

MOUNTAIN UNGULATES AND THE CONSERVATION OF SCARCE PLANT SPECIES: THE CASES OF *DELPHINIUM* *MONTANUM* AND *XATARDIA SCABRA*

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ABSTRACT.— In order to assess the possible negative influence of a high density population of izard (*Rupicapra pyrenaica*) on the occurrence of several restricted range plants in the eastern Pyrenees, a monitoring experiment was carried out in the Cadi-Moixeró Natural Park and Game Reserve. Ungulates predation upon reproductive parts of the plants is rejected as a factor influencing *Delphinium montanum* and *Xatardia scabra* population viability, even when high rates of consumption of flowers and fresh fruits are detected. Population dynamics of both plant species are mainly regulated by the habitat physical conditions and by intraspecific competition. Plantlet occurrence depends on the availability of bare substrate and is not related to seed production, nor the presence of ungulates. Plant density and age structure for these scree species rely on the limited availability of substrate resources, which leads to strong intra-specific competition.

RÉSUMÉ.— Une étude de suivi a été développée dans le Parc naturel et Réserve de Chasse du Cadi-Moixeró (Catalogne, Espagne). Le but était de tester la possible influence négative de la haute densité de population des isards (*Rupicapra pyrenaica*) sur la présence de quelques plantes à aire de répartition réduite dans les Pyrénées-Orientales. La prédation des Ongulés sur les parties reproductives des plantes n'est pas un facteur agissant sur la viabilité des populations de *Delphinium montanum* et *Xatardia scabra* et cela même s'ils arrivent à consommer beaucoup de fleurs et de fruits frais. La dynamique des populations des deux plantes semble régulée par les conditions physiques de l'habitat et par la concurrence intraspécifique. La présence de plantules est en rapport avec la disponibilité de sol nu et se montre indépendante de la production de semences, l'impact des ongulés étant nul. Tant la densité que la structure d'âges de ces plantes glaréicoles peut s'expliquer par la disponibilité limitée de ressources édaphiques, la présence de sol nu ou la compétition intraspécifique.

RESUMEN.— Con el fin de confirmar la posible influencia negativa de una alta densidad poblacional de sarrio (*Rupicapra pyrenaica*) en la frecuencia de varias plantas de

*hábitat restringido en los Pirineos Orientales, se llevó a cabo un plan de seguimiento en la Reserva Nacional de Caza y Parque Natural del Cadí-Moixeró. La predación sobre partes reproductivas de las plantas de *Delphinium montanum* y de *Xatardia scabra* se rechazó como factor influyente en su viabilidad, incluso cuando fueron detectadas altas tasas de consumo de flores y frutos frescos. La dinámica poblacional de ambas especies de plantas viene regulada principalmente por las condiciones físicas del hábitat y por la competencia intraespecífica. La aparición de plántulas es un suceso dependiente de la disponibilidad de suelo desnudo y no está relacionado con la producción de semillas, siendo el impacto de los ungulados inapreciable. La densidad y estructura poblacional de estas especies glareícolas depende de la limitada disponibilidad de los recursos del sustrato, lo que se traduce en una fuerte competencia intraespecífica.*

1. Introduction

In the last twenty years there's been a significant increase in the pyrenean populations of wild ungulates. In the upper mountain areas the izard (*Rupicapra pyrenaica*) is the most common species, but also the mouflon (*Ovis musimon*) occurs in abundance in several places in the eastern Pyrenees. Thus, in the Cadí Game Reserve izard's census has doubled in one decade: 2302 individuals in 2000 against 1103 in 1990. Ungulates densities can achieve high levels in some located places. In the areas of the Cadí range with high consumption rates of *Delphinium montanum* izard's densities in summer are around 40-60 individuals per squared kilometre, with temporal concentrations attaining more than 100 individuals.

Therefore, the impact of such concentrations of herbivores on the flora and vegetal landscape has been a matter of concern in several areas, particularly where rare or endemic species have been conserved.

Ungulate pressure on the flora has been observed and confirmed for two globally restrictly located species, *Delphinium montanum* (*Ranunculaceae*) and *Xatardia scabra* (*Umbelliferae*), eastern pyrenean endemisms related to mountain scree habitats. *D. montanum* is known to occur in very few localities and can be considered as Vulnerable according to the criteria used in the IUCN Red List. *X. scabra* is by far more abundant and is not endangered.

