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Original article

Postfire regeneration in *Cytisus oromediterraneus*: sources of variation and morphology of the below-ground parts

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Abstract

Postfire regeneration in *Cytisus oromediterraneus*, a Mediterranean-basin mountain matorral species, shows a wide range of possibilities and variations in sexual and asexual regeneration. Its interpretation requires basic information on the below-ground structure of parent plants as well as on the origin and development of seedlings and various ramet (sprout clump) types: rootstock, basal-branch, and lateral-root ramets. Morphology and emergence of such ramets in *C. oromediterraneus* is similar to that in related species but with some specific features described here in detail. In order to determine if characteristics of 1-year-old populations depended on the age of the burned parent plants, two populations were investigated: (A 7-year-old, and B 14-year-old). In the most frequent populations in our study area, i.e. those from parent populations of ca. 7 years (A): a—plant density and biomass were highly variable and positively correlated; b—frequency distribution differed significantly from normal distribution for plant weight, but not for other parameters such as diameters, perimeter, and height, in which it did, however, show asymmetry; c—perimeter was the best parameter for estimating individuals' weight; d—there was a higher number of seedlings than ramets but their biomass was smaller; e—the size of seedlings and ramets showed wide variation. In comparison with population A (7-year-old) population B (14-year-old) showed: significantly higher density, slightly lower biomass, higher number of small individuals, mainly seedlings, and less vigorous resprouting. In general, 1 year after fire, *Cytisus oromeditarraneus* population density mainly depends on the germination response, while the above-ground biomass mainly depends on the vegetative response and the intensity of both of them is conditioned by parent plant age.

Keywords: Bulges; Facultative resprouter; Lignotuber; Matorral; Parent age; Population structure

Nomenclature Castroviejo (1999).

1. Introduction

Mediterranean ecosystems are rich in shrub species which have evolved strategies that allow them to survive periodic fires (Trabaud, 1987; Keeley, 1986,1998). Some plants regenerate after fire by resprouting, other plants by producing new seedlings from seeds stored in the seed bank, and other ones by a combination of the two ways (Bond and van Wilgen, 1996). The vegetative resprout can occur from different below-ground organs which have a wide range of names: rootstock, root-crown, lignotuber, burl, lateral roots, root sucker, etc. (Lacey, 1983; James, 1984; Bond and van Wilgen, 1996; Canadell and López-Soria, 1998; Fernández-Santos et al., 1999; Pausas, 1999).

The facultative resprouter species, that are capable of regenerating vegetatively but can also recruit new individuals from seeds, do not always show the same response to fire. Variations in resprouting vigour have been attributed to differences in the burned-plant size (age) (Mallik and Gimingham, 1983,1985; Rundel et al., 1987; Malanson and Trabaud, 1989) or fire intensity (Malanson and O'Leary, 1985; Moreno and Oechel, 1991,1993; Bond and van Wilgen, 1996) and their relationship to the availability of resources has also been studied (Bellingham and Sparrow, 2000; Cruz and Moreno, 2001a; Cruz et al., 2002). However, in many cases the circumstances in which one strategy may have been favored at expense of the other are still not understood.

In Spain, many of the woody species are facultative resprouters and regenerate quickly after disturbances, mainly by resprouting (Casal et al., 1984,1990; Gómez-Gutiérrez et

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al., 1988; Canadell et al., 1991; Ojeda et al., 1997; Vilá et al., 1994; Calvo et al., 1998,2002). Wildfires are an important feature of the Iberian Peninsula, as they are in other Mediterranean ecosystems (Navez, 1975; Trabaud, 1987). However, in Spain a considerable change in fire regime has taken place during the last decades, fires occur more often and affect large areas (Moreno et al., 1998; Pausas et al., 1999). Therefore, at present the burned plants are young, which may be one of the reasons for the preferred vegetative response of matorral species.

