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Competition effect on the resprouting performance of *Erica multiflora* after clipping

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Abstract. Competition plays an important role in structuring plant communities. A manipulation experiment was done eliminating neighbourhood vegetation in order to study the effect of competition on the resprouting vigour of the Mediterranean shrub *Erica multiflora*. The elimination of neighbours increased the number of resprouts and biomass of target plants. The differences between the competition and non competition treatments increased with time. These results suggest that during the early stages of regeneration after a disturbance, plants are less dependent on environmental resources, but later they compete with its closer neighbours.

Resum. *Efectes de la competència sobre la rebrotada d'*Erica multiflora *desprès de tallades.* La competència juga un paper molt important en l'estructura de les comunitats vegetals. Es va portar a terme un experiment d'eliminació de la vegetació veïna per tal d'estudiar l'efecte de la competència en el vigor de la rebrotada de l'arbust *Erica multiflora*. L'eliminació dels veïns va fer incrementar el nombre de rebrots i la biomassa de les plantes d'estudi. Les diferències entre els tractaments de no competència i de competència augmentaren amb el temps. Aquests resultats suggereixen que durant les primeres etapes de regeneració després d'una pertorbació, les plantes són menys depenents dels recursos del medi, però, més tard, competeixen amb els veïns més propers.

Introduction

Competition is defined as an interaction among individuals or populations which has a negative effect on the availability of resources or their control. This negative interaction is also known as interference (Harper 1977). The resources for which a plant may compete include soil mineral nutrients, water, light, space (McConnaughay and Bazzaz 1990) and/or pollinators.

Competition plays an important role in the building of natural communities (Grace and Tilman 1989). Some of the approaches for studying interference are based on descriptive analysis of the relationship between plant performance and density of local vegetation. These methods have been criticized because plants are sessile organisms and competition has to be considered at the individual level (Silander and Pacala 1985).

Experiments in which individuals are manipulated are essential to the study of competition (Tilman 1987). Removal experiments are the more accepted form (Aarsen & Epp 1990). In these experiments, neighbours around specific «target» plants are removed and the performance of these plants is compared with controls surrounded by the undisturbed neighbours. This method has been used to assess competition in different ecosystems. In the Mojave desert Fonteyn and Mahall (1978) demonstrated competition for water between *Larrea tridentata* and *Ambrosia dumosa*; recently, Chapin et al. (1989) showed that competition causes regular spacing on *Alder crispa* in the Alaskan tundra; McPherson and Wright (1989) investigated competition among *Juniperus pinchotii* individuals in a Texas semiarid region and Sala et al (1989) assessed resource partitioning between shrubs and grasses in the Patagonian steppe. We have not found any study which deals with competition in Mediterranean plant ecosystems.

Mediterranean ecosystems are frequently subjected to disturbances like fire, clearcutting and/or grazing. Early regeneration stages after a disturbance are characterized by a reduction of competition among individuals (Sousa 1984), but competition increase rapidly with plant growth. Our objective here is to analyze the importance of competition in plant regeneration by a field experiment. We compared the resprouting performance of clipped plants with and without neighbours at the early and late stages of regeneration.

Material and methods

Species and study site

The study site was located in a coastal shrubland on the Serra de les Comes (40° 53N, 0° 41'E) in El Perelló (Catalonia, Spain) at an elevation of 300 m. a. s. l. The soil is a extremely stony and shallow Lithic haploxeroll associated to a Lithic xerorthent (Soil Taxonomy, 1975). Mean annual temperature in the nearest weather station is 16°C and the mean annual precipitation is 547 mm. The vegetation is dominated by *Quercus coccifera* L., *Rosmarinus officinalis* L., *Erica multiflora* and *Ulex parviflorus*. The area was burned by a wildfire in 1976 and two years later it was replanted with *Pinus halepensis* Mill.

For the present study we chose *Erica multiflora*, an evergreen sclerophyllous (Orshan 1989) shrub which typically occurs on basic soils of the Western Mediterranean Basin, where it is a common component of the matorral. This species produces abundant resprouts from a moderately enlarged stump or from shallow roots after aerial biomass removal.

Experimental design

A randomized block design was used to minimize the effect of spatial heterogeneity. In July 1989 we selected 4 areas of 25x50 m, two of which were located on a south facing slope and two on a north facing slope with a shallower soil than the other one. In each area, we selected at random 15 *Erica multiflora* individuals of the middle size class (50-75 cm height). Target plants were located at least 6 m apart. We clipped the resprouts at ground level and measured their weight after drying at 80°C, for 96 hours.

In each area, 5 plants of *Erica multiflora* were randomly chosen for each of the following 3 intensity of competition treatments:

a) Lowest competition (2m): we clipped at ground level the vegetation within a 2 m radius from the focal plant.

b) Intermediate competition (1m): we clipped at ground level the vegetation within a 1 m radius from the focal plant.

c) Full competition (control): target plants surrounded by undisturbed local vegetation from the focal plant.

