

THE DISTRIBUTION OF ECOMORPHOLOGICAL TYPES AS RELATED TO ALTITUDE IN THE MONTSENY MOUNTAIN RANGE (NE SPAIN). A PRELIMINARY STUDY.

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RESUM

Es presenten els resultats d'un estudi preliminar sobre la distribució dels atributs morfològics de la vegetació al llarg d'un gradient altitudinal del massís del Montseny. L'estudi dels tipus ecomorfològics resulta un mètode eficaç per la caracterització funcional i adaptativa de les comunitats vegetals. Característiques com el percentatge de faneròfits, la caiguda de fulles, l'alçada de les plantes i el diàmetre de les capçades decreix amb l'altitud, mentre que la presència de camèfits s'incrementa gradualment. Les condicions ambientals i les pertorbacions determinen les estratègies adaptatives.

RESUMEN

Se presentan los resultados de un estudio preliminar sobre la distribución de los atributos morfológicos de la vegetación a lo largo de un gradiente altitudinal en el macizo del Montseny. La valoración de los tipos ecomorfológicos es un método eficaz para la caracterización funcional y adaptativa de las comunidades vegetales. Características como el porcentaje de fanerófitos, la caída de hojas, la altura de las plantas y el diámetro de las copas decrecen con la altitud, mientras que la presencia de caméfitos es más importante en las partes más elevadas. Las condiciones ambientales y las perturbaciones determinan las estrategias adaptativas.

ABSTRACT

Changes in the morphological attributes of plant communities are studied along an altitudinal gradient in the Montseny range as a first approach. This preliminary study of ecomorphological types in this area has shown that this method is a useful tool in characterizing different plant communities and it provides a functional and adaptive approach. It has been found that characters like the phanerophytes percentage, the shedding of leaves, the height and crown diameter decrease with altitude while the presence of chamaephytes increase gradually. At the top we find more small leaves which are less tomentose. The morphological and functional attributes which determine adaptation strategies of these plant communities are controlled by the physical environment and disturbance.

Keywords: eco - morphological attributes, functional attributes, growth forms, strategies of plant communities.

INTRODUCTION

Ecomorphological types or monocharacter growth form types are a series of growth form types systems each based on one characteristic only. They have been suggested by Orshan (1986) as a tool in describing vegetation and studying plant - environment relationships. They have been used in Australia (Pate *et al.* 1984), in Chile (Orshan *et al.* 1984), in France (Floret *et al.*, 1987, 1990 ; Romane, 1987), in Israel

(Danin and Orshan, 1990 ; Keshet *et al.*, 1991) and in Spain (Cabezudo *et al.* 1993; Navarro *et al.* 1993; Pérez Latorre *et al.*, 1996). The results obtained are promising since by this approach it is relatively easy to correlate presence and cover parameters of growth form characteristics of each *relevé* to environmental factors along environmental gradients and suggest their adaptative value. They also provide a means of describing plant communities by characteristic combinations.

The aim of the following study is to obtain preliminary results which will render a better insight in understanding the distribution of the dominant plant communities in the Montseny massif (Catalonia, NE Spain) as related to altitude. The Montseny range was chosen because of its distinct altitudinal vegetation belts (Romo, 1989) and its well studied vegetation (Bolòs, 1983).

THE STUDY AREA

The Montseny mountain range is a part of the Catalan range which runs parallel to the Mediterranean about 30 km off the coast. Topography is rough, with a difference of 1600 m in altitude between the summit (1700 m) and the lowlands (100 m). Rocks are basically granites and, to a lesser extent, gneisses, schists and slates.

At the lower altitudes, shallow, stony, greyish brown soils, low in humus and with largely undefined horizons are frequent in the Montseny. At the middle altitudes brown soils, rich in humus are dominant, while in the upper ones they are ranker - type soils (Hereter, 1990)

The climate is characterized by a dry season lasting approximately two months (July and August) in the lower areas, while on the summits rainfall is more plentiful and there is no dry summer season. See the ombrothermic diagrams drawn according to the methodology of Walter *et al.* (1975) for the stations of Breda (lowlands) and Turó de l'Home summit (Figure 1).

