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ECOLOGICAL, LIFE FORMS AND PROVENANCE DIVERSITY IN MIRALRÍO. COMPARISON WITH THE FLORA OF THE WESTERN «LA ALCARRIA» OF GUADALAJARA PROVINCE

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I. INTRODUCTION, AIMS AND METHOD

This paper continues as a second part the geographical phytodiversity study conducted by García-Abad and Panareda (2012). Thereby this previous paper must be consulted for know the methodological background and references about the study area. It carries out a vascular plant inventory in order to establish ecological, life-forms and provenance spectra in nine contiguous 1×1-km grid cells (U.T.M., *Datum* ED50) –C1, C2, C3,...C9–, and their 3×3-km aggregate cell (9C) that they shape around to little town of Miralrio (Province of Guadalajara, Central Spain). The physical-geographic and phytogeographic characteristic traits of this municipality are typical of the Western «La Alcarria» of Guadalajara province landscapes (from now AOG, sub-region that covers a total of 3.200 km^2) to which Miralrío belongs. Since those three geographic units are nested (1×1-km, 3×3-km grid cells and AOG), spectrum each one could be compared between themselves to dilucidate their floristic relationships. At the same time, this study should be encompassed within a major methodological approach of floristic geographic analysis initiated by García-Abad (2009) on a region named Western La Alcarria and «Mesa» of Ocaña (from now AM, that covers a total of 6.700 km^2) to which AOG belongs in turn.

Futhermore, we aim: 1) to present three vascular spectra for that sub-region (AOG): ecologyc, life forms and provenance; 2) to present these same spectra separately for each nine 1×1-km cells (C1, C2,... C9) and unitedly for the 3×3-km (9C) aggregated grid cell (Figures 1 and 2); 2) to compare all these spectra and to get phytogeographical interpretations; and finally 3) to realize a geographically nested analysis of all outcomes.

II. RESULTS

II.1. Plant Ecological Spectrum in Native Flora of AOG and Miralrío

First, absolute data about the ecological spectrum is shown for the three distinct size units –AOG sub-region, 9C and 1×1-km cells- (Table 1). These data are reduced to percentages to allow their comparison (Figures 3 and 4).

The spectrum of 18 ecological groups detecting in the AOG sub-region are relatively similar to that of the regional spectrum (AM). Likewise weed and ruderal plants dominate the entire flora of AOG (278 of the whole of 1270 taxa). Their native flora presents the following ecological order as typical model:

Weed and Ruderals (Hrv) > Unclassified, tolerant and other plants (av) > Therophyte grasses (Ht) > Mesophytic to slightly xerophytic perennial grass-dwarf scrubs (Hm) > Mesophile to wet grazed and anthropic meadows and pastures (Pmh) ≈ Seral dwarf scrubs (Ms) > Semi-shaded nitrophilous to slightly nitrophilous vegetation (Snn)

This order is very similar to that of the aggregate unit (9C) of Miralrío (compare percentages in Figures 3 and 4), with the exception that «Pmh» group decreases as «Snn» group increases. It is possible to deduce that disturbances due to forest activities in Miralrío occurred more than those due to livestock.

The main difference between 9C and AOG models is the greater degree of artificialization in the 3×3-km grid cell (27,2% of weeds and ruderals vs. 21,9% respectively). In the other ecological groups differences are not particularly relevant, just like that it is admissible to consider 9C-AOG ecological patterns to be relatively analogous. The «Hrv» ecological group is major contributor to homogenize floristically AOG, since nearly two thirds of these plants occurre in 9C-Miralrio (182 taxa of all 278). Therefore there is a strong concentration of these plants on 3-km squares of AOG typical landscape. Obviously, human-made activities explain this spatial-functional trait. In a third level of nesting (each 1-km square separately), this human-made trait increases strongly since that spatial concentration of arable weeds and ruderals experiences more relative proportions (by way of example, 140 «Hrv» plants occurre in C4, i.e. the half of all plants occurring in AOG).

At the second level of nesting (3-km square), likewise the whole of oak evergreen micro-forest («Bpe»), your seral mantle decidous shrubs («Asp») and your nemoral floristic cortege («Snn») plants help quite to homogenize the 9C-Miralrío flora (94 taxa of all 147 having AOG).

Less size of 1-km square explains absence of some ecological groups into each of nine separated grid cells. Nevertheless, the average of existing groups is quite high (15,4; with an absolute rank of 14-17). These outcomes exhibit that one typic square kilometer of AOG landscape already contains much of their environment diversity. The 1×1-km grid cells always have the «Hrv» group as leader, but such leadership is unequal depending disturbance factors into they.

The common Flora column (FC, Table 1) provides data on how secular human perturbance has affected to the internal cohesion of plant ecological groups within their regular smaller subunits (1 km^2). And is that only 134 of the 669 (27%) native plants occurre in the nine grid cells! Thereby, the intensive crop exploitation on top of tableland yielded such a landscape fragmentation that has propitiated extinction of more interesting plants for conservation. Consequently, most of plant ecological groups have broken down and have disjointed spatially, and weeds and ruderals have spread widely.

