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COMPARISON OF THE POST-FIRE DYNAMICS OF THE ECTOMYCORRHIZAL COMMUNITY IN TWO *Quercus ilex* STANDS IN NORTHERN SPAIN.

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SUMMARY

CLAVERÍA, V., DE MIGUEL, A.M. & DE ROMÁN, M. Comparison of the post-fire dynamics of the ectomycorrhizal community in two *Quercus ilex* stands in Northern Spain. *Publ. Bio. Univ. Navarra, Ser. Bot*., 15: 19-30.

A comparative study of the post-fire recolonization of ectomycorrhizae in two evergreen oak stands (*Quercus ilex* L. subsp. *ballota* (Desf.) Samp.) in Nazar and San Cristóbal (Navarra, Spain) has been carried out.

In 1993 a stand in Nazar burnt, but it was not until 1998 that the study started. On the contrary, the study in San Cristóbal started immediately after the stand had caught fire in 2000. Therefore we have been able to compare the regeneration in both stands and the species composition five years after the fire and immediately after the fire, as well as the differences in ectomycorrhizal colonization and abundance of morphotypes between the burnt plots and areas which remained undisturbed in both forests, thus acting as control plots.

In both sites the percentage of ectomycorrhizal colonization tended to be lower after the wildfire. In San Cristóbal, in the burnt site there was a lower abundance of morphotypes compared to the control site. However, in Nazar, five years after the fire, we did not find any significant change in species richness, but rather a shift in the abundance of each morphotype when comparing the burnt and the control plots.

There are some species of mycorrhizal fungi which seem to be particularly adapted to fire, such as Type 1 in San Cristóbal and *Cenococcum geophilum* in Nazar. *Sphaerosporella brunnea,* a pioneer species considered to be especially suitable for the colonization of burnt substrates, was only found in Nazar.

Key words: ectomycorrhizae, fire, *Quercus ilex*, succession.

RESUMEN

CLAVERÍA, V., DE MIGUEL, A.M. & DE ROMÁN, M. Comparación de la dinámica post-fuego de la comunidad ectomicorrícica en dos bosques de *Quercus ilex* en el norte de España. *Publ. Bio. Univ. Navarra, Ser. Bot*., 15: 19-30.

Se ha llevado a cabo un estudio comparativo de la recolonización ectomicorrícica post-fuego en dos carrascales (*Quercus ilex* L. subsp. *ballota* (Desf.) Samp.), localizados en Nazar y San Cristóbal (Navarra, España).

En 1993 se incendió un bosque en Nazar, aunque el estudio de la flora ectomicorrícica del mismo no pudo comenzarse hasta 1998. En cambio, en San Cristóbal fue posible comenzar el estudio inmediatamente después de que el bosque se incendiase en el año 2000. Esto ha posibilitado comparar la regeneración en los dos bosques y la composición micorrícica de especies, cinco años e inmediatamente después del fuego, así como las diferencias en la colonización ectomicorrícica y abundancia de morfotipos entre las zonas quemadas y las áreas que no fueron afectadas por el incendio, que actúan como zonas control.

En ambos lugares el porcentaje de colonización ectomicorrícica tiende a ser menor después del fuego. En San Cristóbal, se ha detectado una menor abundancia de morfotipos en la zona quemada que en la zona control. Sin embargo, en Nazar, cinco años después del fuego, no encontramos cambios significativos en la riqueza de especies, pero sí una variación en la abundancia de cada morfotipo al comparar la zona quemada y control.

Hay algunas especies de hongos micorrícicos que parecen adaptadas particularmente al fuego, tales como el Tipo 1 en San Cristóbal y *Cenococcum geophilum* en Nazar. *Sphaerosphorella brunnea*, una especie pionera considerada muy adecuada para la colonización de substratos quemados, fue encontrada solamente en Nazar.

Palabras clave: ectomicorrizas, fuego, *Quercus ilex*, sucesión.

INTRODUCTION

Fire is an important disturbance playing an ecological role in the evolution, dynamics and distribution of vegetation in the world (TRABAUD & GRANDJANNY 2002). Regions with a Mediterranean climate are particularly affected by fire. In these regions, the incidence of fire has recently increased due to human impact and may continue to increase as a result of global climate change (PAUSAS 1997). After reviewing the bibliography on fire we have seen that nowadays there are no studies on the impact of fire on fungi and ectomycorrhizae in

Quercus forests. Most of the studies on the behaviour of ectomycorrhizae after fire have been carried out in conifers, specially in the U.S.A. and Canada (BAAR *et al.* 1999, GROGAN *et al.* 2000), with only one study carried out in the Mediterranean region as far as we know (TORRES & HONRUBIA 1997). In this area most of the studies related with fire are focused on the regeneration and succession patterns of the post-fire vascular flora (TÁRREGA *et al.* 1993, PAUSAS 1997, TRABAUD & GRANDJANNY 2002).

