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LOBARION AS INDICATOR OF ANCIENT FOREST IN THE APPENNINO LUCANO (BASILICATA-SOUTHERN ITALY)

Epiphytic lichens are considered to be particularly sensitive to forest management, many such species are mainly confined to old forests stands (LESICA et al., 1991; KUUSINEN, 1996; ESSEEN et al., 1997).

The scarcity of old forest lichens in younger forest stands could be due to inefficient dispersal of lichen propagules (ESSEEN et al., 1996; SILLETT et al., 2000) or it could be that unfavourable microclimatic conditions in the younger stands preclude establishment. Species confined to ancient natural forests are considered to be sensitive to alteration in environmental conditions (ROSE, 1992).

Lobaria pulmonaria and other members of the Lobarion are considered to be indicators of ancient forests with a long ecological continuity (ROSE, 1976, 1988, 1992).

In this study we compared landscape structure, forest structure and lichen species abundance in three natural and managed forest landscapes, in particular oak, beech and fir forests in the Appennino Lucano Val d'Agri Lagonegrese National Park (Southern Italy), to define the relationship between lichen communities and Sustainable Forest Management.

The epiphytes were recorded on vertical single stems of Quercus (Q. petraea, Q. cerris, Q. pubescens s.l.), Fagus sylvatica L. and on the trunks of Abies alba Mill. for each tree on which L. pulmonaria grew, the abundance of each lichen species was sampled using phytosociological approach.

Keywords: ancient forest; Lichens; *Lobaria pulmonaria*; Lobarion.

Parole chiave: boschi vetusti; licheni; *Lobaria pulmonaria*; Lobarion.

1. INTRODUCTION

In modern forest landscapes, especially in Europe, only small fractions of old-growth forests remain (HANNAH *et al.*, 1995). These remnants are of high importance for many rare and threatened species (e.g. BERG *et al.*, 1994), now occurring only in small and isolated populations.

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Ancient Forest (AF) are those developed during long periods without relevant human impact and natural catastrophic disturbances with distinctive features in terms of, for example, forest continuity, structural heterogeneity, volumes of deadwood, and the presence of old trees (PETERKEN 1996). Although several studies demonstrated the effects of management to many forest-associated lichens in Mediterranean habitats were poorly studied and only recently investigated (NASCIMBENE *et al.*, 2007, 2008; BRUNIALTI *et al.*, 2010). Furthermore, there are very few long-term monitoring programs which consider also lichens (CHIARUCCI and BONINI, 2005; GIORDANI, 2006; BACARO *et al.*, 2008).

Information on Mediterranean AF structure is scarce and the relative density of living and dead trees, in spite of their ecological importance for wildlife (KEDDY and DRUMMOND 1996; FAN *et al.*, 2003), is practically unknown (NILSSON *et al.*, 2003). Despite the fact that Italian landscapes have been modified for millennia, there are remote mountain areas where it is possible to find patches of AF.

The species associated with AF may be restricted to such sites either because they depend on certain microhabitats not found in younger forests, or because they have poor dispersal capacity and thus need a long time for colonization (SILLETT *et al.*, 2000). Populations of a species with poor dispersal capacity, living in a fragmented landscape are likely to go extinct, and the species will have problems recolonizing suitable habitat patches after local extinctions (HANSKI 1999; THOMAS 2000).

In this paper, we provide a first characterization of the structural attributes and lichen, as an ideal case study of an AF in the South Apennines in particular in the Appennino Lucano Val d'Agri Lagonegrese National Park (Basilicata - Southern Italy). Our model organisms are *Lobaria pulmonaria* (L.) Hoffm and other members of the *Lobarion*. These species with a previously wide European distribution is considered to be an indicator of AF with a long ecological continuity, since modern forestry using clear felling reduces the frequency of these species. These species are also thought to be dispersal-limited (ROSE, 1988).

The most common community of *Lobaria* in the study area is *Lobarion pulmonariae* Ochsner 1928, an alliance-dominated, species-rich epiphytic plant community, declining in most parts of Europe (ROSE, 1988).

This research has been inserted in the national project denominated "Lobaria Project" investigations on the populations of *Lobaria pulmonaria* (L.) Hoffm. in Italy (NASCIMBENE *et al.*, 2006) in progress of realization from the Group of Ecology and Vegetation Italian Lichen Society directs to investigate different biological, ecological and vegetational parameters about the Italian populations to *Lobaria pulmonaria* (L.) Hoffm.