In this study we wanted to find out whether the age of burned plants had an effect on post-fire regeneration in *Cytisus oromediterraneus* Riv. Mart. This leguminous species belongs to the group of facultative resprouters (Debussche et al., 1980; Gómez-Gutiérrez et al., 1988; Fernández-Santos and Gómez-Gutiérrez, 1994) and is one of the dominant matorrals of the higher parts in the Mediterranean mountains. Previous studies have also shown that resprouting occurs from different below-ground organs and that a deeper knowledge of the various resprout types was needed, in order to better understand the initial stages of this regeneration and the population dynamics (Fernández-Santos and Gómez-Gutiérrez, 1994). To be able to determine ramet origin as well as the distribution of ramets and seedlings it is necessary to previously describe the structure of parent plants.

Thus, the aims of this study were to: (A) Describe the structures from which resprouting takes place. These structures determine postfire regeneration in *Cytisus oromediterraneus*. (B) Investigate the effect of age of the above-ground part of a burned population on its regeneration and characteristics 1 year after fire.

2. Materials and methods

2.1. Species and study area

Cytisus oromediterraneus Riv. Mart.—previously *C. purgans* (L.) boiss, *C. balansae* (Boiss.) Ball—is a matorral species, which may reach 2 m in height and 6 m in diameter under optimal conditions; whereas under more severe conditions on the slopes it does not exceed 1 m in height. It is found in the mountains of the Mediterranean basin, mainly above 1400 m.a.s.l., forming dense almost monospecific stands occupying vast areas. The matorral is periodically burned (5–8 years) in order to facilitate the growth of grasses.

The study area is situated in the Sierra de Bejar (40°11′–40°24′ N and at 1°50′–2°21′ W), Salamanca, CW Spain. Here, *C. oromediterraneus* is the sole dominant in a shrub between 1400 and 2300 m a.s.l. on the north, and between 1700 and 2300 m a.s.l. on the south slope (Gonzalez-Bartolomé et al., 1987). It also occurs at lower altitudes, where it competes with other shrubs, mainly *Genista florida, G. cinerea, Cytisus scoparius*, and trees, mainly *Quercus pyrenaica, Pinus sylvestris* and *P. pinaster* in planted pine stands.

The study area is situated on the north slope of the mountain range. The climate can be characterized as Mediterranean mountainous, i.e. hyperhumid and cold, with a strong Atlantic influence (García, 1985). The soils overlay granitic bedrock and are shallow and acid. According to the FAO classification, they are distric or humic Cambisols and Rankers (García, 1985). The local people traditionally burned the matorral in small patches. Recently, however, their frequency has been much higher because fires are also started by tourists and hunters.

2.2. Field sampling

In order to describe the resprouting structures plants were carefully excavated from the 1-year cohort as well as from older post-fire populations (20–25 years) and 30 replicates of each resprout type were sampled. Age was estimated from growth rings. Data regarding the 1-year-old-population structure and regeneration, and how it was influenced by population age prior to fire, were collected from two adjoining areas at 1750 m.a.s.l.: population A—originating from a burned parent population whose above-ground part was ca. 7-years-old (the most frequently occurring ones in our study area), and population B—from a 14-year-old one. Both of them were burned in the same summer fire. A sampling quadrat, 1×1 m^2, was placed at random nine times in each population and the number of each type of individuals, i.e. seedlings and various ramet types, was counted. This was done by excavating all the individuals in the quadrats. Their height, perimeter, larger and smaller diameter were measured only in plants of population A; in population B, most of the plants were seedlings with no variation in these features. Dry weight was determined in both populations by drying to constant weight in a forced-air oven at 80 °C for 24 h.

We regarded as a ramet each resprout clump with a clear physical distance from another one. All the sprouts originating from the rootstock of the burned parent plant were counted as only one ramet. In other words, we always considered as ramets those resprouts which, according to their relative position, were most likely to develop into separate individuals with their own root system.