Each target *E. multiflora* genet was covered with a metallic mesh to prevent herbivory by rabbits and sheep. In non competition treatments, the growing vegetation around target plants was removed by hand every month to reduce interference. The biomass of each resprout was estimated using an allometric equation that predicted resprout dry biomass as a function of resprout height and number of ramifications:

ln «biomass» = –4.908 + 1.286 ln «height» + 0.498 ln «number of ramifications», $r^2 = 0.874$, $n = 207$.

In January 1990, July 1990 and January 1991 we measured (for each target plant), the number of resprouts, its height and the number of ramifications.

Statistical analysis

The effect of competition intensity (0, 1 and 2 m clearing radius) on the vigour performance of *Erica multiflora* after 6, 12 and 18 months treatment was statistically analyzed by a two factor ANCOVA. The dependent variables were the number and biomass of the resprouts. The covariable was the plant above-ground biomass before treatment. As the experiment corresponds to a complete randomized block design, the interaction of block x competition was calculated. As we did not find any statistically significant difference between the results for the two areas within the same slope, we pooled them into one block. Pairwise comparisons among the 3 levels of competition treatment were performed by a Scheffé F-test.

Results

There was a statistically significant effect of the location (block), the competition treatment, and the biomass of the plant before treatment, on the number (table 1) and biomass (table 2) of resprouts. The plants with a larger biomass before treatment had more resprouts and larger biomass after treatment than

Table 1. Effect of competition on the number of resprouts of *E. multiflora* after 6, 12 and 18 months treatment. The covariable (weight of the plant before treatment) was natural log transformed and the number of responts was square root transformed to reduce heteroscedasticity. See Fig. 1 for results.

Source	Block	Competition	Plant weight	Block x Competition
6 months				
df	1	2	1	2
F value	4.894	3.835	22.868	1.605
p	0.031	0.028	0.0001	0.21
12 months				
df	1	2	1	2
F value	3.910	3.537	13.739	0.578
p	0.053	0.036	0.000	0.564
18 months				
df	1	2	1	2
F value	5.111	7.617	13.467	1.294
p	0.028	0.001	0.000	0.283

Table 2. Effect of competition on the biomass of *E. multiflora* after 6, 12 and 18 months treatment. The biomass of resprouts and the covariable (weight of the plant before treatment) were natural log transformed to reduce heteroscedasticity. See Fig. 1 for results.

Source	Block	Competition	Plant weight	Block x Competition
6 months				
df	1	2	1	2
F value	9.713	3.124	21.349	0.258
p	0.003	0.052	0.000	0.774
12 months				
df	1	2	1	2
F value	22.579	1.817	21.820	0.217
p	0.000	0.173	0.000	0.805
18 months				
df	1	2	1	2
F value	23.228	9.075	32.729	0.298
p	0.000	0.000	0.000	0.745

did smaller ones. We found no interactions among the competition treatment applied and the plant size before treatment neither between the main effects of competition and block.

Plants of the South facing slope and deeper soil had larger resprout vigour than the ones of the North facing slope. Individuals with neighbours removed had more resprout recruitment than the controls in all the three periods sampled (Fig. 1). However, there were no statistically significant differences in

