



Yew (*Taxus baccata* L.) population dynamics in the Iberian Mediterranean Mountains: natural regeneration and expansion in East Central System (Spain)

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Abstract

Aim of the study: To evaluate demographical dynamics of yew populations in the Iberian Mediterranean mountains in order to assess population trends and a hypothetical natural regeneration of the species.

Area of study: Ayllón Mountain Range, Eastern end of Central Mountain Range, Spain.

Materials and methods: A field survey was conducted on three yew groves, taking data of altitude, orientation, companion woody species, UTM coordinates, height, perimeter (at breast height, 120cm) and sex. Individuals were classified in four age groups, considering height and trunk perimeter: *AgeGroup1*, Seedling; *AgeGroup2*, Juvenile; *AgeGroup3*, Adult and *AgeGroup4*, Old. Finally *Recruitment rate* was calculated for each population.

Main results: Surveyed yew populations include more than 1600 trees, showing elevated *Recruitment rates*, which indicates that there are more seedling and juvenile individuals (*Group1 and Group2*) than adult and old ones (*Group3 and Group4*).

Research highlights: Surveyed yew populations show vigorous regeneration. These results lead us to reconsider the relictic character assigned to the species in the Iberian Mediterranean mountains.

Key words: Ayllón; microclimatic; regeneration rate; relictic; survey.

Authors' contributions: Project design and conception: RBR, HSO and FVE. Field Work: RBR, FVE and HSO. Data analysis and interpretation: RBR. Manuscript drafting: RBR. Critical revision: HSO and FVE. Paper writing: RBR.

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Introduction

As an Atlantic climate species, European yew (*Taxus baccata* L.) presence in the Mediterranean region is scattered. Temperature rise in the current interglacial period and its associated effects, such as increase of evapotranspiration and summer droughts, have restricted yew distribution to mountain areas which act as climatic shelters (Serra, 2007). Therefore, yew is considered a relictic species in the Mediterranean region (Arroyo *et al.*, 2004).

Taxus baccata occurs in all almost Iberian mountain ranges, being more abundant in northern areas, frequent in southeast territories and absent in southwest regions

of Spain. It rarely forms dense monospecific groves (Serra, 2009). Yew main ecological requirement is environmental humidity, habiting only in places with precipitations up to 600mm per year. Thus, Mediterranean region yew distribution is restricted to mountain areas. It grows in fresh, moisture, and shadowed places such as river and stream shores, north exposed slopes or deep valleys, where topography and altitude reduce temperature and evapotranspiration (Cortes *et al.*, 2000).

Currently, yew populations are considered to be regressing (Serra, 2007). The main reason is half mountain ambient changes due to the Holocene climate warming. Although other causes can be considered,

such as, life cycle limitations and the expansion of more competitive species or human disturbances (Serra, 2007).

Besides climate warming, most authors agree that seedling mortality caused by herbivorous trampling and browsing is the main cause affecting natural population regeneration (Cortés *et al.*, 2000; Serra, 2007; Iszkulo, 2011). Therefore, considering current rural land abandonment and livestock pressure reduction (López, 1982) as well as other disturbances like timber extraction, yew populations regeneration dynamics could be anticipated.

In this context, the aim of this study is to survey three groves of *Taxus baccata* in the Ayllón Mountain Range (East Central System), in order to assess its demographic structures and population dynamics considering a hypothetical natural regeneration.

Material and Methods

Study area

The study was conducted in the Ayllón Mountain Range, located at the eastern end of the Central System Range of the Iberian Peninsula, Spain. Topographic heterogeneity and altitudinal variations (from 1000m up to 2272m) act as climatic diversification factors, causing numerous microclimatic conditions where Atlantic species can grow. The survey was carried out on three yew groves: Arroyo de la Tejera (41.247°N- 3.416°O, Rio frío de Riaza municipality, Segovia province); Acebeda de Becerril (41.262°N-3.371°O, Riaza municipality, Segovia province); Arroyo del Ermito (41.146°N-3.497°O, El Cardoso de la Sierra municipality, Guadalajara province).

