Lagascalia 19(1-2): 769-776 (1997)

FLORISTIC RICHNESS EVOLUTION AFTER CONTROLLED FIRES IN TWO WOODS OF NAVARRA (SPAIN)

A. EDERRA, A. URDÍROZ & R. Y. CAVERO

Abstract

Data about floristic richness of vascular and bryophytic flora obtained during three years following the regeneration after controlled fires in a mediterranean *Quercus ilex* L. subsp. *ballota* (Desf.) Samp. and in an atlantic *Quercus robur* L. woods are presented. Sampling has been carried out on sixteen permanent squares of 1 m^2, each of them with different characteristics or treatments: different kinds of wood, fire or topography and with or without addition of unburnt soil. The objective is to compare the floristic richness evolution in both woods and in pair of squares with the same treatments. In relation to vascular plants results show a better floristic richness recuperation in the atlantic wood, while it seems that the floristic richness evolution of bryoflora is not conected with the kind of wood, but with other factors not considered here.

Introduction

Since 1991 we are studing the effects of different kind of controlled fires on the vascular and bryophytic flora and their recuperation after fires in two woods of Navarra (Northern Spain). One of them, Biurrun, is located in the Mediterranean Region and is a wood of *Quercus ilex* L. subsp. *ballota* (Desf.) Samp. belonging in the association *Bupleuro-Quercetum rotundifoliae* (Br.-Bl. & O. Bolós 1957) Rivas-Martínez 1975. The other one, Leiza, is on the Eurosiberian Region and is a wood of *Quercus robur* L. belonging in the association *Hyperico pulchri-Quercetum roboris* Rivas-Martínez & al. 1991 (Fig. 1). The aim of this paper is to compare the results obtained on both woods about the evolution of floristic richness along time.

Material and methods

Three areas of homogeneous aspect were delimited in every wood. One area was burnt with quick fire (crown fire), other one with slow fire (superficial fire) and the third one remained untouched, to be used as reference if necessary. Permanent squares of 1 m^2 were put on the burnt areas, every square with different treatments: different kind of fire, topography and with or without addition of unburnt soil. The total number of permanent squares were 16: 8 in every wood, 4 in the quick fire area and 4 in the slow fire area: among this 4 squares, 2 were on the higher parts and 2 on the lower parts of burnt areas. One of every pair of squares was covered with a thin layer (about 3 cm) of unburnt soil which was taken from unburnt areas of the same woods close to the fired areas. (CAVERO & EDERRA, 1995; URDÍROZ & EDERRA, 1995). To simplify