In the first part the study was related to Habitat distribution of the *L. pulmonaria* in the Appennino Lucano Val d'Agri Lagonegrese National Park, in second part we found some informations about members of the *Lobarion* community (BARKMAN 1958; ROSE 1988) such as *Lobaria* spp., *Nephroma* spp. and *Peltigera* spp. has been also observed to indicate AF in Mediterranean (MARCOS LASO and NAVARRO ANDRES, 1982), temperate and boreal forests of Europe and North America (ROSE, 1988; GAUSLAA, 1985; 1995; NASH, 1996; RICHARDSON, 2004).

2. MATERIALS AND METHODS

This study was carried out in the 12 sampling stations (Table 1) in the Appennino Lucano - Val d'Agri-Lagonegrese National Park 68,996 ha, which perimeter includes some of the highest summits of the Lucanian Apennines from M. Serranetta to M. Volturino, delimiting fanwise the upper valley of the river Agri (Figure 1).

The area is characterized by a meso-temperate humid-subhumid climate with temperate-mediterranean variants and a mean annual temperature of 12.8 °C (BIONDI *et al.*, 1991).

In each site we searched for *L. pulmonaria* on all trees in a plot of 30X30 m, both on the lower and the upper parts of the trees. For each tree on which *L. pulmonaria* grew the following parameters collected by Formal Management Plans (FMP): locality, altitude, exposition, substrate, rain, bibliography, Habitat type, forest management, wood age, then, we recorded numbers of thalli of *L. pulmonaria* observed and epiphytic lichens. The numbers of thalli of *L. pulmonaria* was recorded in five classes; class1: 0 thalli from 0 to 2 m on trunk; 2: 1_5 thalli on trunks; 3: > 10 thalli on trunk; 4: > 20 thalli on trunk.

126 phytosociological relevés of epiphytic lichen were carried out in spring 2007 according to the criteria presented by BRAUN-BLANQUET (1964). The cover scale is the Braun-Blanquet scale.

The relevés were taken at 60, 120 and 180 cm height from the ground.

They were all taken on the trunk of *Fagus sylvatica* L., *Quercus petraea* (Mattuschka) Liebl. ssp. *austrotyrrhenica* Brullo, Guarino & Siracusa, *Q. cerris* L., *Q. pubescens* s.l. and *Abies alba* Mill. in three different Habitat types: A) 91M0 Pannonian-Balkan turkey oak-sessile oak forests; B) 9210* Apennine beech forest with *Taxus* and *Ilex*; C) 9220* Apennine beech forests with *Abies alba* and beech forests with *Abies nebrodensis* according to the Natura 2000 network.

Table 1 – Location and characteristics of the investigated stands for some Ancient Forest from the Appennino Lucano National Park.

Stands	0	1	2	3	4	5	6	7	8	9	10	11	
Locality	Piancardillo	Serranetta	Madonna di Viggiano	Monte Volturino	Monte Pierfaone	Serra di Rifreddo	Serra di Calvello	Fameta	Abetina di Laurenzana	Monte Caldarosa	Bosco Autiero	Bosco Farneto	
Altitude m s.l.m.	1000	1000	1370	1500	1400	1100	1100	850	1114	1397	1100	1200	
Exposition	N-O	N-O	N	N	N	N	N	N	N-E	W	N-E	N-E	
Substrate	red marly limestones	red marly limestones	calcars	red marly limestones	red marly limestones	flych galestrino	red marly limestones	arenaceous schists	calcars	calcars	arenaceous schists	arenaceous schists	
Rain mm/a	790	903	842	1054	1072	903	984	900	1210	1210	1000	1000	
Bibliography	GAVIOLI, 1934	GAVIOLI, 1934	NIMIS & TRETJACH, 1996	NIMIS & TRETJACH, 1996	FASCETTI et al., 2003	POTENZA et al., 2004	POTENZA et al., 2004	POTENZA et al., 2004	new	new	FASCETTI et al., 2003	FASCETTI et al., 2003	
Habitat type	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9220* Apennine beech forests with <i>Abies alba</i> and beech forests with <i>Abies nebrodensis</i>	9180* <i>Tilio-Acerion</i> forest slopes, screes and ravines	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	9210* Apennine beech forest with <i>Taxus</i> and <i>Ilex</i> ; 91M0 Pannonian-Balkan turkey oak sessile oak forests	91M0 Pannonian-Balkan turkey oak sessile oak forests
forest management	coppice	old conversion of coppice into high-forest	high forest	high forest	high forest	old conversion of coppice into high-forest	high forest	old conversion of coppice into high-forest	high forest	old conversion of coppice into high-forest	high forest	high forest	high forest
Wood Age	–	80	150	120	150	80	80	80	120	80	80	80	80
*Thalli of <i>Lobaria</i> observed	–	>10	>20	>20	>20	>10	1_5	>10	>20	>10	>10	>10	>10

Information on locality, altitude, exposition, substrate, rain, bibliography, Habitat type, forest management and wood age are taken from Formal Management Plans (FMP).