2.3. Data analysis

Statistical analysis consisted of: basic data description, comparison of measured variables using the *t* test of Student and correlation of variables. Simple and multiple regression was used to find the best relation between dry weight and some biometric characteristics (greater and smaller diameter, height and perimeter), in order to facilitate future biomass estimations with no destructive methods. The David test (David et al., 1954) was used to check the normality and the Cochran (1941) test to check the homocedasticity.

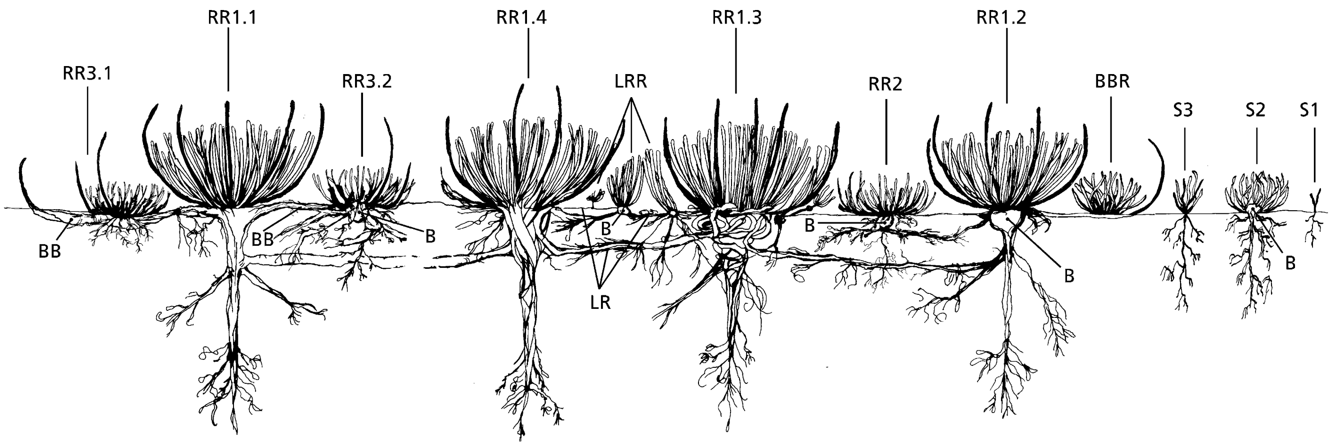

Fig. 1. Regenerative structures in *Cytisus oromediterraneus* after fire and entangled below-ground structures. R.R., rootstock ramet; B.B.R., basal-branch ramet; L.R.R., lateral-root ramet; S, seedling; B, bulge. Burned parts in black (see text).

3. Results

3.1. Description of the regenerative structures

3.1.1. Seedlings

In all the 1-year-old populations seedlings were in various stages of growth and development, indicating a gradual process of seed germination (Fig. 1, S1–3). Seedlings emerged, in variable numbers, in groups around the remains of the burned parent plant, but they have rarely be found directly underneath the parent plant canopy (less than 2% of the total seedling).

3.1.2. Resprouts

The emergence of first sprouts did not occur immediately after fire but after the first autumnal rains—matorral burning starts in late summer or early autumn. Resprouting took place from buried basal branches (BB), from superficial lateral roots (LR) and from rootstock (R) (Fig. 1).

Basal-branch sprouts (Fig. 1, BBR) grew from the parts of basal branches protected from fire by soil formed from the accumulated organic matter from the plant itself and mineral matter transported by wind (Gómez-Gutiérrez et al. 1988). These sprouts did not immediately grow new auxiliary roots. With age they developed their own root system, however, still maintaining connection with the old basal branch, which could be losing its function.

Lateral-root sprouts (Fig. 1, LRR) grew from not very thick lateral root, ca. 5 mm in diameter. In the first year we did not find auxiliary roots below these sprouts. But in older populations (up 5 years) they developed their own root system, although remaining connected to the parent plant by thick superficial roots.