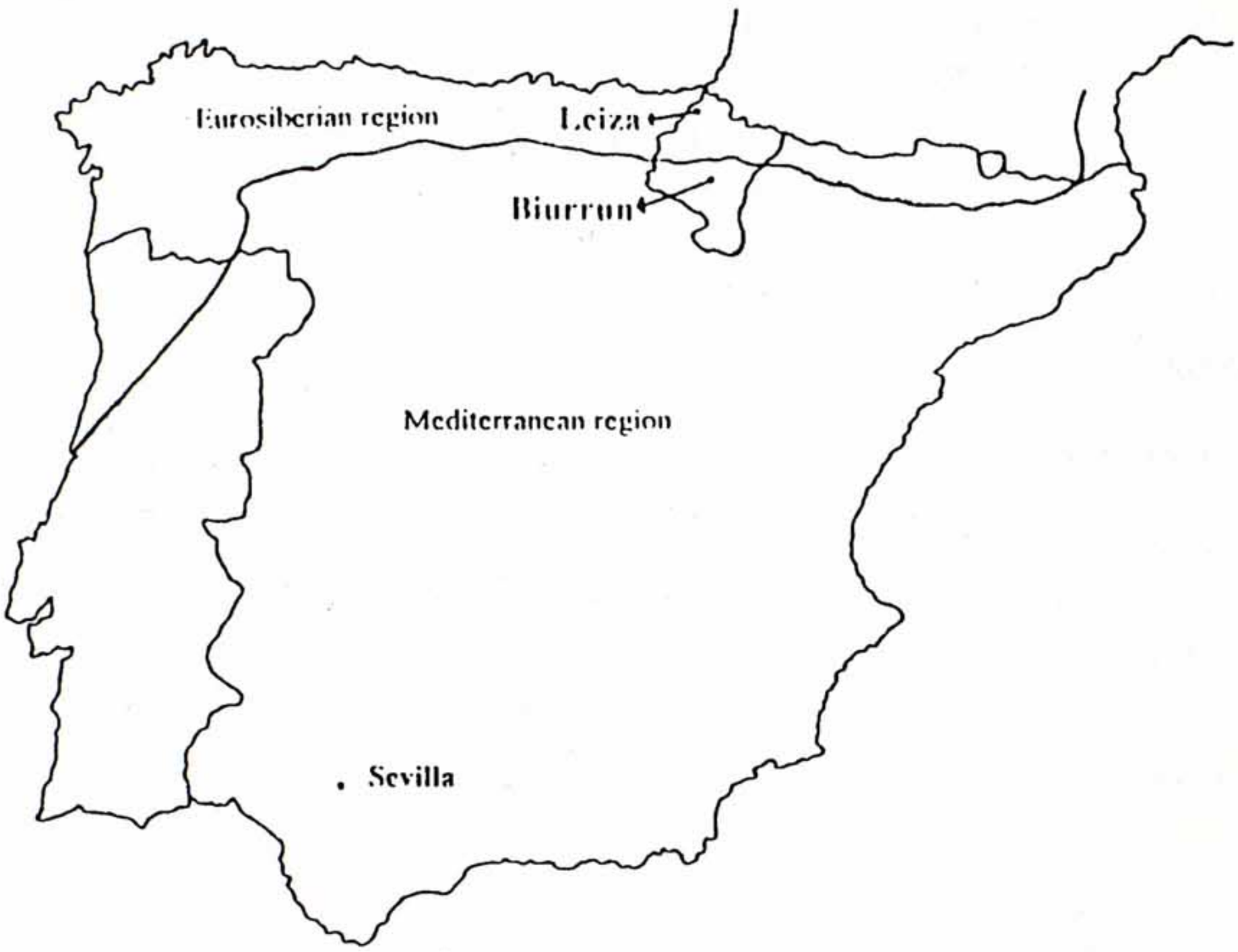

Fig. 1. Location in Navarra (Spain) of the studied woods.

the references to the sixteen permanent squares, we have named every one by four symbols, with the following meaning: L1, wood of Leiza, slow fire; L2, wood of Leiza, quick fire; B1, wood of Biurrun, quick fire; B2, wood of Biurrun, slow fire; S (in third position), higher; I, lower part of areas; S (in the last place), without addition of unburnt soil; C, with addition of unburnt soil.

Along the last three years we have visited monthly both woods to study the way vascular and bryophytic flora are recovering. Among other observations, we have noted, in every sampling, the number of different taxa that were present in every square; we call this number "floristic richness". On other hand, before the fires (and after them on the reference or control areas), we studied the natural flora of the woods: 104 vascular plants and 29 bryophytes were found in Biurrun, whilst 43 vascular plants and 48 bryophytes were identified in Leiza. These numbers of taxa were useful to calculate percentages of recuperated taxa in every permanent square, so as to make possible and logical the comparison between the floristic richness of both woods (it is not the same to have recovered, for example, 10 taxa out of 104 than out of 43); we call these percentages "relative floristic richness".

Results

On Table 1 and 2 there are data of floristic richness of vascular plants and bryophytes respectively. First columns of both tables inform about dates of sampling, each date with a number that is used afterwards in graphics. All the other columns are the relative floristic richness values. On the last row of Table 1 there are the maximum intervals of variability between percentages during the study period.

Results are also represented in Figures 2 (vascular plants) and 3 (bryophytes). Data of permanent squares are represented in these graphics by pairs, each pair taken from the whole 16 in such a way that the only difference is the kind of wood (Leiza or Biurrun) but all the other treatments (kind of fire, topography an addition of unburnt soil) are the same. This kind of graphics makes easier the comparison between both woods.