II.2. Life forms Spectrum in Native Flora of AOG and Miralrío

Second, absolute data about the life forms spectrum is shown similarly for the three distinct size units (Table 2). Likewise, these data are reduced to percentages to allow their comparison (Figures 5 and 6).

This spectrum in the AOG is similar to that of the regional spectrum (AM) presented by García-Abad (2011), although it highlights that hemicryptophytes (440) nearly equal number of terophytes (456), due to submontane to montane character of much of AOG. The model is:

Therophytes (T) > Hemicryptophytes (H) > Chamaephytes (C) > Phanerophytes (F) > Geophytes (G) > Hydrophytes and Pleustophytes > Helophytes > Lianas

In turn, the 9C model fits with that of AOG. However, it differs somewhat in that there is a slight decrease in the number of hemicryptophytes, phanerophytes and geophytes due to increase of therophytes. This fact shows that flora composition is more sensitive to effects of artificialization at finer scales. Likewise, if it consider first five terms, models of almost all grid cells fit with that of AOG. Nevertheless, there are some particular singularities depending of inside landscape configuration of each grid.

Within 9C the most importante gap between 1-km squares consists in the percentage of therophytes and in the therophytes/hemicryptophytes ratio. These facts are very influenced by the different degree of fragmentation and disturbance within them. Extreme exemples: C5 exhibits the larger difference between both life-forms (151 therophytes against 91 hemicryptophytes) due their high degree of anthropogenic pressure, and oppositely, C6 exhibits the smaller difference (144 against 140) due their low corresponding degree.

Regarding common Flora, with data no simplified of Table 2 (FC), chamaephytes and nanophanerophytes are the less dissimilar life-forms against the most dissimilar (geophytes).

A closely related character with life forms is plant survival, and thereby these were grouped in three synthetic categories (Fig. 7) to show proportions at each nesting spatial level. The outcomes yielded by this criterion were: a) percentage of woody species (trees, bushes and shrubs) in 9C is the same of AOG; b) percentage of annual species increases slightly in 9C over AOG; c) consequently, percentage of herbaceous biennial-perennials increases as more semi-natural environments are present.

II.3. Chorological Spectrum in Native Flora of AOG and Miralrío

Third, absolute data about the chorological spectrum is shown similarly for the three distinct size units (Table 3). Likewise, these data are reduced to percentages to allow their comparison by using geographical groups more synthetic (Figures 8 and 9).

AOG is situated in Central Iberian Peninsula and, consequently, their bioclimatic traits are the typical of the temperate zone and the Mediterranean region. Thus, the prevailing chorological type of flora is the strictly mediterranean (almost 30%). In order, the following chorological group is the broadly mediterranean (almost 23%). And thirdly, Iberian and Balearic endemics resulted almost the 9%. As can be seen, these three groups, linked with the Mediterranean Region, sum up almost 62% of the flora.

Chorological broad groups are synthesized in Figure 10. The AOG native flora presents the following order as typical model:

Supra and Extra-Mediterranean > Strictly Mediterranean > Broadly Mediterranean > Iberian and Balearic Endemics

In turn, the 9C model fits with that of AOG. However, it differs somewhat in the low number of endemics due their small area. Almost all 1-km squares have the same model, with some exception and fine-tunings. In general, these consist of that lanscape artificilization mainly affects loss of Supra and Extra-Mediterranean elements (See C1, C3 and C7).

In AOG, Iberian and Balearic endemic flora consists of 110 vascular plants (8,7%) assigned to 29 families, of wich the taxonomically richest are: *Compositae* (18), *Labiatae* (13), *Caryophyllaceae* (11), *Cruciferae* (11) and *Scrophulariaceae* (10). No plant is strictly endemic of AOG because this sub-region is not a particularized floristic area. In the 9C assamblage, there are 38 endemics (5,7%) that represent 34,5% of 110 previously referred.

1-km squares reach a mean of 22,6 endemics per unit area-1 km^2 (maximum of 26, and minimum of 11), that implies a mean of 20,5% of all presents in AOG.

Common Flora column (Table 3) shows a very low cohesion of the different biogeographic aggregates in 9C, above all of the Supra-Extra-Mediterranean elements.

II.4. Non-native Flora of AOG and Miralrío

A provenance analysis of plants made with biogeographic criterion allow us to show synthetically the elementary data for three nested levels (Table 4). A ratio AU/AL between native plants (AU) and alien plantas (AL) was calculated. 138 alien plants were encountered in AOG. Their proportion is higher than in other two nested levels: a ratio of 9,3. This ratio rises slightly in 9C (11,0), but this increase is strongly high in almost all of the 1×1-km grid cells (it ranges from 10,4 to 62,3). The exceptions are those more anthropized (C4, C5, C7 and C2).