*Thalli of *Lobaria* means population size.

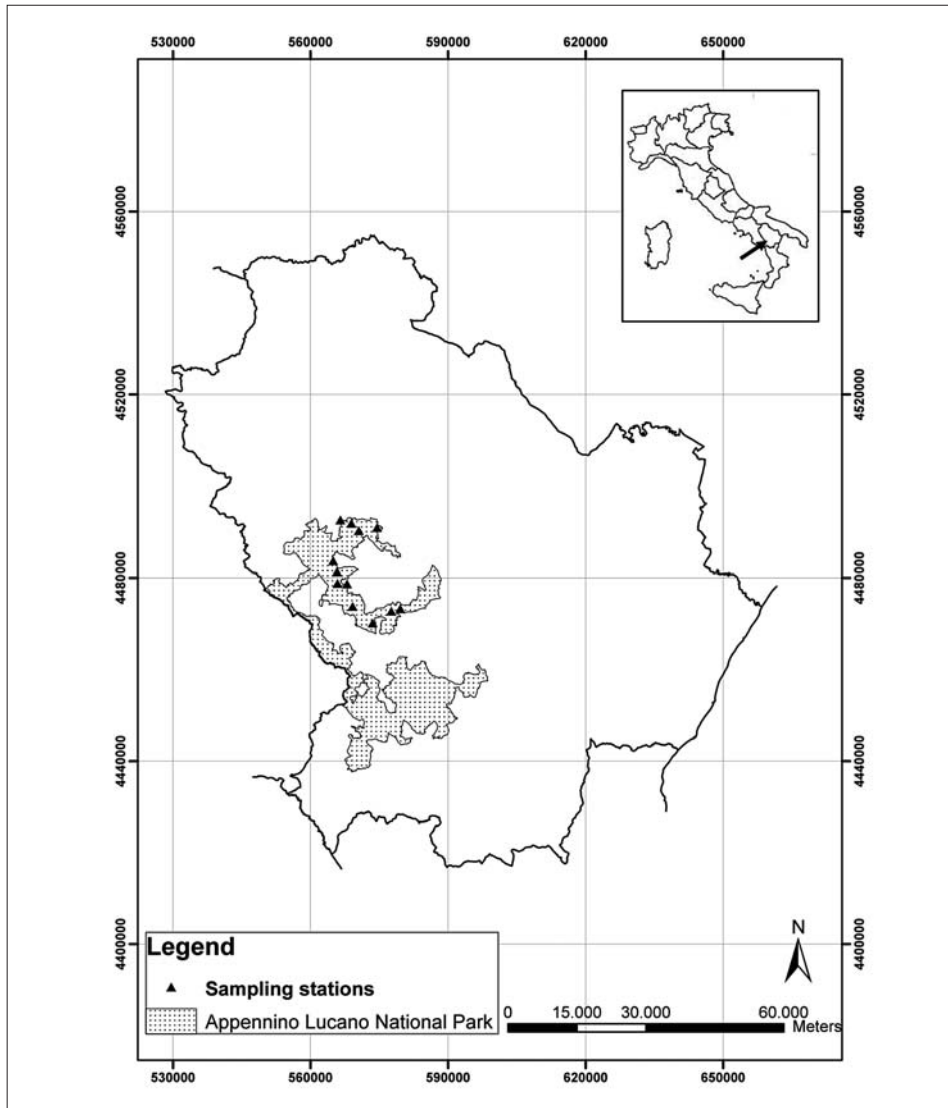


Figure 1 – Study area: Val D'Agri Appennino Lucano-Lagonegrese National Park (Southern Italy).

We use a GPS mapping (Etrex Vista) and Arc Map v. 9.2 by ESRI for georeferencing sampling points and trees.

Species difficult to identify in field were collected for identification in laboratory. The nomenclature of lichen species followed the online checklist of Italian lichens (NIMIS *et al.*, 2008) and the nomenclature of vascular plant followed PIGNATTI 1982.