Field measurements

Localization and survey has taken 17 field work days between September 2017 and May 2018. At first, each population was characterized by the substrate type, altitude, orientation, dominant vegetation and companion woody species. Then, each tree was surveyed taking data of UTM coordinates (Garmin GPS-map 62st), height, trunk perimeter (circumference at breast height, 120cm) and sex. Less than 5cm high seedlings were excluded due to their high mortality rates. Finally, according to Fernández *et al.* (2015), individuals were classified in four age groups considering height and trunk perimeter: 1) *AgeGroup1*, Seedling: Lignified plants between 5cm and 150cm tall; 2) *AgeGroup2*, Juvenile: Trees taller than 150cm

and with a trunk perimeter up to 50cm; 3) *AgeGroup3*, Adult: Trees with trunk perimeter above 50cm and less than 300cm 4) *AgeGroup4*, Old: Trees with trunk perimeters above 300 cm.

Data analysis

According to Serra (2007), *Recruitment rate* can be defined as (Equation 1):

$$Rr = \frac{\text{Seedlings and juvenil trees}}{\text{All population trees}} \quad (1)$$

calculated for each grove and used to define the populations dynamics. Maps were made using the geographic information system QuantumGis.

Results and Discussion

Yew groves are located in places where topographic characteristics originate optimum microclimatic conditions to the biophysics requirements of the species (Cortés *et al.*, 2000). The presence of Atlantic companion species like: *Fagus sylvatica L.*, *Corylus avellana L.*, *Ilex aquifolium L.*, *Vaccinium myrtillus L.*, *Fraxinus excelsior L.*, *Betula alba L.*, *Arctostaphylos uva-ursi (L.) Spreng* or *Quercus petraea (Matt.) Liebl*, indicates that yew groves locations are areas with exceptional humidity and moisture in the Mediterranean region.

Arroyo de la Tejera

“Arroyo de la Tejera” is a mountain creek which runs inside a north oriented Pyrenean oak forest and heath shrubs. The core yew grove is located between 1552m and 1562m of altitude, grown on siluric slates and quartzite. Woody companion species are: *Quercus pyrenaica Willd.*, *Juniperus communis L.*, *Fagus sylvatica*, *Corylus avellana*, *Erica arborea L.*, *Crataegus monogyna Jacq.*, *Ilex aquifolium*, *Vaccinium myrtillus*, *Frangula alnus Mill.*, *Sorbus aucuparia L.*, *Fraxinus excelsior*, *Betula alba*, *Sorbus aria (L.) Crantz.*, *Salix atrocinerea Brot.*, *Cytisus scoparius (L.) Link.*, *Arctostaphylos uva-ursi* and *Quercus petraea*. In all, 171 yew trees were counted (Fig. 1), with a Recruitment rate of $Rr = 0.93$

Acebeda de Becerril

“Acebeda de Becerril” yew grove is located at the altitudinal limit of a north orientated mixed decidu-

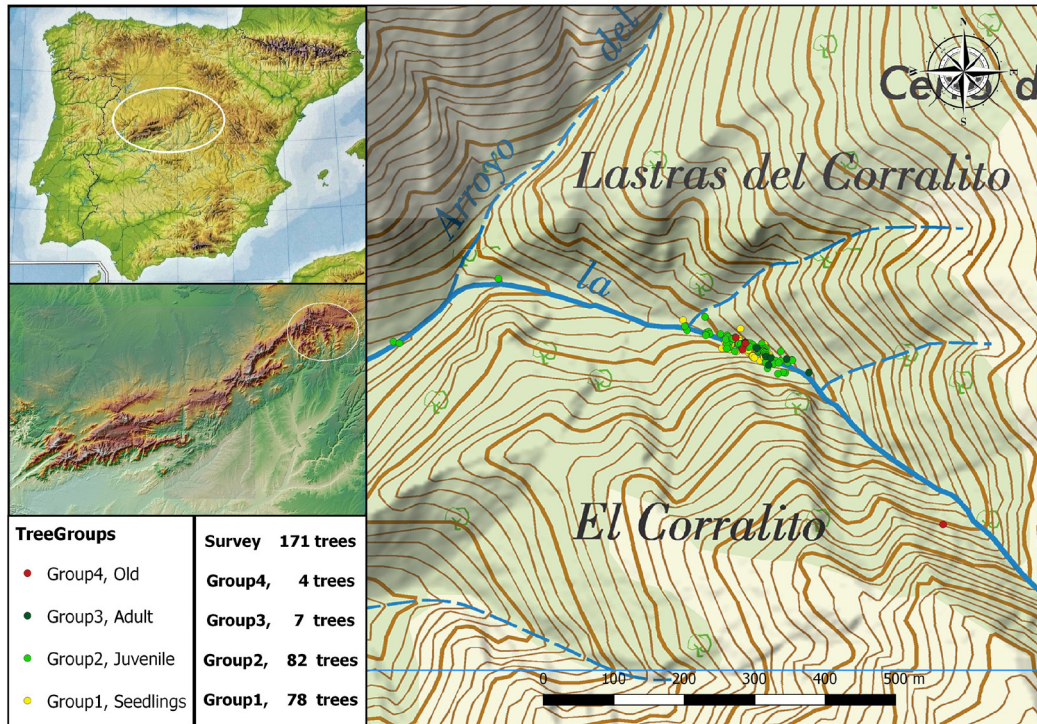


Figure 1. “Arroyo de la Tejera” yew population. In all, 171 yew trees were surveyed.