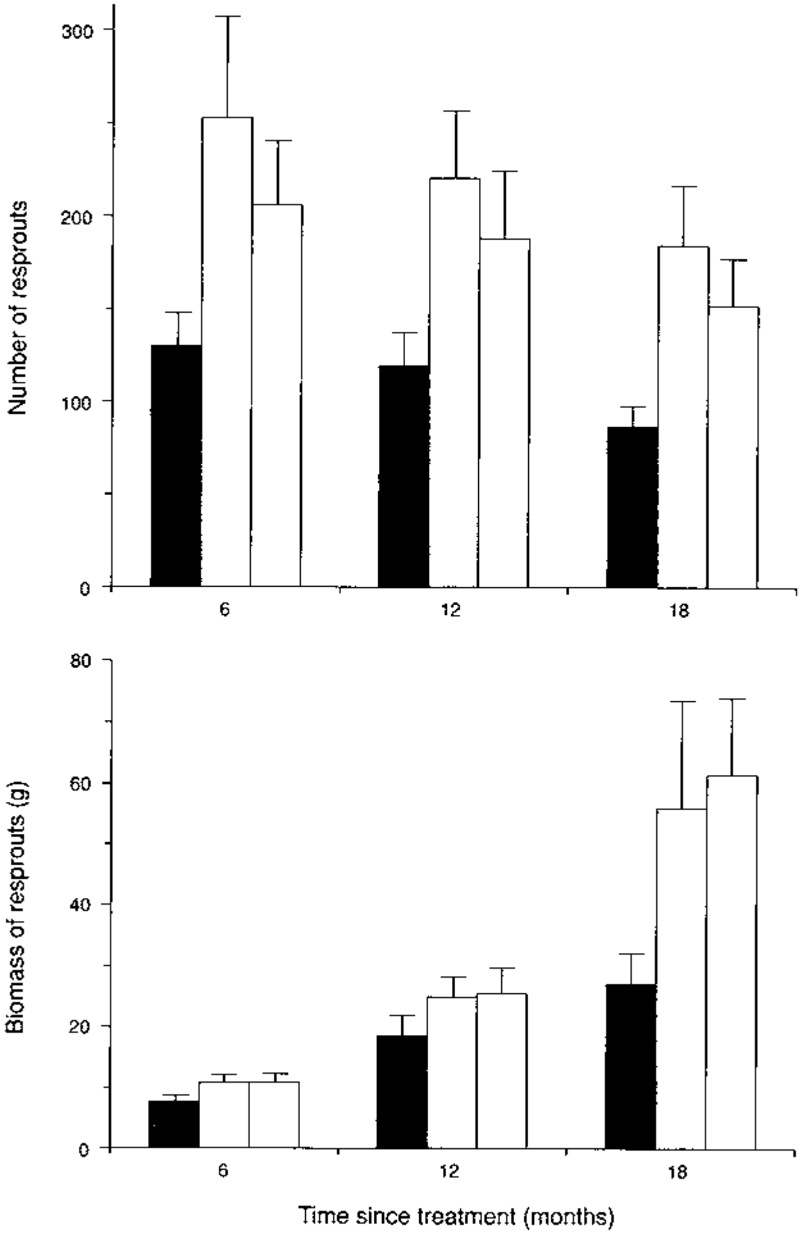

Figure 1. Effect of lower competition (removal of the surrounding vegetation in a 2 m radius circle), intermediate competition (removal of the surrounding vegetation in a 1 m radius circle) and full competition (no removal) on the number of resprouts (above) and biomass of resprouts (below) (+ s.e) of *E. multiflora*. (■) Control, (□) Intermediate competition, (□) Lowest competition.

resprout number between 1m and 2m treatment ($p=0.645$). The differences were between the control plants and the ones with the 1m treatment ($p<0.05$).

Control plants had less biomass than individuals without neighbours (Fig. 1). Nevertheless, the competition effect was not statistically significant until 18 months after treatment and the differences were between controls and both intensities of competition ($p<0.05$). There was no significant difference in resprout biomass between the individuals which competitors were removed at different distances from the target plant ($p=0.941$).

Discussion

The size of the plant before disturbance was positively correlated with resprout vigour. If we assume that there is a positive relationship between above and below-ground biomass, larger plants will have a larger stump; larger stumps will produce more resprouts and more resprout biomass (Zammit 1988). This positive relationship between genet size and resprout vigour was also described for *Erica arborea* (Riba 1991) and it would be related to an increasing number of buds in the bud-bank. A big nutrient storage in big plants and good water and nutrients absorption capacity from the soil will also increase the resprout growth (James 1984), although this has been challenged recently (Canadell et al. in preparation).

Resprouting dynamics was not independent of plant interference usually considered more common in seedlings. The presence of neighbours reduced the number and biomass of resprouts. These negative interactions have also been observed in plants from climatic regions similar to the one studied here (Smith and Goodman 1986, Penridge and Walker 1986).

Individual plants interacted only with their closer neighbours. An increase of the area cleared did not increase resprout vigour. These results were opposite to those obtained by Goldberg and Werner (1983) who found greater *Solidago* sp. growth in the larger openings than in small ones. McConnaughay and Bazzaz (1987) also found a great growth and reproductive output with increasing gap size for some herbaceous plants. In our experiment it seems that the target plant responded to its close neighbours. The negative neighbour effects will be related to the number, size, biomass, distribution (Weiner 1984, Silander and Pacala 1985, Gaudet and Keddy 1988) and root structure (Yeaton et al 1977, Sala et al. 1989, Franco et Noble 1990) of neighbour plants.

We have shown that competition can be an important factor influencing the regeneration of natural Mediterranean shrublands. The target plants surrounded by disturbed (clipped) neighbours had more resprout vigour than those surrounded by the undisturbed vegetation. The competition effect increased during the last regeneration period studied. We suppose that, in the early regeneration stages, plant resprouting was more dependent on stored resources and later, there is an increase of resource competition with neighbouring plants. Further studies might analyze which mechanisms of competition occur during the resprouting period after a disturbance and whether different sorts and regimes of disturbance modify competition relationships and their effect on plant resprouting performance.

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