We classified as rootstock resprout all the sprouts growing from the place where burned basal branches of the former (i.e. parent) plant emerged. We found various below-ground structures determined by the origin of the parent plant and by the presence or absence of a below-ground organ—an enlarged bulge or a tangled structure. Within the rootstock resprout we could distinguish (Fig. 1, RR):

1. Rootstock resprout from a former plant with a tap root emerged in any place on the surface of the rootstock, sometimes only on its edges leaving a central hole forming a small crown (<15 cm diameter) (RR1). The below-ground structure in some plants had a thick tap root (RR1.1), in others a clear compact bulge between the root and the "platform" (RR1.2). But in the majority of cases there was a complex woody mass of a tangled structure consisting of thick twisted roots (RR1.3) or of two tap roots with entangled somewhat smaller roots (RR1.4).
2. Resprouts from former lateral-root (RR2). Repeated fires seemed to induce lateral-root resprouts to sprout again when a new fire occurred. Burned remains appeared on the rootstock, formed on the lateral root, and new sprouts grew between them either on the whole area occupied by former basal branches, if the root resprout was already big, or on the upper area of the bulge in the parent plant between its basal branches and the lateral root (RR2).
3. Resprout from a former basal-branch resprout (RR3) was similar to the latter one (2), with the difference that its parent plant had developed from a buried basal branch. The old basal branch persisted and together with the many auxiliary roots constituted the below-ground structure of a new ramet (RR3.1). Sometimes we also found new ramets of this kind sprouting from a basal-branch bulge in which burned remains were present (RR3.2).
4. Absence of resprouting. Finally, we found burned rootstocks that did not resprout at all. In some of them we could clearly see that fire had affected the below-ground structures. This occurred in patches situated at altitudes above 2100 m.a.s.l. and on shallow sandy mineral soils.

3.1.3. Bulges

One year after fire the bulge existing at the base of some rootstock ramets (8 cm maximum diameter) did not appear in other ramet types or seedlings, although it was beginning to

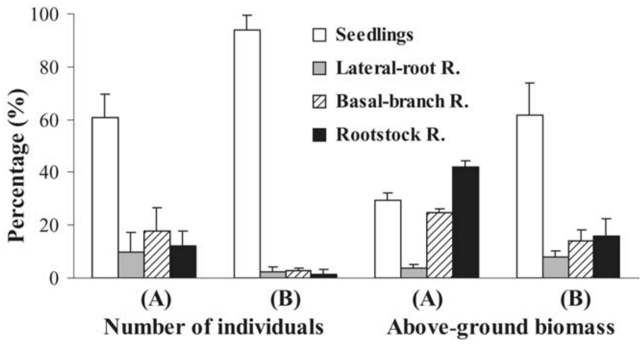

Fig. 2. Proportions of seedlings and different types of ramets found 1 year after fire in population A (from a 7-year-old burned parent population) and in population B (from a 14-year-old one). Mean values ± S.E.; $n = 9$.

show in some lateral-root ramets. Bulges (1–2 cm maximum diameter) were clearly visible 3–4 year after the last fire, whence on they were quite frequent in lateral-root ramets, also in some plants originating from seedlings, and on rare occasions in basal-branch ramets (Fig. 1B); although its position was similar to that in other sprouts in these it was less woody and more callous. In plants originating from seedlings the bulge was less frequent and also located in the root-link part (Fig. 1, S2), and it could be the centre of new sprouts even when not burned. The number of bulges in older populations, 10–12 year, was much lower than in those of 3–4 year.

