Wood macrolichen *Lobaria pulmonaria* on chestnut tree crops: the case study of Roccamonfina park (Campania region - Italy)

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Abstract

Integrating at landscape level the information coming from local environment indicators can help monitoring environmental quality in conservation programs. *Lobaria pulmonaria* is a lichen species widely used to evaluate the spatio-temporal continuity of forest cover and to assess environmental quality in areas of high biogeographical interest. In the *Lobaria* project of the Società Italiana Lichenologica, wood macrolichens were sampled on Chestnut woods in a regional park of Campania Region (Italy). A geographical datasets of lichen distribution, land use, topographical and climatic characteristic was built in GIS environment. Multivariate analysis was conducted to highlight the relationships between lichen distribution and environmental quality. The results show that the agronomic management practiced in this area enabled the establishment of stable conditions over time and the development of species indicator of undisturbed areas. A general framework to analyse landscape-level changes over the area is proposed in this paper.

Keywords: Lobaria, lichens, chestnut, landscape, monitoring.

1. Introduction

No areas was left on our planet that did not experience changes, directly or indirectly connected to human activities. The assessment and monitoring of forest resources for environmental policy and management is recognized to be of prime importance (Loppi et al., 1999). Epiphytic lichens are an integral component of forest ecosystem and represent a characteristic part of the total biodiversity. Habitat fragmentation and other human land use variables, such as urbanization, intensity of agricultural or pastoral use, and forestry management, are increasingly important as predictors of lichen species distribution (Will-Wolf et al., 2002).

In fact, lichens react to disturbances and habitat alterations for several reasons. Firstly, some lichen species are dependent on favorable microclimatic conditions. Some epiphytic lichens, particulary the rarer ones, are stenotopic and require a long habitat continuity, for example substrates such as old or large trees (Friedel et al., 2006). Many epiphytic lichens are strongly affected by forestry practices, particularly logging (Nascimbene et al. 2007). For example, cyanolichens are considered a guild of species extremely sensitive to intensive forest management and so they are good indicators of forest continuity. This is the case of the flagship species *Lobaria pulmonaria* (L.) Hoffm., whose populations was drastically reduced in the recent decades (Nascimbene et al., 2007).

The aim of this work was to analyze the effects of chestnut tree crops management practices on *Lobaria pulmonaria* populations, and on lichens diversity in a natural reserve of Southern Italy.

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2. Materials and methods

The study was carried out in Roccamonfina's Park a reserve located in the northen part of Campania, South Italy. According to the phytoclimatic classification (Nimis & Martellos, 2008), the area is intermediate between humid sub-Mediterranean and humid Mediterranean. The mean annual temperature is 15.7°C and the mean annual rainfall 950 mm. Forests in this area are dominated by chestnut tree crops (*Castanea sativa* Miller).

The monitoring study was carried out between March and July 2008. Sixteen 30x30 m plots were selected, spaced 300-500 m inside four stations differing for forest cover and management. In the center of each plot, 6 trees colonized by *Lobaria pulmonaria* were sampled and geo-referenced. On the selected trees, the presence of all epiphytic lichens was recorded from the trunk base to a height of 180 cm. Species nomenclature and phytoclimatic classification follow Nimis & Martellos (2008).

In addition we calculated *Lobaria pulmonaria* area with the aid of 40x40 cm sampling grids divided into 1x1 cm contiguous quadrants:

%=(total area of Lobaria pulmonaria/ lateral area of trunk)*100

Cartographic processing was carried out using ArcGis 9.3, Ilwis 3.4 and Idrisi Kilimangiaro GIS integrate software. Kriging was the interpolation method used to obtain a geostatistic correlation of the nearest randomly surveyed values inside the plots and to produce an estimate of minimum least squares variance, as a continuos map. The interpolation procedure, followed a pattern analysis that allowed to define the range of action of the algorithm (barriers), in order to minimize disturbance of adjacent areas not subject to survey. Four separate continuos grids, strictly related to the single plot, were subsequently elaborated to present *Lobaria pulmonaria* coverage percentage maps.