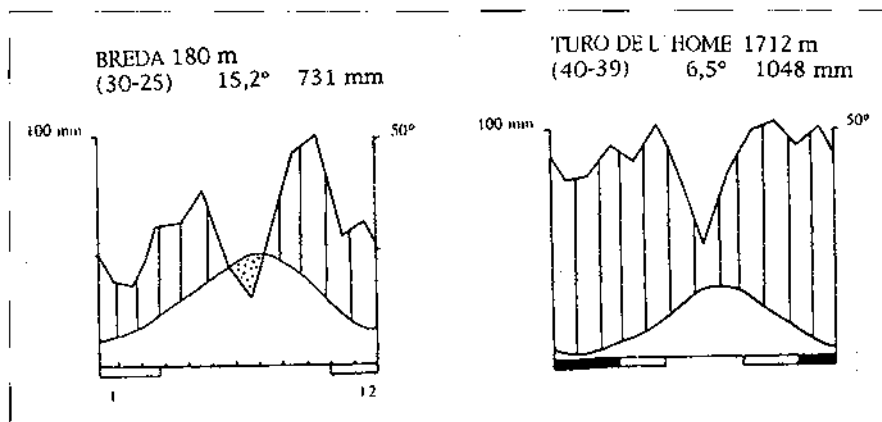


Figure 1.- Ombrothermic diagrams of a station located at the bottom of the range, at Breda, and another on the highest peak, El Turó de l'Home, at both extremes of the studied altitudinal gradient

On the lower slopes, the dominant vegetation communities are evergreen forests. Bolòs (1983) describes the plain situated to the southwest of the range as occupied by *Quercus ilex* communities (*Viburno tini - Quercetum ilicis* Br. - Bl. 1936 em. nom. Rivas Mart 1975). The slopes between 200 m and 600 to 700 m according to aspect, are dominated by *Q. suber* communities (*Carici oedipostylae - Quercetum suberis*, O. Bolòs 1959, Rivas Mart. 1986 em. Romo) ; in higher altitudes, communities of *Q. ilex* (*Asplenio onopteris - Quercetum ilicis* Br. - Bl. 1936, em. nom. Rivas Mart. 1975) reappear. In poorly developed soils they go up to 900 - 1000 m. Still higher, *Fagus sylvatica* communities are dominant (between 900 - 1100 m and 1100 - 1500 m). They are represented by two communities (*Helleboro viridis - Fagetum sylvaticae*, O. Bolòs 1948 and *Luzulo nivae - Fagetum sylvaticae* Suspl. & Br. - Bl. 1952). The highest summits are covered by dwarf juniper scrub (*Genisto - Arctostaphyletum* Br. - Bl. 1948) with numerous subalpine components. In the beech forest there are occasionally large clumps of *Abies alba* on cool, damp, north - facing slopes. Phytosociological nomenclature arise from Nuet *et al* (1991).

MATERIAL AND METHOD

Five representative sites, chosen as sample areas of the main plant communities types were selected, bearing in mind the most representative species of the communities. They represent altitudinal vegetation belts of this massif (Bolòs 1983). Their locations and vegetation types are :

1. Near Arbúcies, 405 m, UTM DG 5931. Dense holm - oak (*Quercus ilex*) forests dominated by young trees 6 - 8 m tall with a cover of 70 - 90%.
2. Near Sant Hilari, Coll de Ravell, 840 m, UTM DG 5333. Scattered cork - oak (*Quercus suber*) forests dominated by trees 12 - 14 m tall of low cover (55%) wich allows considerable development of a shrub layer.
3. Santa Fe, Pla de l'Espinal, 1210 m, UTM DG 5425. Dense beech forests (*Fagus sylvatica*) with trees 20 - 22m tall and a 100% cover.
4. Passavets, 1480 m, UTM DG 5325. Fir (*Abies alba*) forest with trees over 30 m tall and a cover of 65 - 75%.
5. Turó de l'Home, 1630, UTM DG 5225. A lower juniper (*Juniperus communis*) scrub less than 1 m tall with a cover of 90%

A selected *relevé* of each site, chosen in accordance with the appearance of the most representative species of each community (Nuet *et al.*, 1991), was taken by the Braun - Blanquet method. The size of the sample squares was between 100 and 500 m² as taken by Lapraz (1962,1966) and Bolòs (1983). Certain environmental parameters were described and total vegetation cover was estimated. In addition, the total cover of the persisting species (those which remain photosynthetically active throughout the year) and of the ephemeral species were estimated separately. Subsequently, species of both groups were listed and the relative cover of each species as a percentage of the total cover of its group was estimated.