3.2. The effect of parent-population age, before fire, on the new population's characteristics

3.2.1. Features of population A (from a 7-year-old)

One year after fire (Fig. 2) seedlings constituted more than 60% of all the individuals, but their contribution to the total above-ground biomass did not exceed 30%, because their mean weight was low (0.6 g). Resprouts were less numerous (40%), however, they represented more than 70% of the total above-ground biomass. They were usually bigger than seedlings, and showed considerable differences between them depending on their origin. Rootstock ramets reached greatest dimensions and weight (mean value 4.8 g) and although there were not many, only 12% of the total number of individuals, they represented 42% of the total above-ground biomass. Basal-branch ramets were more numerous (18%) than the rootstock ones but smaller (mean value 1.9 g), and their contribution to the total biomass was 25%. Lateral-root ramets were least in number (<10%) and smallest (mean value 1.0 g), contributing less than 4% to the total above-ground biomass. The number of individuals varied considerably between samples (5–90 indiv/m^2), with a mean value of 33 plants/m^2. Total above-ground biomass (always expressed in g.d.w.) also varied much (4–113 g/m^2), with a mean value of 46 g/m^2 (Table 1).

Frequency distribution for plant biomass differed significantly from normal distribution (Table 2). Nonetheless, according to the plant dimensions (diameter and height) frequency distribution within the population did not differ from

Table 1
Density of different types of individuals and above-ground biomass found in two *Cytisus oromediterraneus* populations 1 year after fire: population A from a 7-year-old burned parent population; B, from a 14-year-old one. Mean values ± S.E., and comparisons of the populations using the *t* test of Student. Correlation coefficient between density and above-ground biomass for each population

Variable	Population A	Population B	*t* Student
Biomass (g/m^2) (1)	46.3 ± 13.5	26.0 ± 7.6	N.S.
Number of individuals/m^2			
Total (2)	33.0 ± 8.5	86.0 ± 13.8	**
Seedlings	20.0 ± 5.4	80.6 ± 13.5	***
Rootstock R. (R.R.)	4.0 ± 1.0	1.1 ± 0.6	*
Basal-branch R. (B.B.R.)	5.9 ± 1.1	2.2 ± 0.7	**
Lateral-root R.	3.1 ± 1.6	2.1 ± 0.7	N.S.
R.R. + B.B.R.	9.9 ± 2.1	3.3 ± 1.2	**
Ramets (all)	13.0 ± 3.2	5.4 ± 1.5	***
Correlation 1, 2	$r = 0.788$ **	$r = 0.136$	

Difference significance: * $\alpha = 0.10$, ** $\alpha = 0.01$, *** $\alpha = 0.001$.

normal, but showed a certain asymmetry to the right. Height was the variable with the least dispersion of values (CV = 0.33). In the rest of dimensions dispersion was similar and very high (CV between 0.6 and 0.7).

To estimate individual weight without harvesting them we obtained best results using the horizontal dimensions. The relation between variables was not linear but exponential, and the highest percentage of explained variations (R-squared) was found after transforming, Ln(y + 1), the weight of individuals (y), where the variable x is perimeter (Fig. 3) or multiple regression with four dimensions: $\mathrm{Ln}(y + 1) = 0.023 \times 1 + 0.028 \times 2 + 0.019 \times 3 + 0.023 \times 4 - 0.289$, where x_1 = greater diameter, x_2 = smaller diameter, x_3 = height, and x_4 = perimeter, (R-squared 0.854).

3.2.2. Characteristics of population B (from a 14-year-old)

In this population seedlings represented more than 93% of the plants (Fig. 2) and many of them did not exceed 0.2 g weight. Ramets were bigger than seedlings, mainly rootstock ones (mean weight 3.7 g), but their density was low (6%) and represented less than 40% of the total above-ground biomass (Fig. 2). Plant density showed low dispersion (CV = 0.29), with a mean of 86 plants/m^2. Total aerial biomass varied more (CV = 0.66), with a mean of 26 g/m^2. The two variables were not correlated (Table 1). Frequency distribution for plant dry weight showed clear asymmetry to the right and differed significantly from normal distribution (Table 2).