Floristic data were analyzed with multivariate statistical methods (Podani 2007), namely a classification analysis (cluster analysis) and an ordination analysis (PCA, Principal Component Analysis), using SYN-TAX 2000 software. Cluster analysis was performed with group average link method (upgma) with chord distance for binary data as the dissimilarity coefficient, in order to identify the classification dendrogram. For ordination analysis a centred PCA was applied, obtaining the biplot of the species-stations dispersion and the screeplot showing the percentage of variability explained by each of the detected axes.

Ecological indices were calculated to detect local trends related to pH of the substratum, solar irradiation, aridity, eutrophication and poleophoby referring to the Italian Lichen System (Nimis & Martellos, 2008).

3. Results

A total of 74 lichen species were recorded during the survey on the 96 sampled trees, four of which were new findings for Campania region (*Calicium abietinum* Pers., *Lobarina scrobiculata* (Scop.) Nyl., *Physconia subpulverulenta* (Szatala) Poelt v. *subpulverulenta*, *Platismatia glauca* (L.) W. L. Culb. & C. F. Culb). Most of the lichens (83.56%) presented a coccoid green alga as photobiont, whereas few of them had cyanobacterium (15.07%) or *Trentepohlia* (1.37%). Foliose lichens prevailed (50%), followed by crustose (39.18%) and fruticose (10.82%).

Concerning phytoclimatic classification, temperate species prevailed (41.25%), divided in temperate (26.25%), mild temperate (10%) and cold temperate (5%). Then followed the sub-oceanic species (22.5%), and holartic (17.5%). The remaining 18.75% was divided in several phytoclimatic groups, among which the mediterranean.