The research in our group has been focused during the last four years on the description and identification of ectomycorrhizae in burnt *Quercus ilex* stands, and in adjacent areas which were not affected by fire and act as control plots for the study. (DE ROMÁN & DE MIGUEL, 2000, 2001a, 2001b, 2002, DE ROMÁN *et al*. 1999) The aim of this study is to compare the post-fire recolonization of ectomycorrhizae in two *Quercus ilex* L. subsp. *ballota* (Desf.) Samp. stands located in San Cristóbal and Nazar (Navarra, Spain) respectively.

Fig. 1: Control site at Nazar.

Fig. 2: Burnt site at Nazar.

Fig. 3: Control site at San Cristóbal.

Fig. 4: Burnt site at San Cristóbal.

MATERIALS AND METHODS

The study sites are two *Quercus ilex*. L. subsp. *ballota* (Desf.) Samp. stands located in Nazar (30TWN5821 and 31TWN5921) (Figs. 1 and 2) and San Cristóbal (30TXN0945 and 30TXN0845) (Figs. 3 and 4) respectively.

In September 1993 a stand in Nazar caught fire, but it was not until November 1998 that the study started. On the contrary, the study in San Cristóbal started one month after the stand caught fire, in October 2000, thus enabling us to analyse the mycorrhizal communities in the first stages after the fire. We compared the percentage of ectomycorrhizal colonization and the diversity and abundance of ectomycorrhizal morphotypes occurring in the burnt areas and in adjacent unburnt late-successional areas, as well as the regeneration of the stands and the species composition five years after the fire and immediately after the fire.

The sampling of ectomycorrhizae has been done in Nazar seasonally, from autumn 1998 to winter 2001 while in San Cristóbal the monitoring of mycorrhization has been done in autumn 2000, spring 2001 and spring 2002, so far.

Samples of soil containing roots were taken with a 10 cm-deep soil corer at a distance of 1m from the tree trunk. In the laboratory, each sample was divided into two subsamples: 150 g in order to calculate the mycorrhizal colonization, and 300 g to calculate the diversity and abundance of ectomycorrhizal morphotypes. Mycorrhized tips were washed and separated using two sieves (1.7 mm and 0.7 mm respectively).

The analysis of the mycorrhizal colonization at both sites was done following the gridline intersect method (BRUNDRETT *et al*. 1996) and the results are given in percentage of mycorrhized root tips.

The ectomycorrhizal morphotypes were characterized according to AGERER (1987-1998), and identified when possible by comparison with literature descriptions (AGERER *et al*. 1996-2001, AGERER & RAMBOLD 1998, BENCIVENGA *et al.* 1995, DONNINI & BENCIVENGA 1995, GOODMAN *et al*. 1996-2000, INGLEBY *et al*. 1990). Unidentified morphotypes were given a number, but we need to point out that the numbers are not consecutive due to the fact that this is a common nomenclature within the research group and that the remaining morphotype numbers have been found in other study areas by other researchers of the group.

RESULTS AND DISCUSSION

Both in Nazar and San Cristóbal, the percentages of ectomycorrhizal colonization tended to be lower after the wildfire (Fig. 5 and 6). The lower abundance of ectomycorrhizae in burnt areas in comparison with undisturbed ones has already been reported in the literature (ALLEN 1991).

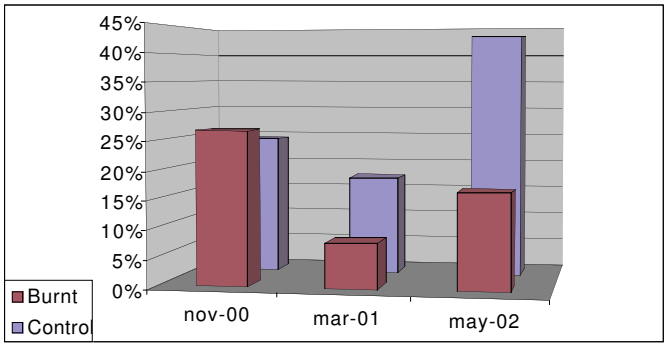

Fig. 5: percentage of mycorrhization in S. Cristóbal.

