



Regression and invasion of bryophytes in the south and southeast of the Iberian Peninsula

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The climate of the south and south-east of the Iberian Peninsula, with long dry periods alternating with periods of scarce precipitation, has caused the regression of a great number of bryophytes, mainly pleurocarpic mosses and Jungermannian hepatics. Some have found refuge in areas with a humid ombroclimate (Sierra de Algeciras), other in shady ravines of the Sierra Nevada. The acrocarpic mosses, on the other hand, are spreading considerably, especially those that undergo intense vegetative multiplication and, above all, the arid-region Pottiaceae species.

INTRODUCTION

The regions of Andalucía and Murcia in the south of the Iberian Peninsula are characterized by low rainfall and a long dry summer period with very high temperatures. The Atlantic influence decreases appreciably from west to east, passing from a humid ombroclimate in Algeciras to a semiarid and arid ombroclimate in Almería and Murcia. The ombrothermic diagrams of the three characteristic meteorological stations (Algeciras, Granada and Cieza) give a general idea of the climate of the area (Fig. 1). The climatic change in the Mediterranean area is the primary causal agent of the desertization, human activity being a mere catalyzer that accentuates and accelerates the climatic action. The progressive deforestation and desertization can be considered as the main cause of the spread of heliophilic and xerophilic, and regression of ombrophilic and mesophilic, species.

RESULTS

Species in regression

In the above conditions, species which in the past probably colonized extensive areas now only

survive in relict microhabitats in the Sierras of Algeciras, Nevada and Alcaraz.

Following the chorological categories of Duell (1983, 1984, 1985) and the nomenclature of Grolle (1983) and Corley *et al.* (1981), some examples of species that suffer regressive processes in the S and SE of the Iberian Peninsula are given in Table 1.

The numerous shady and almost permanently humid ravines of the fundamentally siliceous Sierra de Algeciras (730 m altitude), in close proximity to the Straits of Gibraltar (Fig. 1), contain many species that are considered very rare or extinct in the rest of the Iberian Peninsula. They include *Neckera intermedia*, *Marchesinia mackaii*, *Ulota calvescens* and *Hyocomium armoricum*, all formerly cited by various authors (Allorge & Allorge, 1945; Gil & Guerra, 1981a,b). Table 1 shows the principal atlantic (oceanic and oceanic–mediterranean *sensu lato*) species which in the south of the Iberian Peninsula are practically confined to the Sierra de Algeciras, thus an important refuge for oceanic taxa in regression.

The Sierra Nevada, due to its height (3478 m), represents a refuge for arctic and arctic–alpine species such as *Aulacomnium palustre*, *Blindia acuta* and *Oncophorus virens*, which are not found elsewhere in the whole of Southern Spain (Table 1), although they are common in Central Europe. This is also the case for some boreal and boreal–mountain species shown in Table 1. Gil and Varo