Two clusters for the stations (hereafter cluster A and B) and five for the species (hereafter cluster 1 to 5) were identified by classification analysis (Figure 1). The PCA (Figure 2) confirmed the groups identified by the *cluster analysis*.
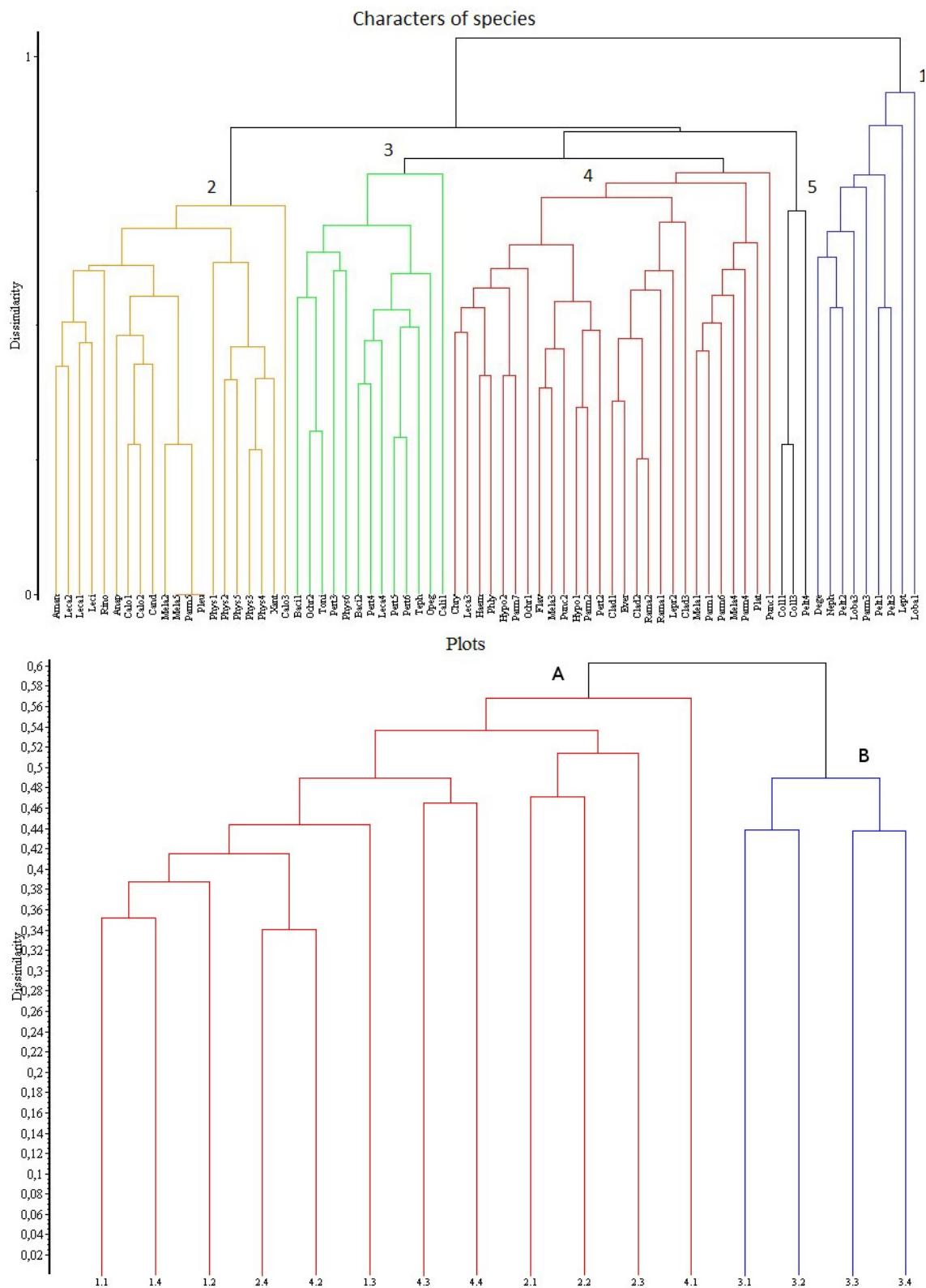
Figure 1 Dendrograms showing the main clusters of species (above) and stations (below)
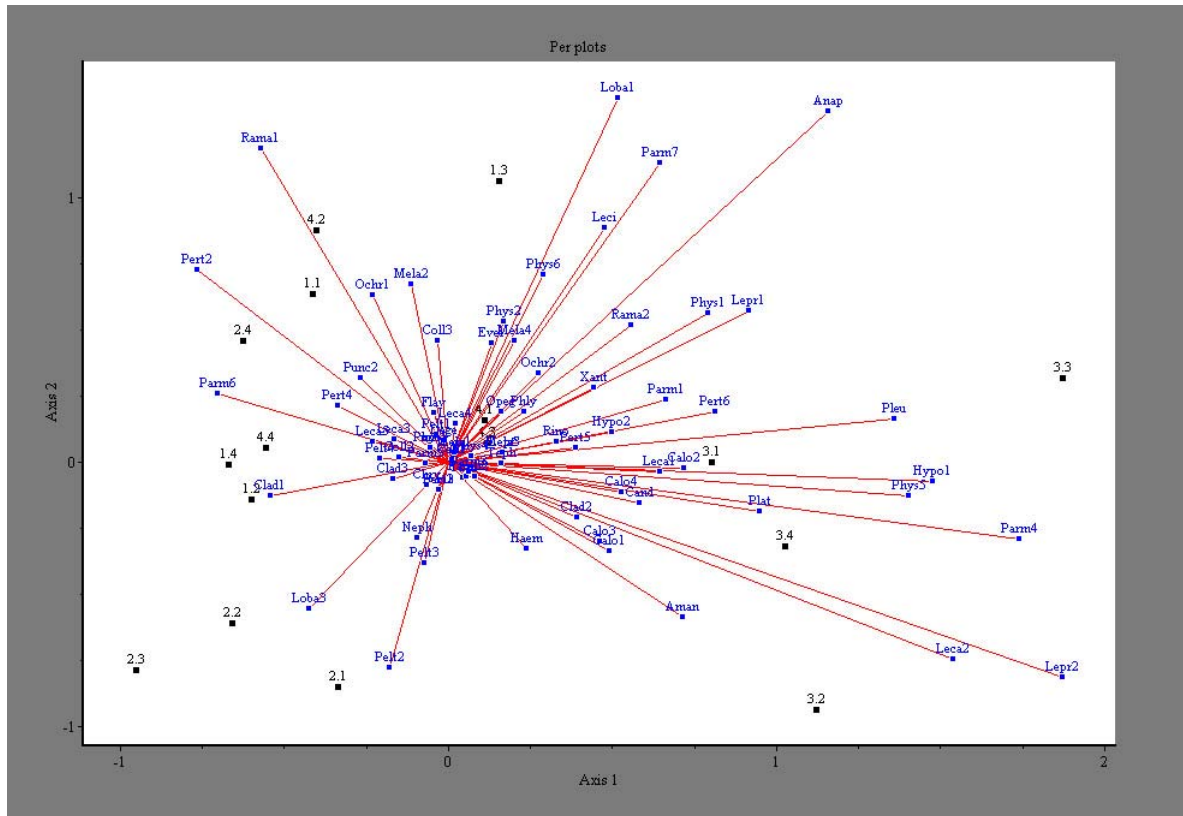
Figure 2: Biplot showing the main axis of PCA ruled on species and stations