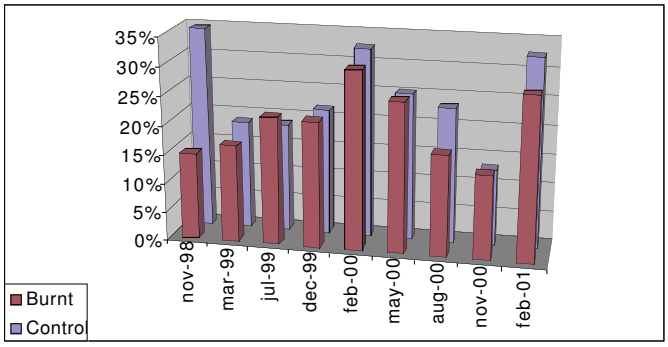

Fig. 6: percentage of mycorrhization in Nazar.

Altogether, the study of the ectomycorrhizal diversity yielded a total of 45 different morphotypes, 35 in San Cristóbal and 33 in Nazar. In the undisturbed sites we found 17 species in common between Nazar and San Cristóbal, while in the burnt ones there were 14 coincidences. Regarding the species richness, we found that in San Cristóbal (Fig. 7) it was much lower in the burnt site than in the control site, while in Nazar the species richness was similar in both sites (Fig. 8). The decrease in species richness ocurring in San Cristóbal has also been reported in other studies on the effect of fire on the ectomycorrhizal community (BAAR *et al.* 1999, DAHLBERG *et al.* 2001, TORRES & HONRRUBIA 1997). Nevertheless, our results in Nazar are consistent with those of JONSSON *et al.* (1999) in a *Pinus sylvestris* stand, who did not find any significant change in species composition or in species richness, but rather a shift in the abundance of each morphotype following wildfire. The reason for this could be the ability of the resprouting *Quercus ilex* to serve as a reservoir of ectomycorrhizal fungi (TORRES & HONRUBIA 1997, DE

ROMÁN & DE MIGUEL 2002), thus maintaining the same species richness after fire.

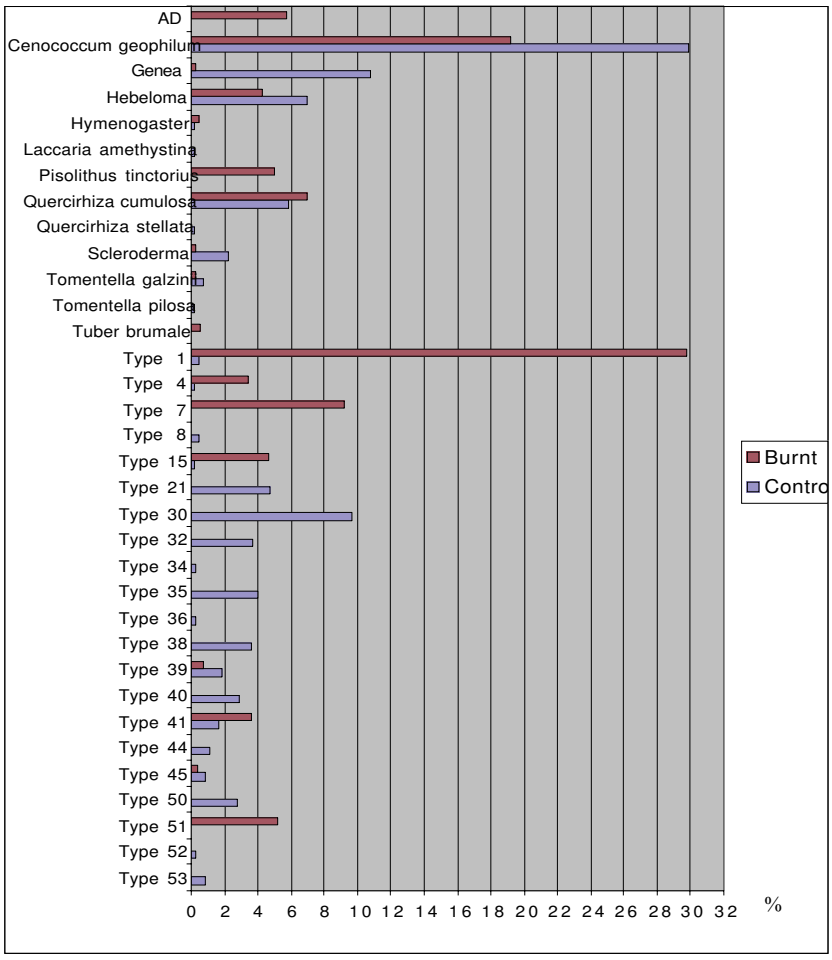

Fig. 7: Abundance of each ectomycorrhizal morphotype in both sites in S. Cristóbal.