Ecomorphological types, as defined by Orshan (1986), were determined for each species in the field. The following characters were described :

Above - ground shoot system

1. Renewal buds location
2. Organs periodically shed
3. Plant height
4. Crown diameter
5. Canopy density
6. Stem consistency

Photosynthetic organs

7. Leaf size
8. Leaf colour
9. Tomentosity

Out of the data thus collected, a species - character matrix was made for each site and stored in a computer. From the matrixes of the different plant communities examined, tables and figures representing the distribution of ecomorphological types along altitudinal gradients were compiled. A data base was created and relative and absolute presence was calculated.

RESULTS AND DISCUSSION

Above ground shoot system

1. Renewal buds location

Figure 2A shows the renewal bud location types of the different plant communities. It is evident that the percentage of phanerophytes markedly decreases with altitude. There are no chamaephytes in the lower sites but only in the juniper scrub their partial presence reaches 60%. The percentage of hemicriptophytes is rather low or nil in the two lower sites but reaches around 40% in the three higher ones. There are practically no cryptophytes except for the cork oak site where they reach about 10%.

The fact that the percentage of phanerophytes falls rapidly with altitude suggests that even in the lower altitudes water is not a limiting factor but temperature is limiting in the higher ones. The fact that the percentages of hemicryptophytes and of chamaephytes are relatively high in the upper sites supports this hypothesis

2. Organs periodically shed

The percentages of leaf shedders are high (50 - 60%) in the lower three sites and decrease to around 20% in the two higher ones (fig. 2B). Basipetal branch shedders are either absent or appear in low percentages in the lowermost and uppermost sites. The percentage of the acropetal branch shedders is between 19 and 29% in the two lower sites and reaches 40% in the uppermost one.

The distribution of the organs periodically shed characteristics is similar to that of the renewal bud location ones. The percentage of leaf shedders decreases with