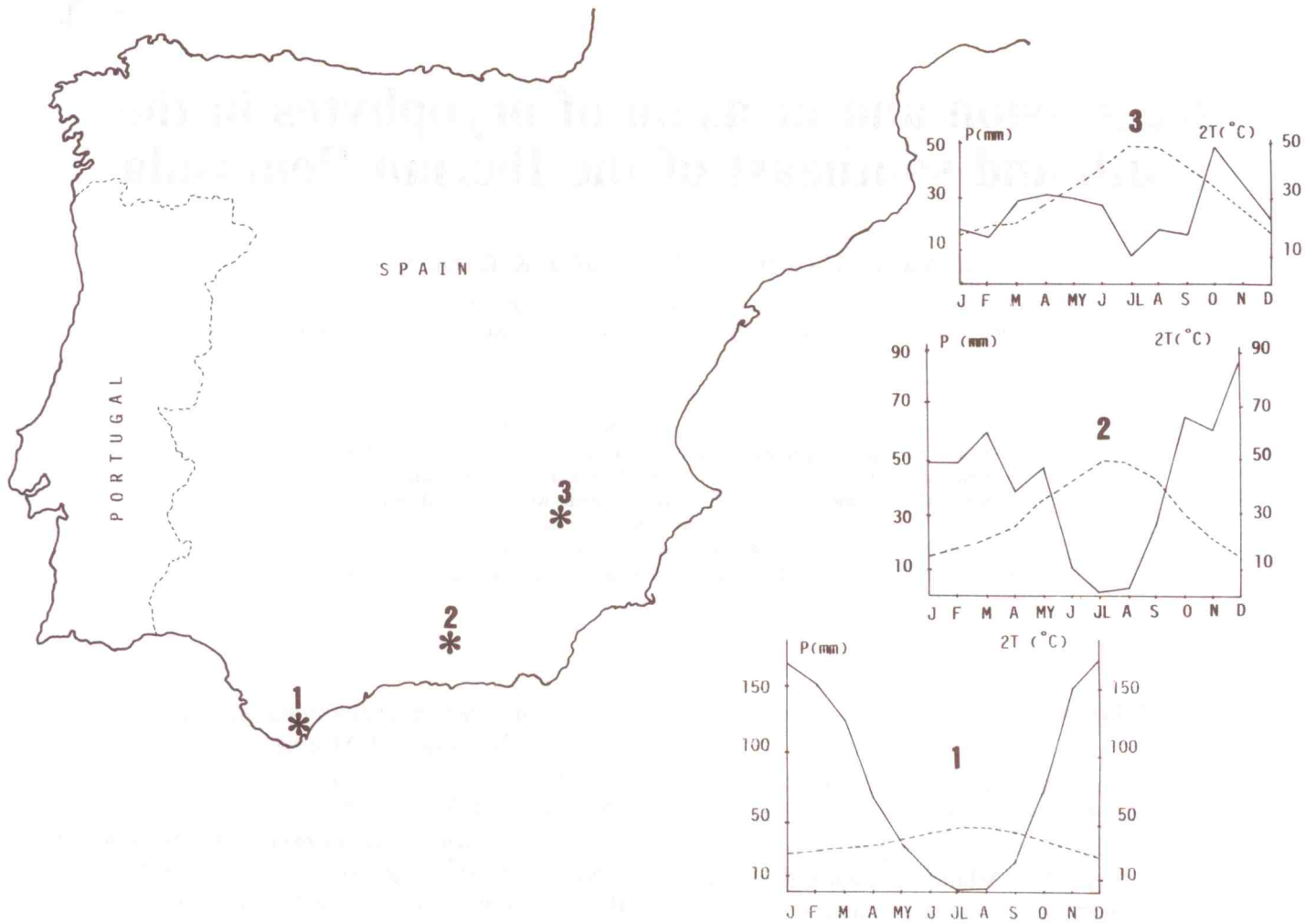


Fig. 1. Location of the Sierra de Algeciras (1), Sierra Nevada (2) and Sierra de Alcaraz (3) in the Iberian Peninsula, and precipitation and temperature data for the three regions. -----, Temperature (T); —, Precipitation (P).

(1973), Zafra and Varo (1974), Guerra and Gil (1981) describe the socioecological behaviour of these species and provide numerous data on their habitat.

The Sierra de Alcaraz (1798 m height) and other close-by mountainous systems provide a refuge for other species of varied chorological behaviour. Oceanic and suboceanic species such as *Claopodium whippleanum* and *Homalia lusitanica*, and some boreal-mountain species (*Dicranum scoparium*, *Ctenidium molluscum* and *Jungermannia atrovirens*) can be found, all very localized, rare or infrequent in the semiarid or dry areas surrounding this system (cf. Guerra *et al.* 1989).

It is particularly interesting that some cosmopolitan elements (*Aulacomnium androgynum*, *Ceratodon purpureus*, *Hedwigia ciliata*) are extremely rare in the southern Iberian Peninsula, being confined to small populations in very specific places of high or medium-high altitude (Table 1).

Invading species

The mediterranean and the cosmopolitan heliophilic and xerophilic Pottiaceae, Funariaceae and Bryaceae are those that benefit the most from the present climate. In these areas, the Pottiaceae can represent up to 50% of the total bryoflora.