Stations

Cluster A includes the stations 1, 2 and 4, located at relatively lower elevations. Cluster B includes four plots located at higher elevation and is characterized by the presence of almost exclusive species such as *Hypogymnia physodes*, *Platismatia glauca*, *Physconia subpulverulenta* v. *subpulverulenta* e *Parmelina pastillifera,* and some other species that are represented with a higher frequency relative to the other cluster, such as *Leprocaulon microscopicum* and *Lecanora chlarotera.*

Species

Cluster 1 includes lichen species of the *Lobarion pumonariae* alliance, such as *Lobaria amplissima* var. *amplissima* (the spesies with the highest frequency in the sampled area), *Lobarina scrobiculata*, *Degelia plumbea*, *Peltigera collina*, *Nephroma laevigatum*, *Leptogium cyanescens.*

Cluster 2 is dominated by species of the *Xanthorion paretinae* alliance, with some species of *Lecarion subfuscae*: *Lecanora clarotera*, *Lecanora carpinea*, *Lecidella elaeochroma*, *Physcia adscendens*, *Physconia distorta*, *Xanthoria parietina*, *Punctelia subrudecta*. These species are typical of heliophilous, xerophilous, nitrophilous communities distributed in anthropized environments, where they show a good resistance to pollution.

Cluster 3: Species of Graphidion scriptae: *Opegrapha atra*, *Ochrolechia balcanica*, *Pertusaria amara*, *Pertusaria hymenea.* These are communities of crustose pioneer lichens, usually found in forest environments and rarely in anthropized areas, that precede in the succession or sometimes coexist with the species of *Lobarion* and *Parmelion*.

Cluster 4: species of *Parmelion parlatae* and *Xanthorion parietinae* alliances: *Flavoparmelia caperata*, *Parmotrema perlatum*, *Hypogymnia physodes*, *Parmelia sulcata*, *Parmelina tiliacea.* These are species of mesophilous and sub-acidophilous communities, less adapted to dry and nitrified environments compared to *Xanthorion*, but relatively more sensitive to pollution,

though in some case they are found in anthropized areas if atmospheric humidity allow their presence.

Cluster 5 includes several species that may be considered closer to *Lobarion pulmonariae* than to *Parmelion perlatae* or to *Xanthorion parietinae*.