3.2.3. Comparative study of populations A and B

One year after fire plant density was significantly higher in population B than in A, whereas above-ground biomass was lower (Table 1). Furthermore, in the frequency distribution according to size class (dry weight) of individuals, the asymmetry was greater in population B. All this is due to the great differences existing in the number and weight of individuals,

Table 2
Statistical description of values obtained for each of the variables in *Cytisus oromediterraneus* individuals, found 1 year after fire in population A (from a 7-year-old burned parent population), and for dry weight in population B (from a 14-year-old one). S.D., Standard deviation; C.V., Coefficient of variation; R/S.D., test of David; R, range

Variable	*N*	Max.	Min.	Mean	S.D.	C.V.	Mode	R/S.D.	Skewness
Dry weight (g)—B	774	10	0.02	0.3	0.91	–	0.02	11.13 *	6.837
Dry weight (g)—A	297	16.5	0.01	1.57	2.24	–	0.2	7.14 *	3.822
Greater diameter (cm)	297	31	0.2	8.23	5.04	0.61	7	5.95	0.961
Smaller diameter (cm)	297	23	0.2	6.02	4.19	0.69	3	5.26	1.219
Height (cm)	297	21	3	9.61	3.13	0.33	9	5.76	0.363
Perimeter (cm)	297	72.5	2.5	20.43	12.9	0.63	12.5	5.43	0.96

* Normality refused for $\alpha = 0.05$.

depending on their regeneration origin. It is also due to the differences in the regeneration after fire, which depends on the age of the burned plants. Seedlings, the lowest mean dry weight individuals, were the most frequent individuals in both populations but their density was significantly higher in B than in A. Conversely, the number of ramets, mainly the biggest ones (basal-branch and rootstock + basal-branch ones), was significantly lower in population B than in A. Furthermore, the mean and maximum values of individual's dry weight were lower in B (Table 2). The increase in seedling number in population B was greater than the decrease in large-ramet number, hence plant density was significantly higher in population B (Table 1). But the minimal size of seedlings, as compared to ramets, resulted in lower above-ground biomass in population B. So, biomass and number of individuals were significantly correlated in population A but not in B one.

4. Discussion

The results obtained in this study show that *Cytisus oromediterraneus* populations regenerated after fire by seed germination and resprouting from different below-ground organs, and that the quantitative characteristics are determined by the age of the burned plants. Some species of the same genus in the Mediterranean basin are also facultative resprouters after fire, notably *C. scoparius* (Tárrega et al., 1992) and *C. multiflorus* (Fernández-Santos et al., 1999).

The bulges found in *Cytisus oromediterraneus* show similar features to those described for "lignotubers" (Kerr, 1925). They are situated at the root-link and their initial stages appear as small swellings (Hanes, 1981). They resprout after disturbances, but also develop sprouts without being burned (Lacey, 1983; Messleard and Lepart, 1989; Keeley, 1992; Canadell and López-Soria, 1998; Cruz and Moreno, 2001a;

