clustering levels 1 and 2

Level 1		Level 2		Included syntaxa
A	Aquatic vegetation	A		*Lemnetea, Potametea, Ruppietea*
H	Helophytic vegetation	H		Phragmitetea
C	Coastal vegetation	Cc	Coastal cliffs	*Crithmo-Staticetea, Cakiletea, Saginetea*
		Cd	Coastal dunes	*Ammophiletea,(Malcolmietalia)*
S	Salt marshes	S		*Salicornietea, Juncetea, Thero-Salicornietea*
R	Rock vegetation	Rc	Chasmophytic vegetation	*Asplenietea, (Hypericion ericoidis)*
		Rs	Scree and wall vegetation	*Thlaspietea, Adiantetea, Anogrammo-Polypodietea, Parietarietea, Sedion*
G	Mesic grasslands	Gm	Mesic calcareous grassl.	*Festuco-Brometea*
		Gw	Wet grasslands	*Molinio-Arrhenatheretea*
N	Nitrophilous (ruderal) vegetation	Np	Perennial	*Onopordetea*
		Nw	Woody	*Pegano-Salsoletea*
Nh	Hygronitrophilous vegetation	Nh	Hygronitrophilous vegetation	*Bidentetea, Imperato-Erianthion, Solano-Polygonetalia, Chenopodietalia*
T	Therophytic vegetation	Ta	Annual grasslands	*Tuberarietea*
		Ts	Subnitrophilous annual grasslands	*Poetea bulbosae, Brometalia rubenti-tectorum, Polygono-Poetea*
		Tw	Weed and ruderal annual vegetation	*Sisymbrietalia, Secalietalia*
D	Dry shrublands and grasslands	DG	Dry grasslands	*Lygeo-Stipetea*
		DM	Dry shrubland (matorral)	*Rosmarinetea*
		DS	Sclerophyllous shrubland	*Pistacio-Rhamnetalia*
F	Forests and woodlands	Fs	Sclerophyllous forests	*Quercetalia ilicis*
		Fr	Riparian forests and thickets	*Populetea, Querco-Fagetea, Rhamno-Prunetea, Nerio-Tamaricetea*

from syntaxonomical relationships, classes or high rank syntaxa related to similar habitats are commonly close together.

Indicator species analysis

The indicator species analyses carried out at the three classification levels reported 630 species with significant indicator values (*IV*) with respect to one group of relevés at least in one of the levels. By aggregating the species with significant *IV*s at lower levels into the upper levels, we compiled the character species set for the classification levels used, i.e., the complete set of species being significantly related to one of the relevé groups considered, at least at one of the three levels. In the measure that these species are consistently linked to the main habitats recognized and represent an important fraction of the species captured by the relevé set, they can be used to infer the plant attributes or characteristics selected in each habitat.

The analysis of the indicator species by main habitats and attributes is illustrated in Fig. 3. Life forms of indicator species show some obvious trends, like the composition of aquatic, helophytic or annual-dominated habitats. In other cases vegetation groups floristically related differ greatly in their life forms at the second level of classification, as in rock vegetation, ruderal vegetation or dry shrublands and grasslands. Habitats characterised by extreme environmental conditions tend to show less life form diversity. Finally, it is noteworthy the high life form diversity of the indicator species of forests, woodlands and shrublands.

Alien species are mainly distributed in wet or disturbed habitats, reaching their maximum proportions in hygronitrophilous vegetation types and in helophytic communities. Endemics show a rather opposite pattern, being present in a number of different habitats but with a clear overrepresentation in chasmophytic communities, followed by other habitats characterised by thin or poorly developed soils: Mediterranean shrublands, sea cliffs, screes and xeric grasslands.