2. Study area and methods

Several areas of Cadí-Moixeró range (northeastern Prepyrenees, Spain) and of the Valley of Eina (Puigmal range, eastern french Pyrenees) hold several populations of *D. montanum* and *X. Scabra*, as well as variable densities of izard. Mouflon only occurs in the Valley of Eina.

In both areas, countings of flowers and fresh fruits availability and percentage of predation upon this parts of the plants were completed with the determination of plant recruitment and age structure for both species in areas of, respectively, high and low izard densities.

3. Results and discussion

In one of the most important populations of *D. montanum*, located in the Cadí range, a 98 % rate of consumption of flowers and green fruits has been estimated. Such an intense predation rate has been observed repeatedly during the last ten years. Moreover, Izards may also forage on important aspects of the leaf mass.

In the Valley of Eina *X. scabra* is the species suffering from this similar predation on the reproductive structures, by izards and also mouflons. In one study area 50% of the plants were predated. In this case, however, only 8% of the inflorescences were completely eaten, while the remaining 48% only showed a partial consumption.

The loss of seeds caused by this predation suggested that, especially for *D. montanum*, ungulates could eventually be an important fact affecting population viability. In order to assess this possibility for both species, population structures in areas highly affected by ungulates were compared with those located in less affected sites. The hypothesis was that if the ungulates were actually damaging plant viability, the affected populations would have a lower recruitment rate and would end in a modified age structure that would show up in an unusual proportion of adult plants. The results however were different to those intuitively predicted.

In *D. montanum* patches plant recruitment was by far higher in the population intensively predated by izards (plantlets was 21.7% of total individuals; n=1284) than in the population less predated (only 2.7% of plantlets; n=1367). On the other hand, for *X. scabra*, maximum recruitment was verified in the less affected population (79.9% of plantlets; n=1012), although the percentage of plantlets was also important in the highly predated samples (39.9%; n=283).

These results show that the consumption of reproductive structures, although impressive as they may be, does probably not affect population viability. The availability of a suitable substratum for germination could probably have a stronger influence on plant recruitment than the number of seeds produced. Therefore, areas with low plant density would be more appropriate for the germination, as would screes containing smaller rocky fragments.

Several patches of *D. montanum* were surveyed during summer and it was confirmed that plantlet mortality is higher in high density samples. In heavily predated population patches with an early summer density of 5.8 plantlets per squared metre reached 2.3 at the end of the season. On the other hand, in less predated *Delphinium* population, initial densities of 1.7 ended in 1.0 plantlets per squared metre. Therefore, plant densities show a trend to equalise at the end of summer in samples with quite different starting values.

A similar trend was observed for *X. scabra*. Non predated populations have densities of 31.6 plantlets and 0.53 reproductive individuals per squared metre. In heavily predated population plantlet density was much lower, at 5.8, but with a density of 0.35 reproductive individuals. Densities of reproductive plants show a very similar pattern in samples with very different plantlet densities.

It was even more interesting to confirm that population structures, when only adult individuals are considered, are very constant for each one of the study species, independently either from recruitment tax or izard's pressure. *Delphinium* populations have 28.9% non-reproductive individuals versus 71.1% of reproductives in heavily predated sites (n=1058), and a very similar 22.0% versus 78.0% in less predated areas (n=1330). *Xatardia* populations have 92.9% non-reproductive vs. 7.1% reproductives (n=181) and 91.6% vs. 8.4% (n=203) in predated and non predated sites respectively. These typical structures are an almost exclusively consequence of intra-specific competition.

4. Conclusions

The former observations seem to demonstrate that:

Plantlet production in both species is determined first of all by the availability of bare ground. Total seed production, on the other hand, is not an important factor. Therefore, when the screes where these plants inhabit become fixed, recruitment tax will decrease and these populations will reach a regressive stage.

Plant density and age structure in scree species are mainly regulated by the lack of physical resources, which leads to a strong intra-specific competition.

Although very notorious in some areas, predation by ungulates has a negligible impact in population dynamics of *X. scabra* and *D. montanum*, which would be once more regulated by the scarcity of physical resources and intra-specific competition.