3. RESULTS

In total 126 trees with *L. pulmonaria* were found at the study sites from 2005 to 2007 in 11 sampling units. *L. pulmonaria* was never seen in the Piancardillo locality for the environmental change and modern human activities.

L. pulmonaria was found on five nemoral broad leaved deciduous trees species; beech *Fagus sylvatica* (21 trees), *Abies alba* (9 trees), oak *Quercus cerris* (48 trees), *Q. frainetto* (3 trees), *Q. petraea* (30 trees) and *Q. pubescens* (15 trees).

The youngest *Lobaria*-wood was a 80-year-old oak, and the oldest was also an oak, 150 years old.

The constant species of the suballiance *Lobarion pulmonariae* Ochsner 1928 are found by comparing MARCOS LASO and NAVARRO ANDRES (1982), BARKMAN (1958), ROSE (1988) and GAUSLAA (1995). The most important composition of those *Lobarion* communities in the Appennino Lucano Val d'Agri National Park is shown in the synoptic table below (Table 2).

The *syntaxa* described are well-differentiated, although they form a syntaxonomical continuum.

Syntaxonomical schema of Epiphytic community of hygrophilous lichens is:

Frullanio dilatatae-Leucodontea sciuroidis Mohan 1978 em. Marst. 1985

Orthotrichetalia Hadac 1944

Neckeretalia pumiliae Barkman 1958

Lobarion pulmonariae Ochsner 1928

4. CONCLUSION

In the Appennino Lucano National Park we checked 11 sites with the presence of *Lobaria pulmonaria* and *Lobarion* community.

In according to NASCIMBENE *et al.*, 2006, 2007, 2008 and BRUNIALTI *et al.*, 2010, we confirmed a major influence of forest structure and management on these organism. There are a distinctive group of lichen species associated with the bark of the trunks of old trees, which are not found in any of the other young stands. These are the species of the *Lobarion* community.

Lobarion alliance is the climax community of epiphytes on the trunks of the big old trees. It is important indicator of the forests quality.

Many specimens of *L. pulmonaria* were recorded from protected areas (nature reserves or national parks) (Figure 1).

Table 2 – Synoptical table of *Lobariion* community in the Appennino Lucano Val d'Agri-Lagonegrese National Park.

Relevés	3	5	4	1	4	1	11	11	4	3	6	7	9	9	1	2	5	6	9	10	10	10	7	8	8	11	6	9	2	2	3	5		
Locality	V	SR	MP	Se	MP	Se	BF	BF	MP	V	SC	Fa	MC	MC	Se	MV	SR	SC	MC	BA	BA	BA	Fa	AL	AL	BF	SC	MC	MV	MV	V	SR		
Altitude m a.s.l.	1500	1100	1400	1000	1400	1000	1200	1200	1400	1400	1500	1100	850	120-180	60-120	0-60	1370	1100	1100	1397	1100	120-180	1100	850	1114	1200	1100	1370	1370	1500	1100	1500		
Tree species	Fs	Qp	Fs	Qc	Fs	Qc	Qc	Qc	Fs	Fs	Qc	Fs	Aa	Aa	Qc	Fs	Qp	Qc	Aa	Fs	Fs	Fs	Fs	Qc	Qc	Qc	Qc	Aa	Fs	Fs	Qp	Qp		
Diameter cm	55	35	55	40	55	40	60	60	55	55	30	30	30	30	30	35	30	30	30	30	55	55	30	30	35	60	30	30	55	55	55	35	35	
Levels of tree	0-60	120-180	60-120	120-180	120-180	60-120	60-120	120-180	0-60	60-120	60-120	120-180	120-180	60-120	60-120	0-60	0-60	60-120	0-60	0-60	120-180	120-180	60-120	60-120	0-60	0-60	0-60	120-180	60-120	120-180	120-180	0-60	0-60	120-180