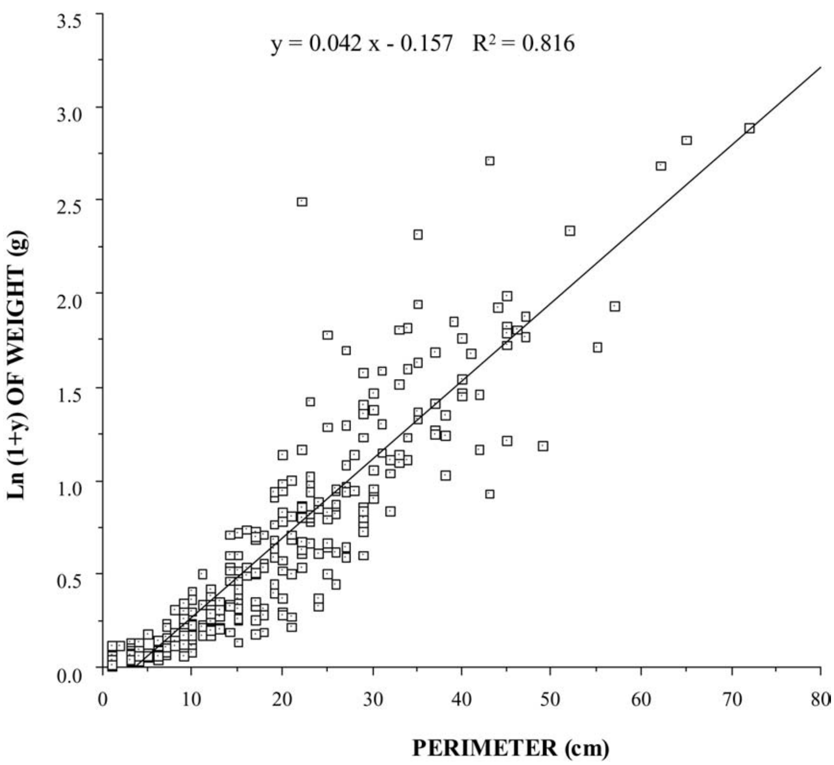

Fig. 3. Regression between perimeter (x) and dry weight (y) of *Cytisus oromediterraneus* individuals, found in population A after the $\text{Ln}(y + 1)$ transformation of data. Regression equation and proportion of explained variations, based on $n = 297$ individuals.

Cruz et al., 2002), and seem to function as nutrient storage (James, 1984; Kummerow, 1989; Pausas, 1999). However, there are some differences that do not let us regard them as lignotubers. Namely, resprouting does not occur only on the edges, forming a crown of greater diameter than the former one (Hanes, 1981), but can take place on the whole upper area of the bulge and, if the parent plant was big, within the platform created by basal branches. Moreover, although increasing in size during the first years, bulges never reach large dimensions as do lignotubers (Lacey, 1983; Cruz and Moreno, 2001b). In old populations, from 10 year onwards, bulges tend to disappear. On the other hand, the complex woody mass and the entangled structure forming some of the rootstocks appear to be similar to the description of "burls" (Garland and Marion, 1960). In our case, they probably result from repeated burning, since after each resprouting of the rootstock new roots grow and with time increase in thickness and size.

"Rootstock resprout" is the term commonly used in Spain to describe a resprout growing from the base of a matorral whose above-ground biomass had been destroyed by fire or other perturbation (Casal et al., 1984; Herrera, 1987; Gómez-Gutiérrez et al., 1988). Our results show that this term comprises different below-ground structures similar to other organs described in other species. Thus, the term rootstock, as we have applied it in our studies, is less defined than those of "lignotuber" and "burl". Nonetheless, in all the forms, destruction of the above-ground part activates numerous dormant buds (Kummerow, 1989) giving rise to above-ground sprouts. The absence of resprouting in patches situated at altitudes above 2100 m.a.s.l. could be due to the "live-coal effect": The relatively abundant dead plant matter fallen onto the soil is not decomposed and mineralised. As a result, the rootstock and lower parts of basal branches remain covered by a layer of organic matter. This cover is readily combustible, burning easily and intensely—live-coal effect—when a fire starts, killing the whole plant.

Vegetative regeneration from other structures, such as buried branches and superficial lateral roots, is similar to that in some low woody matorrals dominated by *Calluna vulgaris*., in which callous bulges (Mallik and Gimingham, 1983) around basal branches were also reported.

Post-fire regeneration of *C. oromediterraneus* and the recurrent fires gave rise to a complex below-ground structure in this population; in a way similar to that in other species, e.g. in the genus *Quercus* (Kummerow and Mangan, 1981; Rambal, 1984; Tiedemann et al., 1987), and makes the task of discriminating old genets (Harper, 1977) extremely difficult. However, in order to be able to carry out quantitative studies it is essential to recognise the origin of ramets (Fernández-Santos and Gómez-Gutiérrez, 1994).

In relation to the mode of regeneration, high temperatures increase seed germination of *Cytisus oromediterraneus* (Añorbe et al., 1990), as has been reported for other species (Tárrega et al., 1992; González-Rabanal and Casal, 1995; Valbuena et al., 2000). Nevertheless, a too high, probably lethal, temperature can be reached under burned plants during fire, as has been found for other species (Ne'eman et al., 1992; Segura et al., 1998; Odion and Davies, 2000).

