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# Refuge selection by two sympatric species of arid-dwelling land snails: Different adaptive strategies to achieve the same objective

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**Abstract**

Terrestrial gastropods, especially those dwelling in dry habitats such as the Mediterranean, are highly susceptible to dehydration. In this study, the use of refuges by *Iberus gualtieranus gualtieranus* and *Sphincterochila candidissima* is compared. These two species belong to families with different distribution ranges, but they live in sympatry on a mountain in southern Spain with a dry Mediterranean climate. *I. g. gualtieranus* used mainly rock crevices as refuges, consistently throughout the year. *S. candidissima* hibernated beneath humus during autumn and winter (*I. g. gualtieranus* did not hibernate). In spring, *S. candidissima* seemed active, while *I. g. gualtieranus* was already aestivating. In summer, *S. candidissima* aestivated on vegetation, while *I. gualtieranus* aestivated deep within crevices. These differences in the use of refuges may be explained on the basis of the need for more protection by *I. g. gualtieranus* because of its morphology, which is less suited to the dry habitat, but has evolved to enable this species to exploit karstic crevices as refuges more efficiently. These results illustrate that behaviour and morphology interact allowing both species to coexist in sympatry in an arid environment using different adaptive strategies.


*Keywords:* Seasonal cycle; Morphology; *Iberus g. gualtieranus*; *Sphincterochila candidissima*; Microhabitat

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## 1. Introduction

Dry environments, usually having high temperatures, low moisture and scarce vegetation impose very restrictive living conditions on animals, which are especially critical for hydrophilic animals (Pianka, 2000). Terrestrial gastropods, having permeable skin and moving by laying down moist mucus trails, suffer high rates of dehydration (Prior, 1985; Luchtel and Deyrup-Olsen, 2001), and thus their distribution is affected by moisture, with more species and individuals in moister zones (Tattersfield, 1990; Wardhaugh, 1995; Ports, 1996). Nevertheless, some snails dwell in arid zones, where they must employ behavioural, physiological and/or morphological adaptations to minimise the risk of dehydration. For example, the species of the genus *Sphincterochila* lose mass by dehydration at different rates, those from drier environments losing water more slowly (Arad et al., 1989).

It might therefore be assumed that in dry environments the risk of dehydration is one of the primary selective forces acting on gastropods. Because snails in these environments are under similar selective forces, we might expect these species to evolve similar traits against dehydration (evolutionary convergence; Pianka, 2000). However, it is difficult to predict the evolution of populations of two different species with similar ecology in a given environment, as different solutions can resolve the same problem (Partridge and Harvey, 1988). The evolutionary route followed by a species depends on the initial evolutionary and phylogenetic constraints, and when certain traits have already evolved, it may be easier for a species to take one evolutionary path than another (McKitrick, 1993; Bennett and Owens, 2002). The result is that ecologically similar species may exhibit different traits in the same environment.

In this study, I compare the refuge selection in two species of gastropods, *Sphincterochila candidissima* and *Iberus gualtieranus*, that inhabit in sympatry in the Sierra Elvira. This is a mountain with a climate classified as accentuated mesomediterranean (UNESCO, 1963), with 5 months of drought in the study area (Alonso et al., 1985; see Fig. 1), thus a harsh environment for animals as hydrophilic as snails. In Sierra Elvira, *S. candidissima* and *I. gualtieranus* are the two dominant species, with similar densities, and are not found in

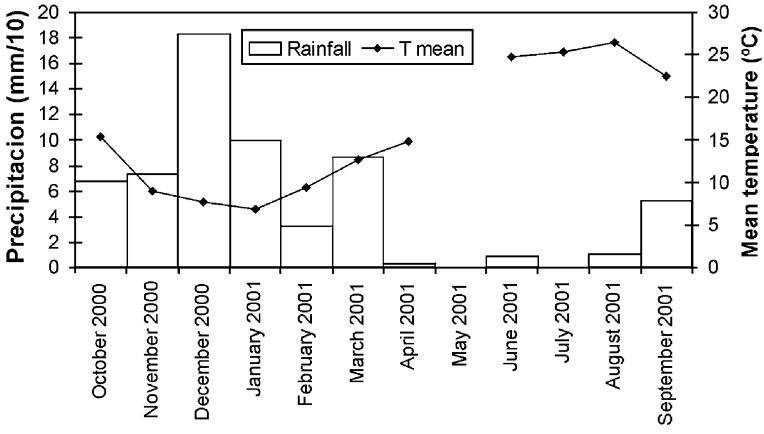


Fig. 1. Total rainfall (in mm/10; bars) and average temperature (in °C; line), by month from the Cubillas reservoir. No data were available for May.