ous forest, grown on siluric slates. The main specimens are located between 1711m and 1717m of altitude. Woody companion species are: *Fraxinus excelsior*, *Quercus pyrenaica*, *Quercus petraea*, *Fagus sylvatica*, *Acer monspessulanum* L., *Sorbus aria*, *Sorbus aucuparia*, *Juniperus communis*, *Rhamnus*

alpines L., *Crataegus monogyna*, *Rosa canina* L., *Erica australis* L., *Calluna vulgaris* (L.) Hull, *Arcostaphylos uva-ursi*, *Cistus laurifolius* L., *Corylus avellana*, *Vaccinium myrtillus*. A total of 974 yew trees were counted (Fig. 2), with a Recruitment rate of $R_r = 0.81$

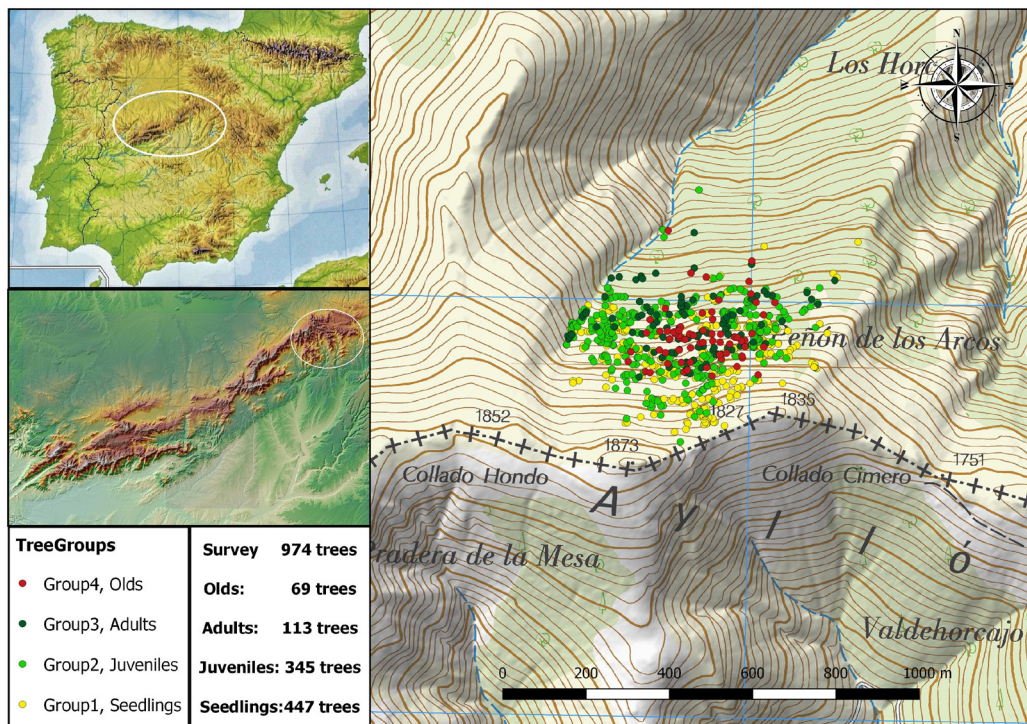


Figure 2. “Acebeda de Becerril” yew population. In all, 974 yew trees were surveyed.