These results showed that the quantitative characteristics depend on the age of the above-ground part of the burned population. In the first year after fire and when the former population was 7 year old, both the vegetative and germination response were important. The seed germination provided a greater number of individuals, whereas the vegetative one mainly contributed to the above-ground biomass. Compared with other leguminous species, the biomass percentages are similar to those in *Ulex europea* (Casal et al., 1984): resprouts 81% and seedlings 19%. Greater development of resprouts than seedlings was also found in other facultative resprouters (Hanes, 1981; Keeley, 1986; Calvo et al., 1998; Fernández-Santos et al., 1999). It could be due to a number of factors such as the availability of reserves accumulated by the parent-plant below-ground structure, their earlier emergence, and root competition on poor sandy soils (Canadell et al., 1991; Putz and Canham, 1992; Canadell and Lopez-Soria, 1998). Furthermore, ramets were found to be the larger the closer they were to the rootstock. That the resprouting vigour may be positively related to the size of below-ground structures was also observed in other species of the genus *Cytisus* (Fernández-Santos et al., 1999) and in other woody species of the Mediterranean region (Vilà et al., 1994).

Decrease in ramet number and size due to the age of parent plants could be a reflection of lower vegetative-regeneration capacity in older plants, as occurs in other species (Malik and Gimingham, 1983,1985; Malanson and Trabaud, 1989). Whereas the increase in seedling number in population B could result from greater seed production before fire owing to the higher capacity to produce seed by older plants. Young individuals diverted their limited reserves into growth (unpublished data), the 7-year-old *C. oromediterraneus* plants were in the exponential growth stage while the 14-year-old ones almost reached a plateau in the sigmoid model (Martínez-Ruiz et al., 1994). Nevertheless, it is also possible that the lower ramet vigour could indirectly favour seed germination, and very probable that by lower competition it favours seedling survival.

On the other hand both density and biomass, above all the former, showed smaller variation within population B than A. But, whereas in population A they were positively correlated, in B the variations in biomass were independent of the number of individuals. These changes seemed to respond to a less aggregated spatial distribution of individuals in population B. It could be explained by less resprouting, lower ramet number, and by greater distance between ramets—both between basal-branch ones and between basal-branch and rootstock ramets, since buried basal branches were longer and extended more. However, perhaps the lower vegetative response could favour the increase in the number of places suitable for seed germination and seedling establishment and growth.

5. Conclusions

1. *Cytisus oromediterraneus* populations showed both germination and vegetative post-fire regeneration. The recurrent fires gave rise to a complex below-ground structure consisting of tap roots, tangled structures, interconnected thick lateral roots, buried basal branches, superficial lateral roots, small roots growing from all of the mentioned as well as from their resprouts. This complex below-ground structure makes the task of discriminating old genets extremely difficult. Therefore, in quantitative studies it is advisable to differentiate ramets.
2. *C. oromediterraneus* plants often have bulges at the root-link; in populations 3–4 year after fire these structures show similar morphology to lignotubers, but at more advanced ages they are more like burls.
3. Characteristics of *C. oromediterraneus* populations (plant density, above-ground biomass, frequency and spatial distribution, regenerative response) 1 year after fire are determined by the age of the burned plants in the studied areas. The new population structure arising from older parent plants, i.e. older prior to the fire disturbance, shows a higher number of seedlings and a lower number of large ramets.
4. In general, 1 year after fire, population density mainly depends on the sexual regeneration way, while the above-ground biomass mainly depends on the vegetative way. Seedling dry weight was lower than that of ramets, and ramets were found to be the larger the closer they were to the rootstock.
5. In these *C. oromediterraneus* populations differences between individuals were more pronounced in the horizontal dimensions, mainly perimeter. The latter is the most suitable parameter to characterise individuals or to estimate the above-ground biomass indirectly, whereas height is the least suitable one.

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