Lobariion pulmonariae Ochsner I9II8

<i>Physconia venusta</i> (Ach.) Poelt	III	III	III	III	III	II	III	III	I	I	II	III	.	II	II	.	II	II	.	I	I	I	.	I	.	.	.	.	.	.	.	.	.	.
<i>Degelia plumbea</i> (Lightf.) M. Jørg. & P.James	.	III	III	III	III	III	II	II	I	III	II	.	.	.	I	II	I	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Anaphychia ciliaris</i> (L.) Körb.	II	.	I	.	.	.	I	II	IV	I	II	I	II	I	II	I	II	I	II	I	II	II	.	I	.	.	.	.	.	.	.	.	.	.	.
<i>Lobaria pulmonaria</i> (L.) Hoffm.	II	II	III	I	I	.	.	I	.	I	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Nephroma laevigatum</i> Ach.	.	I	.	I	.	.	II	III	I	III	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Hypogymnia physodes</i> (L.) Nyl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.
<i>Collema flaccidum</i> (Ach.) Ach.	.	.	.	II	I	I	.	.	.	I	.	.	.	.	I	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Leptogium saturninum</i> (Dicks.) Nyl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Peltigera collina</i> (Ach.) Schrad.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Flavoparmelia caperata</i> (L.) Hale	.	.	.	.	.	.	.	.	.	.	I	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lobaria amplissima</i> (Scop.) Forssell	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Nephroma resupinatum</i> L. (Ach.)	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Pannaria conoplea</i> (Ach.) Bory	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Peltigera praetextata</i> (Sommerf.) Zopf	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Lobaria scrobiculata</i> (Scop.) Nyl.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Se= Serranetta, Mv= Madonna di Viggiano, V= Volturino, MP= Monte Pierfaone, SR= Serra di Rifreddo, SC=Serra di Calvello, Fa= Fameta, AL= Abetina di Laurenzana, MC= Monte Caldarosa, BA= Bosco Autiero, BF= Bosco Farneto; Qc= *Quercus cerris*, Fs= *Fagus sylvatica*, Qpe= *Quercus petraea*, Aa= *Abies alba*.

The positive results and good forest habitat conservation have been certified by the many Sites of Community Importance (SCI) in the Appennino Lucano Val d'Agri National park defined in the European Commission Habitats Directive (92/43/EEC).

The particular value of these woodland types as epiphytic habitat is related to ancient forests, continuity of woodland conditions over many hundreds of years and the survival of very old trees.

Analysing the numbers of *L. pulmonaria* thalli in forest site types in more detail, we found that Oak forests may dominate in some of these forests due to the coppice-with-standards regime of the past centuries. If the intensity of the management decreases beech and also *Ilex* often regenerate spontaneously provide favourable conditions for *L. pulmonaria*, which is confirmed by the presence of nearly half of the populations of *L. pulmonaria* in forests of these types (Table 1).

These forests are dominated by mixed oak and beech forests and others suitable phorophytes (e.g. *Acer* spp.) appear as subdominants. However, *L. pulmonaria* is more frequent in AF (more than 100 years) than in younger forests. The occurrence of *L. pulmonaria* mainly in older forest age classes has been shown in several earlier studies (e.g. LESICA *et al.*, 1991; KUUSINEN, 1996; ESSEEN *et al.*, 1997).

RIASSUNTO

***Lobarion* come indicatore di boschi vetusti nell'Appennino Lucano (Basilicata)**

I licheni epifiti sono particolarmente sensibili alla gestione forestale, in boschi vetusti si trovano molte specie (LESICA *et al.*, 1991; KUUSINEN, 1996; ESSEEN *et al.*, 1997).

La scarsità di licheni indicatori di boschi vetusti in boschi giovani potrebbe essere attribuita alla loro inefficiente dispersione di propaguli (ESSEEN *et al.*, 1996; SILLETT *et al.*, 1998) o potrebbe essere attribuita alle condizioni microclimatiche non favorevoli. Le specie confinate nei boschi vetusti sono considerate sensibili ai cambiamenti delle condizioni ambientali (ROSE, 1992).

Lobaria pulmonaria ed altre specie della comunità del *Lobarion* ed i cianolicheni sono considerati indicatori di boschi vetusti con una lunga continuità ecologica (ROSE, 1976, 1988, 1992).

In questo studio abbiamo comparato la struttura di paesaggio, la struttura forestale, la ricchezza di specie licheniche e l'abbondanza di licheni epifiti in tre tipologie di boschi naturali e gestiti, in particolare boschi di querce, faggi ed abete bianco nel Parco Nazionale della Val d'Agri Appennino Lucano Lagonegrese per definire la relazione tra le comunità licheniche e la gestione forestale.

I licheni epifiti sono stati individuati su tronchi di *Quercus* (*Q. petraea* *Q. cerris*, *Q. pubescens* s.l.), *Fagus sylvatica* L. e sui tronchi di *Abies alba* Mill. Per ogni albero sul quale *L. pulmonaria* era presente, è stata rilevata l'abbondanza di ciascuna specie lichenica utilizzando un approccio fitosociologico.

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