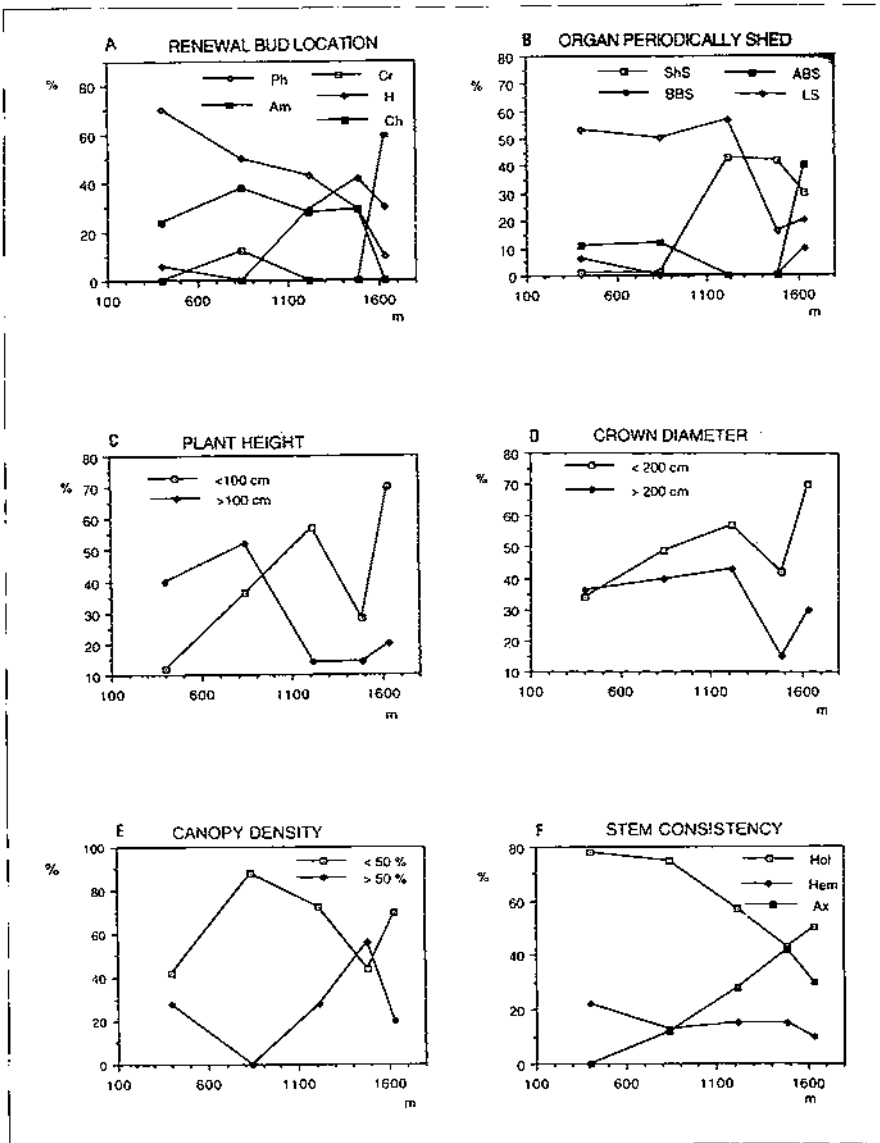


Figure 2.- Distribution of different species-character related to above-ground shoot system along an altitudinal gradient in the Montseny massif. The distribution of each character is expressed as a percentage of the total number of species (Ch = Chamephytes, Ph = Phanerophytes, Am = Amphyphytes, Cr = Cryptophytes, H = Hemicryptophytes ; ShS = Shoot shedders, BBS = Basipetal branch shedders, ABS = Acropetals branch shedders, LS = Leaf shedders ; Hol = Holoxyles, Hem = Hemixyles, Ax = Axyles).

altitude. This agrees with the parallel reduction in the percentage of the phanerophytes. The percentage of branch shredders increases sharply in the summit, a great part of them are chamaephytes and the other part phanerophytes. Their percentage is generally low except for the juniper scrub site where the percentage of the acropetal, and basipetal, branch shredders put together is about 60%, like that of the chamaephytes.

3. Plant height

Figure 2C shows the distribution of plants lower and higher than 100 cm at different altitudes. It is evident that the percentage of the former shows a general tendency of increase and that of the later a general tendency of decrease with altitude. It should be pointed out that the fir forest is an exception in this respect.

4. Crown diameter

Figure 2D shows the distribution of plants with crown diameters lower and higher than 200 cm at different altitudes. The percentage of the former markedly increases while that of the later shows an insignificant trend of decrease with altitude.

The fact that plant height and crown diameter decrease generally with altitude suggest that low temperatures are here more important than aridity as affecting the growth of plants in size. The fact that the percentages of holoxyles decrease and those of axiles increase with altitude supports the above suggestion.

5. Canopy density

Figure 2E shows the distribution of plants with canopy density lower and higher than 50%. The former show an optimal curve with a maximum at the cork - oak forest except for the juniper scrub for which the values are rather high. The curve of the later is of a mirror shape of the former.

6. Stem consistency

Figure 2F shows the distribution of holoxile, hemixile and axile plants expressed as percentages of the total number of species. It is evident that the percentage of the holoxile decreases with altitude and that of the axile decreases. The percentage of the hemixiles remains practically unchanged.

Photosynthetic organs

7. Leaf size

Figure 3B shows the distribution of leaves larger and smaller than 2.25 cm². The percentage of the former clearly decreases and that of the later increases with altitude.

Small leaves are suggested to be an adaptation either to drought or to low temperatures. The fact that leaf size decreases with altitude (except for the highest site) is in accordance with this suggestion.

8. Leaf colour

Figure 3C shows the distribution of green leaves against that of grey or white ones. All the leaves of the plants at the lower altitudes are green while the percentage of the green plants at the two higher altitudes gradually decreases and that of the grey or white ones increases.

Leaves are all green in the lower sites. The fact that their percentage decreases to a certain extent and those of the grey or white ones increases may be due to the higher radiation in higher altitudes.