Indeed, most alien plants are concentrated near the village of Miralrío (C4). They are linked to orchards (abandoned or not), springs, sheds, threshing-floors, recreational facilities and communication routes.

Phytoecological meaning of AOG alien flora is related with the relative large extension of the agricultural landscape (weeds in arable land, fruit trees in edges and hedgerows). This pattern is also present in 9C and in C1, C3, C4 and C7. Traditional agriculture has impacted widely: *Rosaceae* fruits (*Prunus* spp. and other), Mediterranean triad (cereals, vines, olives), walnuts, figs, etc. In this way, herbaceous neophytes are widely expanded as weeds (*Amaranthus*, *Xanthium*, etc).

Table 5 shows taxonomical spectrum in alien flora of three nested unit types. In AOG, top position is headed by the same three families leading typical model in native flora (García-Abad & Panareda, 2012). Unique difference is that the *Rosaceae*, matched with *Gramineae* in the third position, joins the leader group. The order in typical model is:

Compositae = Leguminosae > Gramineae = Rosaceae > Amaranthaceae = Solanaceae = Cucurbitaceae ≈ Oleaceae

Likewise it highlights that three minoritary families in native spectrum such *Amaranthaceae*, *Solanaceae* and *Cucurbitaceae* increase their composition in alien spectrum.

In turn, the 9C model fits relatively with that of AOG. It highlights that: a) *Rosaceae* are the leadership, b) *Gramineae* decrease their presence; and c) there is not *Cucurbitaceae*. That typical model in 1-km squares is partially disrupted depending the different conditions each one. Alien flora has very few cohesion between those 1-km grid cells because their distribution is uneven (example: 46% of alien plants are in C4). This fact can be also explained by Ornamental character of several taxa.

The attributes of life forms of non-indigenous taxa are presented in Table 6. This spectrum differs a lot of the indigenous flora (see Table 2 and Figure 5). Despite therophytes slightly increases their percentage (39,1%), the group of phanerophytes surpasses them (39,9%). This increase comes at the expense of hemicrypthophytes (10,9%), geophytes (5,1%) and chamaephytes (3,6%). Cultivated trees and small trees for crops and ornamental use explain this important compositional variation. The life forms characteristics of C4, by being the square more influenced by alien composition, is extrapolated to 9C.

Table 7 shows chorological spectrum in alien flora. The geographic origins of alien plants occurring in AOG are fairly distributed. Without aggregations, strictly tropical plants dominate (*Cucurbita* spp., *Physalis* spp., *Setaria* s*pp*., etc, sum up 15,2%) being usually naturalized in arable lands and ruderal environments. In 9C this group has less presence (8,2%: *Amaranthus hybridus*, *Conyza bonariensis*, *Echinochloa crus-galli* and *Setaria viridis* area encountered as weeds in mesophilic environments). In AOG, aggregate geographical origins are in order the following: Euroasiatic (*Rosaceae* agricultural trees, *Ailanthus altissima*, *Juglans regia*, *Ulmus pumila*, etc), strictly Mediterranean and broadly Mediterranean (*Medicago sativa*, *Vitis vinifera*, *Rhus coriaria*, etc), American non-Tropical (*Amaranthus* spp., *Xanthium* spp.), near-European (*Centaurea* spp., etc),

Last, of 138 alien taxa found in AOG, only 23 has invasive character. They are an important risk for the survival of the autochthonous flora. Table 8 shows a quantitative synthesis where allochthonous and damnific plants are apportioned. These data are reduced to percentages (Figure 11).

In AOG, 16,7% of non-native plants are invasive. This percentage is similar in 9C. In turn, C2, C4, C6 and C8 have analogous percentages. Conversely, less rich 1-km grid cells have smaller ratios. Mainly, in AOG invasive alien plants spread through agricultural crops (*Amaranthus* spp., *Conyza* spp., *Xanthium* spp.). There are important invasions along most roads and rural tracks (*Ailanthus altissima*, etc).

III. DISCUSSION AND CONCLUSIONS

A new methodological variant was proposed with regard to traditional biogeographical studies in Spain, consisting to: a) emphasize floristic analysis; b) analyse continuous and regular geographical units of small area to know more detailed biogeographical facts; c) compare resultant values of these units with those of the regions to which belonging. This nested comparation allows that: a) absolute amounts and percentages obtained have both descriptive value as predictive, and b) detailed and current floristic inventories propitiate periodical revisions and updates, thus promoting improve of floral databases.

Human use of landscape in Miralrio alters the vegetation structure and floristic composition as follows: a) weeds and ruderal plants proportionally increases as more reduced is the extension of geographic units due to landscape fragmentation, and b) phytoecological groups undergo a general disruption within the 1-km grid cells, except when semi/natural elements of landscape remain. However, in 9C unit the floristic models of Alcarria region are nearly similar.