Arroyo del Ermito

“Arroyo del Ermito” is a mountain creek which runs inside a Pyrenean oak forest. It grows on siluric gneiss and it is western orientated. Yew grove is located between 1485m and 1489m of altitude. Woody companion species are: *Quercus pyrenaica*, *Juniperus communis*, *Erica arborea*, *Adenocarpus hispanicus* (Lam.) Dc., *Sambucus nigra* L., *Ilex aquifolium*, *Betula alba*, *Cytisus scoparius*, *Rosa* sp, *Fagus sylvatica*, *Salix atrocinerea*, *Salix caprea* L. Altogether, **459** yew trees were counted (Fig. 3), with a Recruitment rate of $Rr = 0.71$

All three populations show high recruitment rates as seedling and juvenile trees are more numerous than adult and old ones, and thus, surveyed yew populations show regeneration dynamics (Serra, 2007). This vigorous natural regeneration seems to be related with the last decades reduction of human pressure, particularly of domestic herbivorous (López, 1982). Even so, feral browsing pressure was recorded in “Acebeda de Becerri” and “Arroyo del Ermito” groves, as yew is an evergreen species integrated in deciduous forest, its foliage is the main herbivorous resource during the winter (Serra, 2007). However, browsing pressure was not recorded in “Arroyo de la Tejera” grove because most seedlings and juvenile trees are covered by a heather shrub layer which acts as nurse plants, reducing herbivorous trampling and browsing (Cortes *et al.*, 2000, Serra, 2007).

These results lead us to partially reconsider the relictic character assigned to the species in the Iberian Mediterranean Mountains (Arroyo *et al.*, 2004). Actually, scattered yew population’s presence is conditioned by humidity and precipitation. But the image of dense monospecific yew forests in regression, leading to isolated yew groves or solitary trees (Serra, 2007), is refuted by our data, as we observe vigorous natural regeneration. Yew presence in the Iberian Mediterranean Mountains is associated with areas where specific topographic characteristics favor forest diversity, leading to mixed forest where yews are integrated. And, it is in these areas where conditions such as the presence of nurse plants facilitating seedlings growth or the presence of fleshy fruit species increasing seed dispersal birds (Serra, 2009), favor yew natural regeneration.

In conclusion, yew populations are vigorously naturally regenerating. This make us reconsider the relictic character assigned to the species in the Iberian Mediterranean Mountains. Finally, the study of the facilitating elements for yew regeneration should be deepened, as well as survey and mapping the yew populations of the Central Iberian Mountain Range, currently poorly studied.

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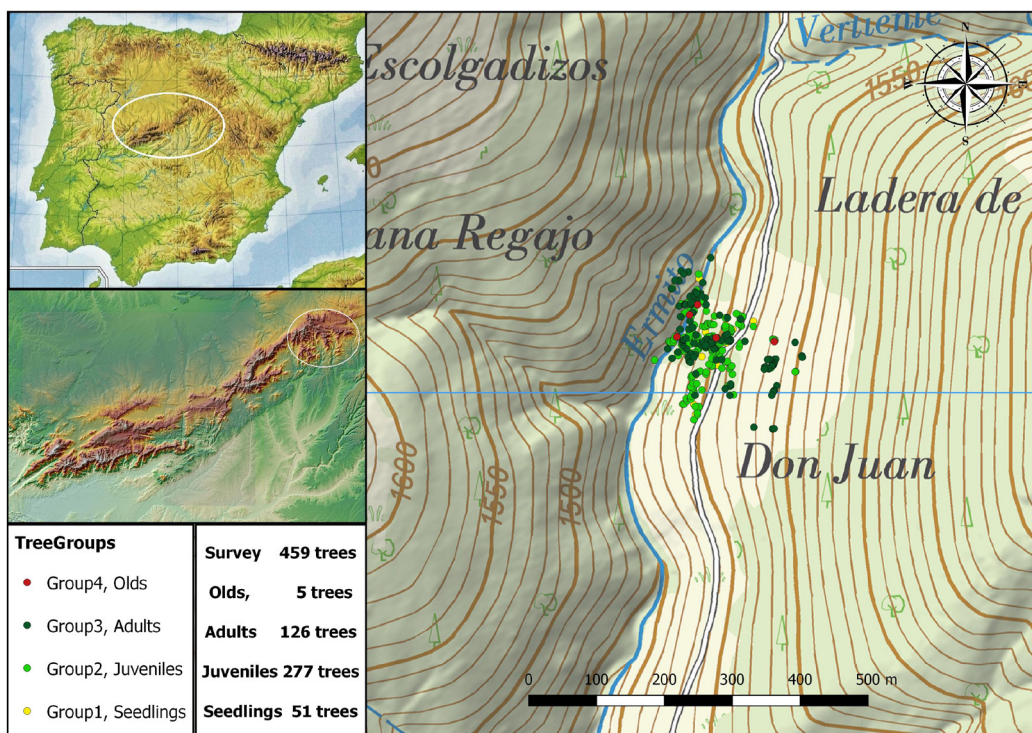


Figure 3. “Arroyo del Ermito” yew population. In all, **459** yew trees were surveyed.

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