Lack of data is annotated with a hyphen in tables and with absence of line in graphics.

Discussion

Vascular flora

In relation with vascular flora (Fig. 2) is evident that the relative floristic richness is nearly always greater in the oak wood of Leiza than in the wood of Biurrun. This fact could make us think that the post-fire recuperation is easier in Leiza than in Biurrun, this is to say, it is easier in the eurosiberian zone than in the mediterranean one. However, the good quality of the vascular vegetation recuperation must be related not only with floristic richness but also with stability and continuity of the species which are reinstalling, with the abundance-dominance and coberture of the species, with their strategies of life (whether they are nitrophylous, pioneers, invaders, colonists, characteristics of wood, etc.) and with the structure that the vegetational strata have developed.

Analysing the intervals of variation of the relative floristic richness in every square, this is to say, the difference between maximum and minimum of these values, it is possible to see (Table 1) that they are bigger in the oak wood than in the *Quercus ilex ballota* wood. Besides, variability along time is generally bigger in Leiza than in Biurrun, since in Leiza there are several maximums and minimums, whereas in Biurrun the evolution of the floristic richness is more uniform and sustained (Fig. 2). It is remarkable that the highest intervals of relative floristic richness are those of the square in Leiza L2SC (27,9) and its homologous in Biurrun B1SC (8,7) (though in the last one the variation is much more small); both squares with addition of unburnt soil. On the contrary, the smaller variations between maximum and minimum of relative floristic richness correspond to L2SS (13,9) and B1IS (7,7); both squares without addition of unburnt soil. We think that the addition of unburnt soil, at first, is favourable to increase the floristic richness, because a lot of seeds can be added with the soil; but, on other hand, it is unfavourable, because prevents some species from re-sprouting, if the