Cartographic analysis

Four maps of *Lobaria* percent cover were obtained for the sampled stations. *Lobaria* cover values ranged between 0.009 and 35%, clustered in nine classes in the maps (Figure 3). The species did not show very high cover values, except in one of the plots of the first station.
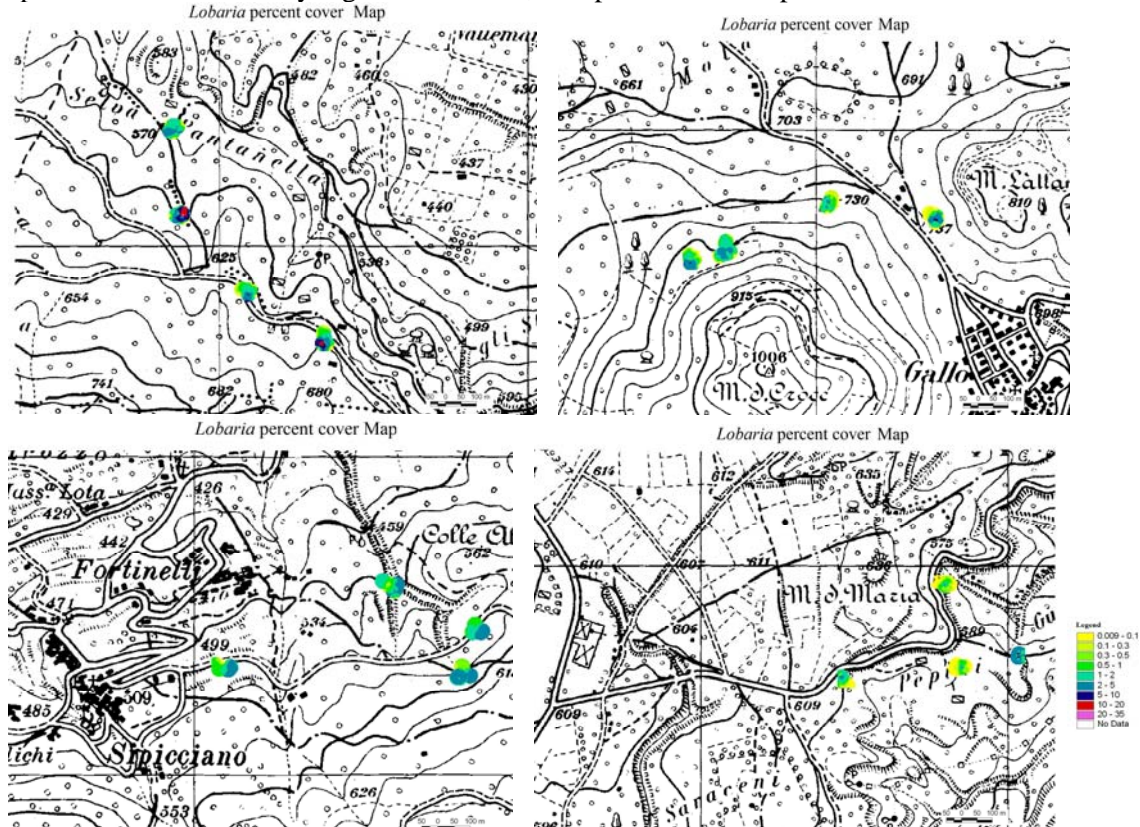

Figure 3: *Lobaria* sp Cover map elaborated from the surveyed data

4. Discussion

Lichen biodiversity resulted relatively high in the sampled areas, both for the numerical representation of taxa and for their floristic quality, though rich of generalist species adapted to disturbed areas. *Lobaria* cover, however, presented relatively low cover values on the studied area, as it resulted from cartographic analysis. Also the other species of the *Lobarion pulmonariae* alliance were not very diffuse on the area. Ecological indices showed that many of the sampled species are typical of natural or semi-natural habitats, with a hygro-mesophylous behaviour, preferring high availability of diffuse light, but escaping direct sun radiation. Though the list of sampled species represents only a small portion of the lichen flora in the studied area, the marked presence of temperate and sub-oceanic species is well correlated with the sub-mountain character of the area.

A limited number of species characterized by low tolerance to air pollutants prevailed in cluster A, whereas a greater number of species was found in cluster B, most of which typical of undisturbed areas or small mountain urban sites. The most frequent species belonging to the alliance of *Lobarion pulmonariae* are *Lobaria amplissima* and *Lobaria pulmonaria*; other species, such as *Lobarina scrobiculata* e *Peltigera collina*, resulted to be rare and sporadic,

mainly in the northern side of the park, inside the ancient volcanic caldera. These species are good indicators of wood stability over time. They were mainly found in chestnut forests, rather than in coppiced oak mixed wood areas (*Quercus pubescens*, *Olea europaea*, etc.), more represented in the western side of the park. Despite landscape fragmentation, the results could suggest that the agroforestry management carried out over many decades in the north-east of the park allowed wide forest corridors to get established, which could be an important factor of ecological continuity. This ensured the conservation of biodiversity due to the local presence of a large number of vegetative propagules, inducing several colonization events of rare lichen species over surrounding areas. So a fruit chestnut wood, subjected to a good agronomic and forestry management, would give better results in terms of biodiversity than an oak mixed forest, characterized by a more natural floristic composition but strongly disturbed by frequent coppice.

The method used to estimate the actual coverage of the monitored species associated with the cartographic approach, allowed to quantify the species areal extent as monitored on individual trees, and to propose an estimation of the visible cover of the species in the studied area. This kind of study represents a good starting point for further investigations, specifically designed to monitoring possible deviations from current conditions and focused to assess the effectiveness of environmental policy actions taken at municipal and regional level.

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