In general, the pleurocarpic mediterranean mosses are suffering a strong regression. Some—*Antitrichia californica*, *Pterogonium gracile*, *Leucodon sciuroides* and *Metaneckera menziesii*—are frequent, although not sufficiently for them to be considered as spreading.

A false idea of expansion could be attributed to species with a poorly known chorology, such as *Orthotrichum acuminatum*, *Triquetrella arapilensis* or *Pyramidula algeriensis*, for which recent studies have broadened their known area. The same is true of other more recently described species, such as *Acaulon casasianum* Brugués & Crum, *Acaulon*

Table 1. Oceanic, boreal and subboreal, arctic and alpine, and cosmopolitan species in regression in the southern Iberian Peninsula

	Algeciras	Sierra Nevada	Sierra de Alcaraz
Oceanic species (<i>sensu lato</i>)			
<i>Amphidium mougeotii</i>		+	
<i>Campylopus fragilis</i>	+		
<i>Campylopus introflexus</i>	+		
<i>Clopodium whippleanum</i>	+		+
<i>Chryphaea heteromalla</i>	+		
<i>Cynodontium bruntonii</i>		+	
<i>Heterocladium heteropterum</i>	+		
<i>Homalia lusitanica</i>	+		+
<i>Hookeria lucens</i>	+		
<i>Hyocomium armoricum</i>	+		
<i>Leucobryum glaucum</i>	+		
<i>Lepidopilum virens</i>	+		
<i>Neckera intermedia</i>			
var. <i>laevifolia</i>	+		
<i>Neckera cephalonica</i>	+		
<i>Racomitrium lanuginosum</i>	+		
<i>Rhynchostegiella durieui</i>	+		
<i>Rhynchostegiella letourneuxii</i>	+		
<i>Sematophyllum bottinii</i>	+		
<i>Ulota calvescens</i>	+		
<i>Diplophyllum albicans</i>	+		
<i>Frullaria teneriffae</i>	+		
<i>Marchesinia mackaii</i>	+		
<i>Pallavicinia lyellii</i>	+		
<i>Porella canariensis</i>	+		
Boreal and subboreal species			
<i>Calliergon stramineum</i>		+	
<i>Dichodontium pellucidum</i>		+	
<i>Dicranum scoparium</i>	+	+	+
<i>Sphagnum subsecundum</i>		+	
<i>Sphagnum teres</i>		+	
<i>Conocephalum conicum</i>		+	
<i>Lophozia sudetica</i>		+	
<i>Jungermannia atrovirens</i>		+	+
<i>Jungermannia leiantha</i>		+	
<i>Scapania irrigua</i>		+	
<i>Ctenidium molluscum</i>		+	+
Arctic and alpine species			
<i>Aulacomnium palustre</i>		+	
<i>Blindia acuta</i>		+	
<i>Gymnostomum recurvirostre</i>		+	+
<i>Oncophorus virens</i>		+	
<i>Athalamia hyalina</i>		+	+
<i>Lophozia heterocolpos</i>		+	
<i>Mannia triandra</i>		+	
Cosmopolitan species			
<i>Aulacomnium androgynum</i>		+	+
<i>Brachythecium albicans</i>		+	
<i>Ceratodon purpureus</i>			+
<i>Hedwigia ciliata</i>		+	+
(rare)			
<i>Hypnum cupressiforme</i>	+	+	+
<i>Polytrichum commune</i>		+	+
(rare)			
<i>Pseudoscleropodium purum</i>		+	+
(rare)			

dertosense Casas *et al.*, *Acaulon fontiquerianum* Casas & Sérgio, *Phascum cuynetii*, *Phascum longipes* Guerra *et al.* or *Goniomitrium seroi*.

Species which are obviously spreading are the widely distributed nitrophilic *Sphaerocarpus michelii*, *Sphaerocarpus texanus*, *Didymodon australasiae* (Hook & Grev.) Zander, *Trichostomopsis trivialis* and *Tortula rhizophylla*. A similar expansion is seen with the xerophytes of other semiarid and arid regions, such as *Tortula brevissima*, *Crossidium aberrans* Holz. & Bartr., *Aloina bifrons*, *Phascum vlassovii* Laz. It is interesting to note the predominance of the Pottiaceae among the invading bryophytes.

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