	B1IC	B1IS	B1SC	B1SS	B2IC	B2IS	B2SC	B2SS	L1IS	L1IC	L1SS	L1SC	L2IS	L2IC	L2SS	L2SC
1992																
1 = Mar.	4,81	5,77	2,88	10,58	1,92	0,96	0,96	5,77	–	–	–	–	–	–	–	–
2 = Apr.	6,73	6,73	3,85	13,46	5,77	4,81	0,96	9,61	–	–	–	–	–	–	–	–
3 = May.	7,69	9,61	1,92	11,54	9,61	13,46	2,88	9,61	13,95	6,98	16,28	13,95	13,95	9,3	16,28	9,3
4 = Jun.	8,65	11,54	4,81	12,5	11,54	15,38	6,73	13,46	20,93	13,95	16,28	11,63	20,93	16,28	23,26	23,26
5 = Jul.	9,61	10,58	3,85	14,42	10,58	14,42	5,77	12,5	20,93	13,95	18,6	11,63	23,26	23,26	18,6	20,93
6 = Aug.	9,61	10,58	3,85	13,46	11,54	14,42	5,77	12,5	20,93	23,26	18,6	13,95	27,91	30,23	20,93	25,58
7 = Sep.	9,61	10,58	3,85	15,38	9,61	12,5	5,77	11,54	20,93	18,6	18,6	16,28	23,26	27,91	18,6	23,26
1993																
8 = Feb.	10,58	11,54	7,69	7,69	11,54	14,42	9,61	9,61	–	–	–	–	–	–	–	–
9 = Mar.	10,58	12,5	6,73	10,58	13,46	13,46	12,5	12,5	20,93	20,93	25,58	20,93	20,93	25,58	20,93	23,26
10 = Apr.	10,58	13,46	6,73	9,61	11,54	16,35	10,58	10,58	18,6	27,91	23,26	20,93	23,26	23,26	23,26	25,58
11 = May.	11,54	10,58	7,69	8,65	11,54	16,35	12,5	10,58	13,95	25,58	20,93	20,93	20,93	18,6	18,6	27,91
12 = Jun.	11,54	7,69	7,69	8,65	9,61	15,38	10,58	11,54	16,28	27,91	20,93	23,26	25,58	23,26	23,26	37,21
13 = Jul.	11,54	7,69	7,69	7,69	8,65	15,38	10,58	7,69	20,93	27,91	20,93	23,26	27,91	25,58	20,93	32,56
14 = Sep.	10,58	7,69	8,65	7,69	8,65	15,38	9,61	7,69	25,58	30,23	20,93	25,58	30,23	25,58	23,26	30,23
15 = Oct.	9,61	7,69	8,65	6,73	7,69	16,35	10,58	7,69	25,58	30,23	20,93	25,58	30,23	23,26	23,26	30,23
16 = Nov.	8,65	7,69	6,73	6,73	7,69	16,35	10,58	7,69	25,58	27,91	20,93	25,58	27,91	23,26	23,26	30,23
17 = Dec.	8,65	7,69	6,73	6,73	7,69	14,42	11,54	7,69	25,58	27,91	20,93	25,58	25,58	23,26	23,26	27,91
1994																
18 = Feb.	8,65	8,65	6,73	11,54	7,69	15,38	10,59	9,61	27,91	32,56	23,26	27,91	27,91	25,58	25,58	25,58
19 = Mar.	9,61	8,65	6,73	11,54	8,65	15,38	9,61	10,58	27,91	30,23	27,91	30,23	30,23	27,91	30,23	30,23
20 = Apr.	12,5	8,65	6,73	12,5	8,65	15,38	9,61	9,61	30,23	27,91	25,58	30,23	27,91	32,56	30,23	30,23
21 = Jun.	13,46	8,65	9,61	15,38	8,65	15,38	12,5	8,65	30,23	30,23	23,26	25,58	32,56	27,91	27,91	30,23
22 = Jul.	10,58	7,69	9,61	11,54	5,77	15,38	11,54	6,73	30,23	32,56	25,58	27,91	30,23	27,91	25,58	32,56
23 = Sep.	9,61	7,69	9,61	11,54	7,69	13,46	9,61	8,65	30,23	30,23	20,93	25,58	30,23	27,91	25,58	27,91
24 = Oct.	9,61	8,65	10,58	11,54	7,69	13,46	8,65	8,65	32,56	27,91	20,93	25,58	23,26	20,93	23,26	25,58
Intervals of variability	8,65	7,7	8,7	8,6	11,5	15,4	11,5	7,7	18,6	25,6	11,6	16,3	18,6	23,3	13,9	27,9

Table 1. Relative floristic richness of vascular plants along time.