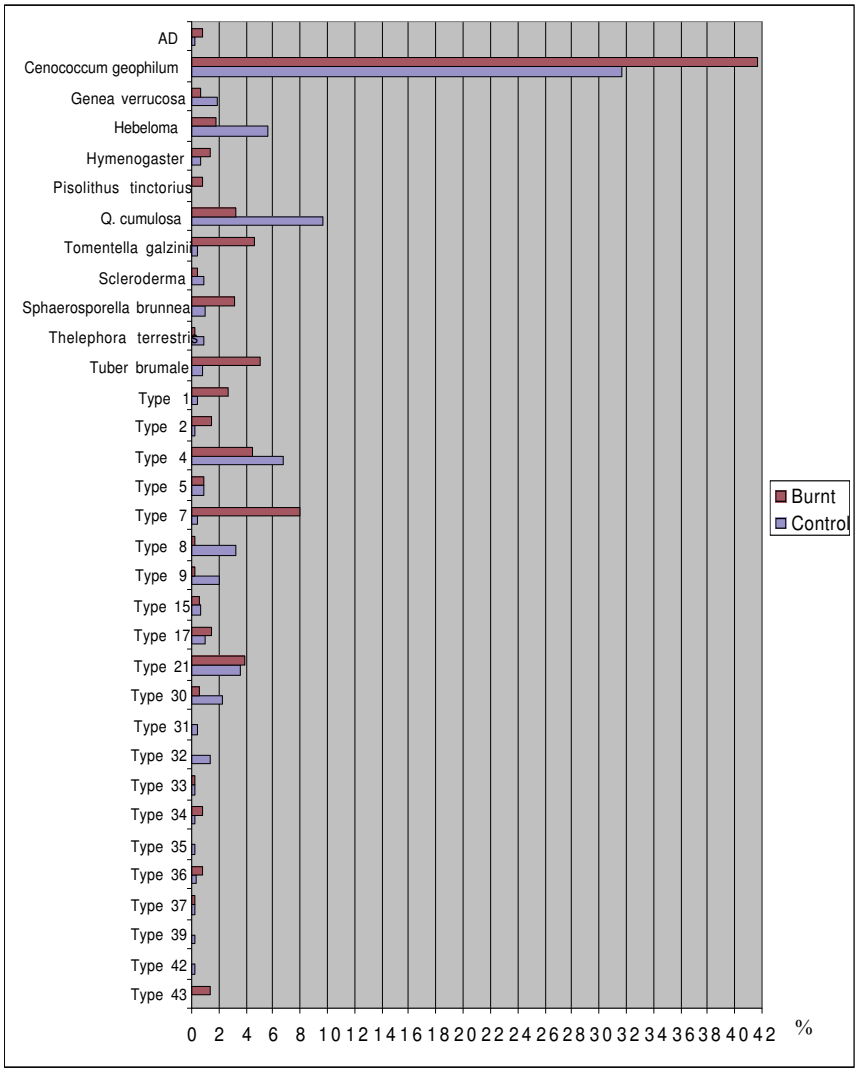

Fig. 8: Abundance of each ectomycorrhizal morphotype in both sites in Nazar.