9. Leaf tomentosity

Figure 3D shows the distribution of non tomentose leaves against that of leaves tomentose on their lower side and on both sides. The percentage of the non tomentose leaves increases and that of the tomentose on both sides decreases with altitude. The percentage of the leaves tomentose on both sides reaches certain values at the uppermost as well as at the lowermost sites.

The decrease of leaf tomentosity with altitude may point to the role of tomentosity as reducing transpiration.

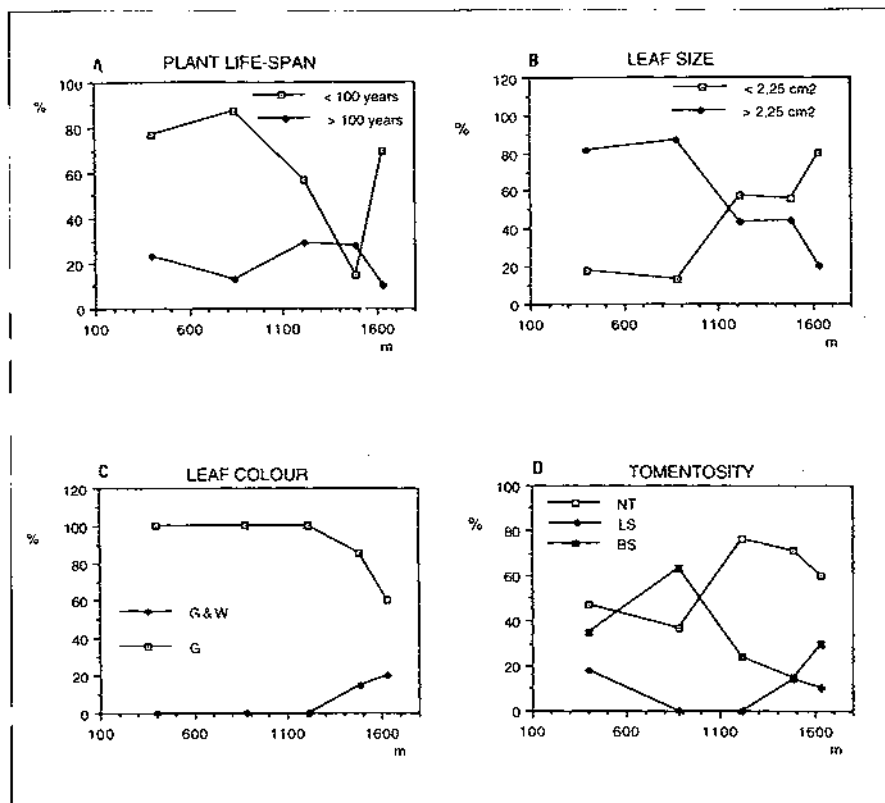


Figure 3.- Distribution of different species-character related to longevity and photosynthetic organs along an altitudinal gradient in the Montseny massif. The distribution of each character is expressed as a percentage of the total number of species (G & W = green and white leaves, G = all green leaves ; NT = non hairy leaves, LS = leaves hairy on lower sides, BS = leaves hairy on both sides)

CONCLUSIONS

The established relationships between morphological and functional attributes and environment, using an altitudinal gradient in the Montseny massif, provides an approach to plant communities which is both functional and adaptative.

Phanerophytes decrease clearly with altitude whereas the presence of chamaephytes increases notably with the extreme conditions found on the higher level. There is a strong shedding of leaves at the three lowest levels dominated by broad-leaved trees but not in the upper zone with a severe climate. The height and crown diameter decrease sharply at higher altitude. Adverse atmosphere conditions lead to a decline in the number of the most long-living plants. Leaf character also reflects altitudinal gradient. Leaf size, tomentosity and green color decreases from the lowest level to the upper.

It seems that the change in certain characteristics along the altitudinal gradient is reasonable and will probably be found more changes in other characters if a more detailed study will be carried out. One should point out, however, that plants adapted to the Mediterranean type climate with a relative dry summer will be more numerous in the lower altitudes whereas those adapted to a more humid climate where temperature turns to be the limiting factor will penetrate the higher altitudes.

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