	B1IC	B1IS	B1SC	B1SS	B2IC	B2IS	B2SC	B2SS	L1IS	L1IC	L1SS	L1SC	L2IS	L2IC	L2SS	L2SC
1992																
1 = Jul.	–	–	–	–	–	–	–	–	0	0	0	2,08	0	2,08	0	4,16
2 = Aug.	–	–	–	–	–	–	–	–	4,16	2,08	0	6,25	4,16	4,16	0	8,33
3 = Sep.	–	–	–	–	–	–	–	–	4,16	6,25	0	8,33	4,16	6,25	2,08	10,42
4 = Oct.	–	–	–	–	–	–	–	–	4,16	10,42	4,16	8,33	6,25	8,33	4,16	10,42
5 = Nov.	6,9	0	0	3,45	3,45	0	0	6,9	4,16	8,33	4,16	10,42	8,33	8,33	8,33	10,42
6 = Dec.	6,9	3,45	6,9	6,9	3,45	3,45	3,45	3,45	–	–	–	–	–	–	–	–
1993																
7 = Jan.	10,34	3,45	13,79	3,45	3,45	6,9	0	10,34	2,08	10,42	4,16	8,33	8,33	8,33	6,25	10,42
8 = Feb.	10,34	3,45	17,24	10,34	6,9	10,34	6,9	10,34	–	–	–	–	–	–	–	–
9 = Mar.	10,34	3,45	17,24	6,9	10,34	10,34	0	10,34	10,42	10,42	6,25	8,33	8,33	8,33	8,33	12,5
10 = Apr.	6,9	10,34	6,9	13,79	13,79	10,34	6,9	10,34	8,33	10,42	6,25	10,42	6,25	8,33	8,33	10,42
11 = May.	6,9	3,45	3,45	6,9	3,45	6,9	0	10,34	6,25	8,33	4,16	8,33	6,25	8,33	8,33	10,42
12 = Jun.	6,9	3,45	6,9	6,9	6,9	6,9	6,9	10,34	8,33	10,42	4,16	10,42	8,33	8,33	10,42	8,33
13 = Jul.	10,34	3,45	3,45	13,79	6,9	6,9	6,9	13,79	6,25	10,42	4,16	8,33	6,25	8,33	8,33	12,5
14 = Aug.	6,9	6,9	3,45	6,9	6,9	6,9	6,9	10,34	–	–	–	–	–	–	–	–
15 = Sep.	10,34	6,9	10,34	10,34	6,9	6,9	6,9	10,34	6,25	8,33	6,25	6,25	8,33	8,33	8,33	12,5
16 = Oct.	10,34	10,34	6,9	13,79	6,9	6,9	6,9	10,34	8,33	10,42	6,25	8,33	10,42	8,33	12,5	12,5
17 = Nov.	13,79	6,9	13,79	10,34	6,9	6,9	6,9	10,34	6,25	8,33	4,16	8,33	8,33	10,42	10,42	12,5
1994																
18 = Feb.	13,79	13,79	17,24	10,34	6,9	10,34	10,34	13,79	10,42	10,42	6,25	8,33	10,42	10,42	12,5	12,5
19 = Apr.	10,34	10,34	10,34	13,79	6,9	10,34	10,34	10,34	8,33	10,42	8,33	8,33	10,42	10,42	12,5	12,5
20 = Jun.	10,34	3,45	6,9	10,34	6,9	6,9	10,34	13,79	8,33	8,33	8,33	12,5	10,42	12,5	12,5	12,5
21 = Jul.	10,34	6,9	6,9	13,79	6,9	10,34	6,9	10,34	6,25	8,33	6,25	12,5	12,5	10,42	10,42	12,5
22 = Sep.	10,34	6,9	10,34	10,34	6,9	6,9	10,34	10,34	10,42	8,33	6,25	12,5	10,42	8,33	8,33	12,5
23 = Oct.	13,79	6,9	10,34	10,34	6,9	6,9	6,9	6,9	8,33	12,5	8,33	12,5	14,58	8,33	10,42	14,58

Table 2. Relative floristic richness of bryophytes along time.

sprouting parts of these species result to be buried by the added soil. So, although the addition of unburnt soil could cause an increase of floristic richness, it does not favour either the stability or the continuity of the characteristic species of woods.

Bryophytic flora

Both in Table 2 and Figure 3 it is possible to see that the recuperation of bryophytes delays several months in the *Quercus ilex* wood (Biurrun) in comparing it with the *Quercus robur* wood (Leiza). It is easy to explain this fact: climatic conditions of Leiza,