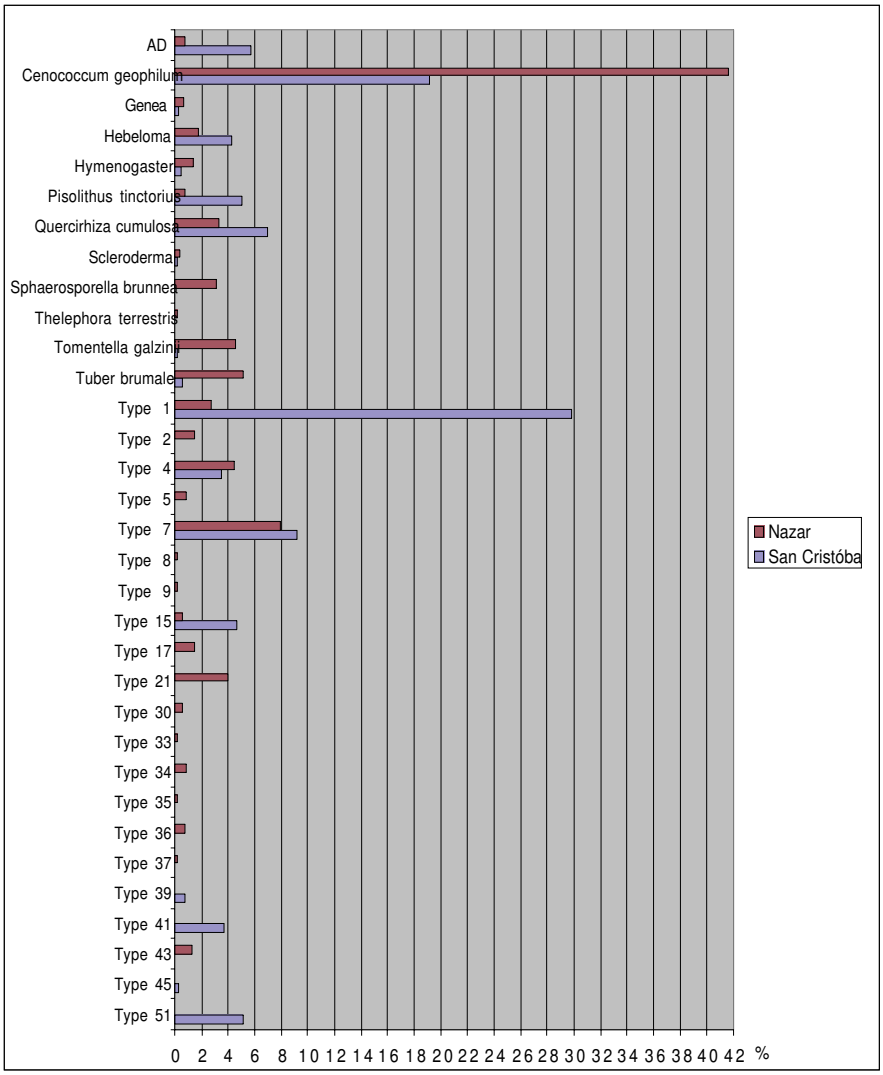

Fig. 9: Comparison of the abundance of each ectomycorrhizal morphotype in the burnt sites in both stands.

Cenococcum geophilum (Fig. 10) was the most abundant morphotype in both stands. It is a cosmopolitan fungus adapted to a variety of environments and especially resistant to drought (LoBUGLIO 1999). VISSER (1995) described this species as a multi-stage fungus able to survive fire thanks to its sclerotia. Another outstanding fact was the amount of *Tomentella*-like morphotypes (Figs. 11, 12 and 13) found in both stands, fact which is reported in detail by DE ROMÁN *et al.* (2002).

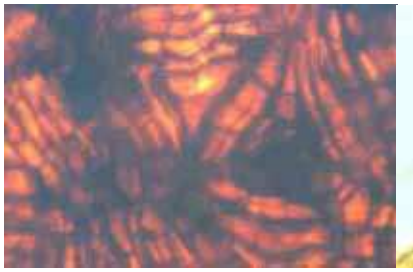

Fig. 10: *Cenococcum geophilum* Outer mantle x 100

Fig. 11: Type 4. Cystidia x 100

Fig. 12: *Tomentella pilosa.* Cystidia x 100

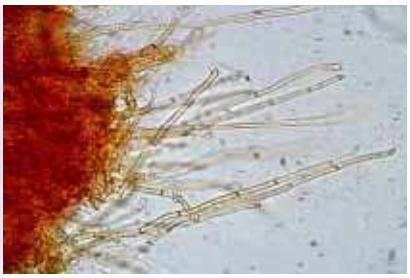

Fig. 13: Type 52. Cystidia x 100

Fig. 14: Type 1. Hyphae x 100

Fig. 15: Type 51. Cystidia x 100

In San Cristóbal, ectomycorrhizal morphotypes occurring mainly in the burnt site immediately after the fire (Fig. 9) included the *Pisolithus tinctorius* type, *Quercirhiza cumulosa* type, the AD type (angle droit; GIRAUD 1998), type 1 (Fig. 14), type 7 and type 51 (Fig. 15). Type 1 has been the morphotype which has taken the greatest benefit immediately after the fire. In spite of the fact that *Sphaerosporella brunnea* is considered to be a pioneer species especially suitable for the colonization of burnt substrates (MEOTTO & CARRATURO 1987-88), it has not been found in San Cristóbal stand. However, it occurs in Nazar, where we can also observe *Pisolithus tinctorius* type, *Tuber brumale* type, *Tomentella galzinii* type, type 4 (Fig. 11) and type 7.

In conclusion, we may say that the extent of ectomycorrhizal colonization in the two *Quercus ilex* stands was reduced by fire. Furthermore, immediately after the fire there was a decrease in the diversity of ectomycorrhizae morphotypes. However, five years after the stand caught fire this diversity had been almost recovered. Our results are still preliminary though, and more research is needed in order to analyse the time elapsed since the disturbance and how do this two stands eventually change.

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