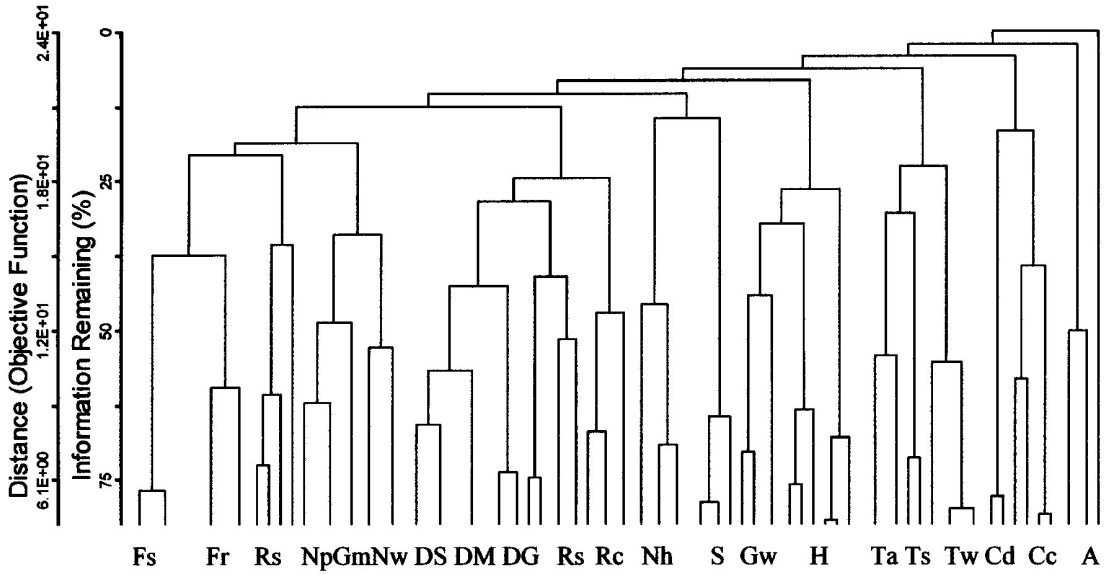

Fig. 2 – Results of classification performed on 82 relevé groups

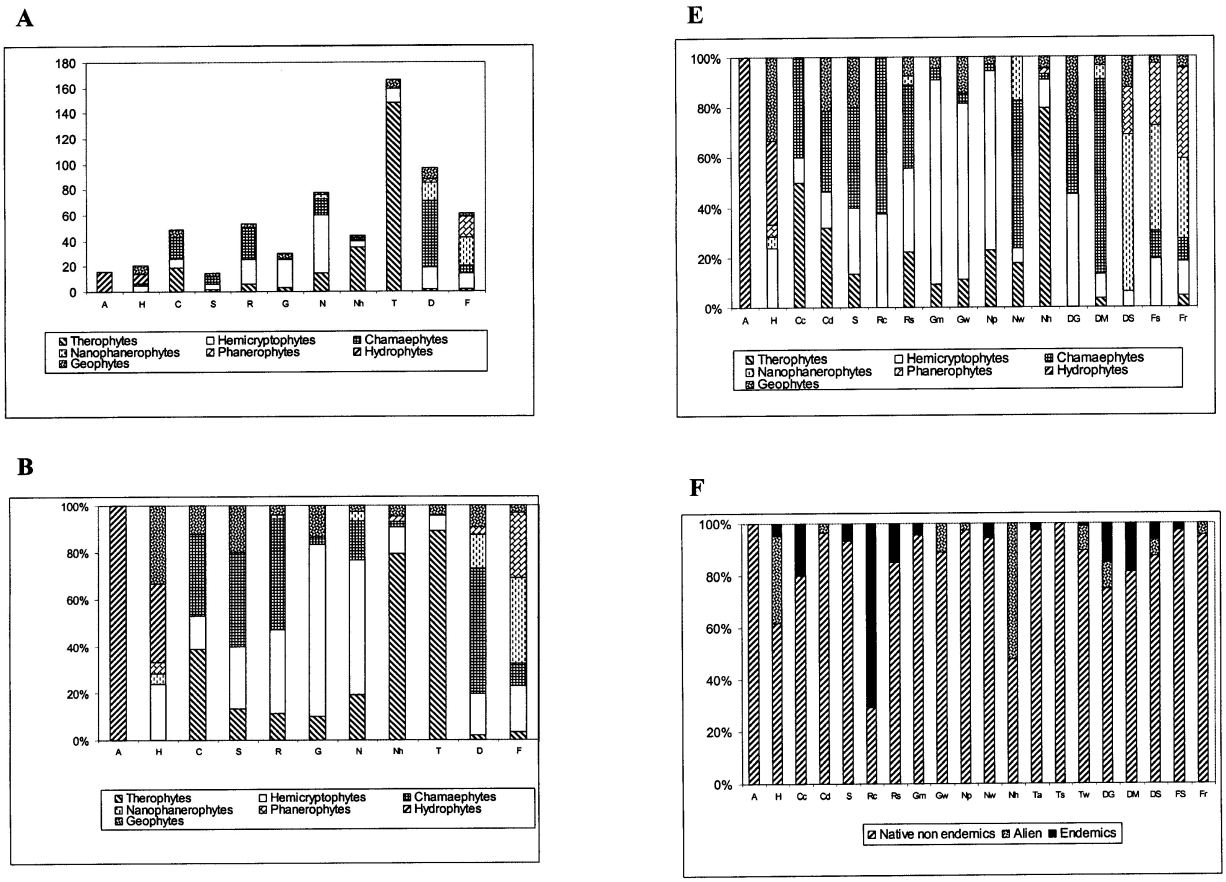

Fig. 3 – Number (A,C) and proportion (B,D) of species with significant indicator values by life forms (A,B) and by distribution range (C,D) for each habitat type at the level 1, and proportion of species with significant indicator values by life forms (E) and by distribution range (F) for each habitat type at the level 2 of classification

References

Bolòs O., Vigo J., Masalles R. & Ninot J.M., 1990. Flora manual dels Països Catalans. Ed. Pòrtic. Barcelona. 1246 p.

Dufrêne M. & Legendre P., 1997. Species assemblages and indicator species: the need for a flexible asymmetric approach. Ecol. Monogr. 67: 345-366.

McCune B. & Mefford M.J., 1999. PC-ORD. Multivariate analysis of ecological data, Version 4. MjM Software Design, Gleneden Beach, Oregon.

Médail, F. & Quézel P., 1997. Hot-spots analysis for conservation of plant biodiversity in the Mediterranean Basin. Ann. Missouri Bot. Gard. 84: 112-127

Pérez Badia, R., 1997. Flora y vegetación vascular de la comarca de La Marina Alta (Alicante). Inst. Juan Gil Albert. Diputación de Alicante. 577 pp.

Rivas-Martínez S. & Loidi J., 1999. Bioclimatology of the Iberian Peninsula. Itinera Geobot. 13: 41-48