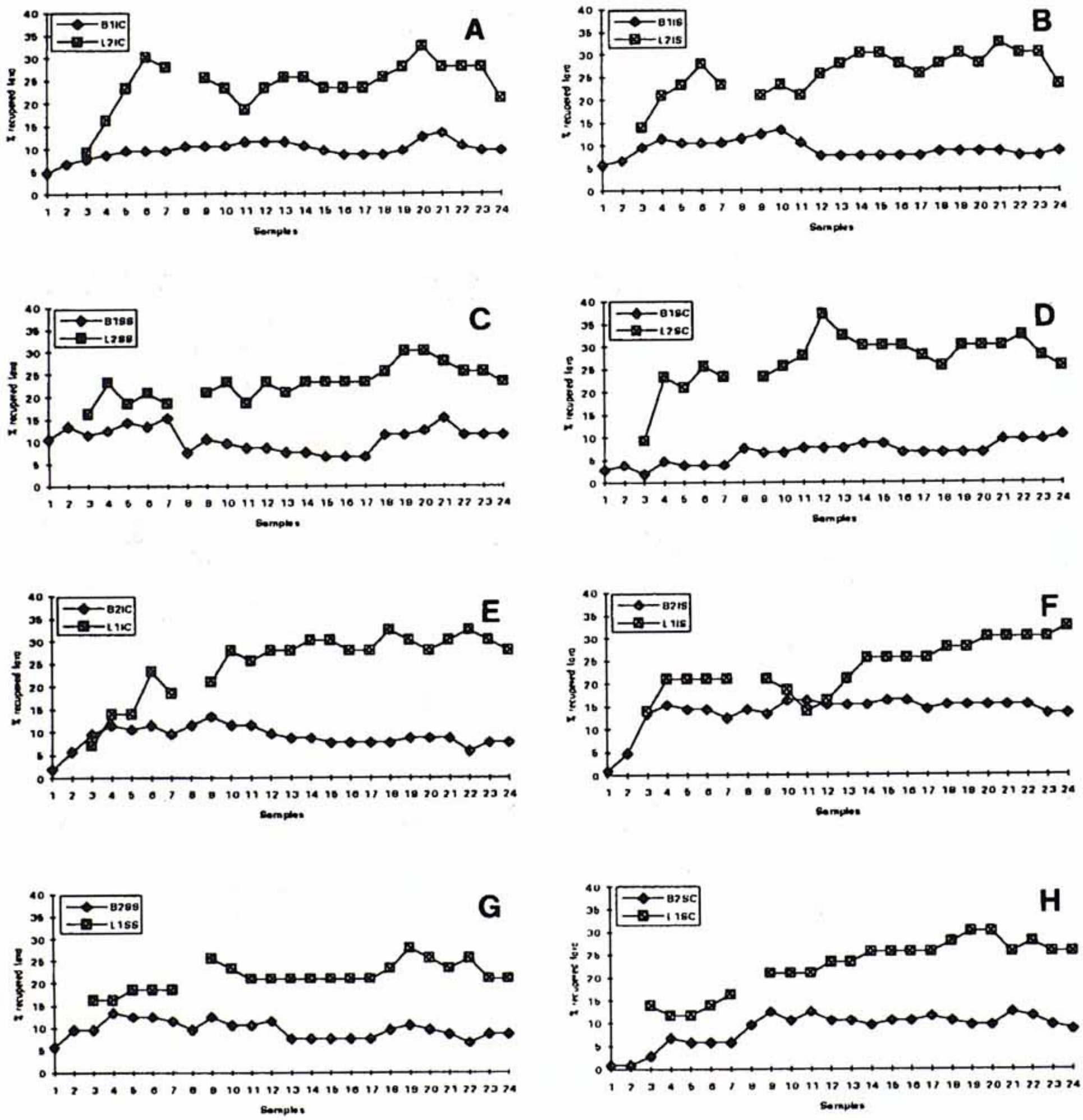

Fig. 2. Evolution along time of relative floristic richness (% of recuperated taxa) of vascular flora. A-D, Squares treated with quick fire. E-H, Squares treated with slow fire.

wet and not very cold, location on Eurosiberian region and the rich bryophytic flora of the wood before the fires, are all positive factors to let bryophytes to reinstall quickly after the disturbance. But, apart from this, it is not possible to make any deduction on the influence of the kind of wood in the evolution of the floristic richness, because nearly all pairs represented in graphics of Fig. 3 follow different patterns. It could be said that kind of wood must be not really important for the recovering of the bryoflora and that the main influent factors must be others.

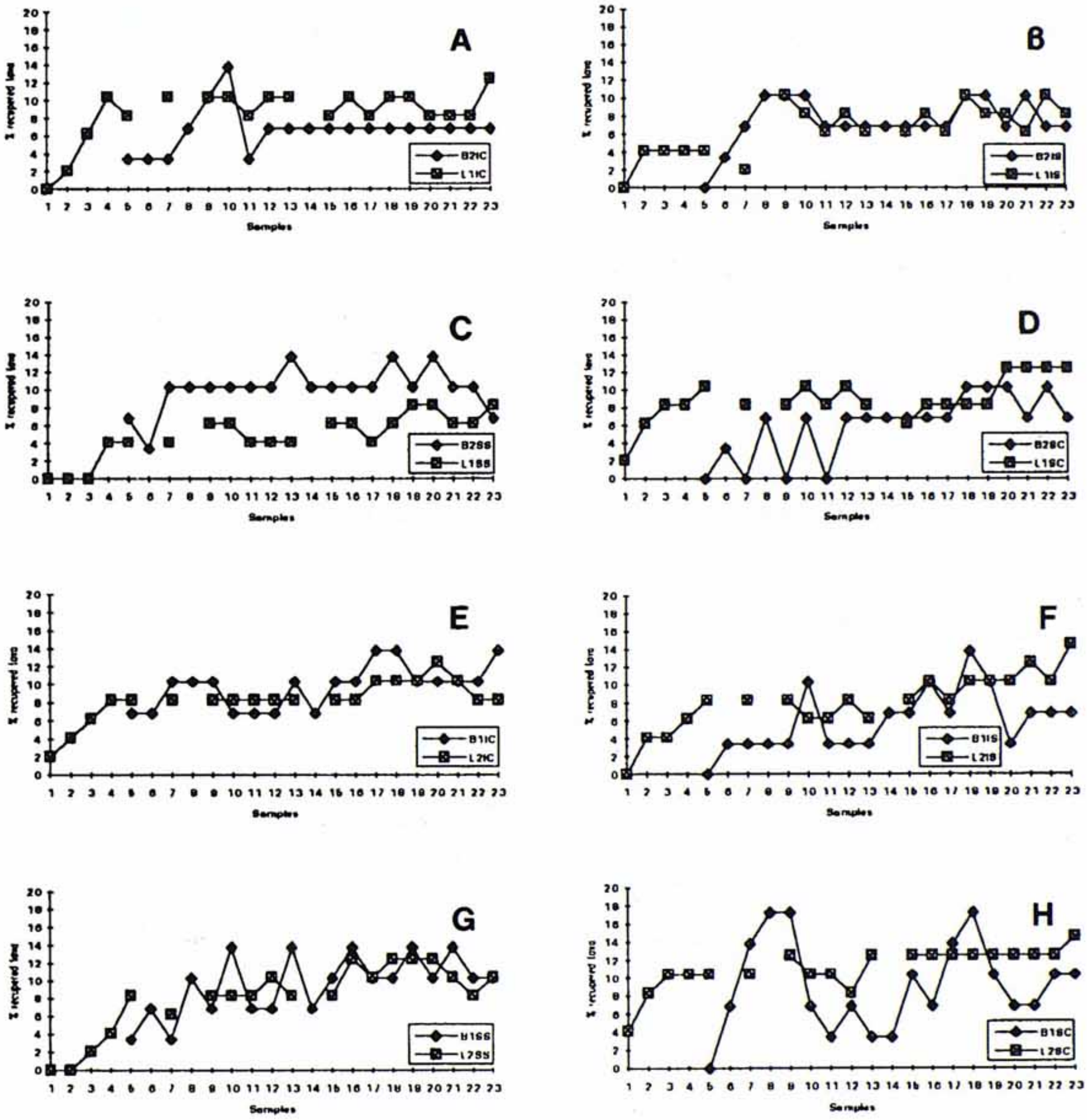

Fig. 3. Evolution along time of relative floristic richness (% of recuperated taxa) of bryophytes. A-D, Squares treated with quick fire. E-H, Squares treated with slow fire.

References

CAVERO, R. Y. & A. EDERRA (1995). Evolución de la riqueza florística después de incendios controlados en un robledal de Navarra (España). *Ecología* (en prensa).

URDÍROZ, A. & A. EDERRA (1995). Estudio del impacto causado por los incendios en la brioflora de un robledal de Navarra (España). *Cryptogamie, Bryol. Lichénol.*, **17(2)**: 135-142.

Address of the authors:

Drs. A. Ederra, A. Urdíroz & R. Y. Cavero, Departamento de Botánica, Facultad de Ciencias, Universidad de Navarra, 31080 Pamplona, Spain.