available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/funeco

Epiphytic lichen conservation in the Italian Alps: the role of forest type

Juri NASCIMBENE[a,b,*], *Pier Luigi NIMIS*[b], *Matteo DAINESE*[c]

[a]*Museo di Scienze Naturali dell'Alto Adige, via Bottai 1, 39100 Bolzano, Italy*
[b]*Università degli Studi di Trieste, Dipartimento di Scienze della Vita, via Giorgieri 10, 34100 Trieste, Italy*
[c]*Università degli Studi di Padova, Dipartimento Territorio e Sistemi Agro-forestali, Viale dell'Università 16, I-35020 Legnaro, PD, Italy*

ARTICLE INFO

Article history:
Received 26 March 2014
Revision received 16 May 2014
Accepted 30 May 2014
Available online
Corresponding editor:
Darwyn Coxson

Keywords:
Climate
Environmental gradient
Forest structure
Species composition
Species richness
Water-energy conjecture

ABSTRACT

Epiphytic lichens are a functionally important and species-rich component of Alpine forests, including several species of conservation concern. Their dependence on specific host trees predicts that forests with different tree species composition host different lichen communities, enhancing lichen diversity in forest landscapes. In this study, we tested for the first time the effect of forest type on patterns of epiphytic lichen diversity, in the Italian Alps. We sampled the main forest types of the South Tyrol, a typical Alpine region of Italy. We also assessed the influence of factors related to forest structure and climatic conditions. Our results demonstrate that different forest types host statistically different lichen communities, suggesting that the conservation of lichen diversity is entrusted to the maintenance of forest landscape heterogeneity, including forest types of minor economic value and rural habitats. The highest number of species was found in grazed larch forests and in high-elevation spruce forests, while the poorest pool was found in low-elevation spruce forests, beech forests and Scots pine (*Pinus sylvestris*) forests. High-elevation spruce forests also had the highest number of red-listed lichens, as the non-intensive management of these forest type allows the establishment of a rich lichen biota. Our results also emphasize the role for lichen conservation of some forest types that are of minor economic importance, such as oak (*Quercus pubescens*), riparian, and silver-fir (*Abies alba*) forests. This can also apply to grazed larch (*Larix decidua*) forests that are maintained by traditional farming, which shape one of the most pleasing aspects of the Italian Alpine landscapes.

Introduction

The forest landscape of the Alps is dominated by pure spruce (*Picea abies*) forests that since centuries are mainly managed for timber production (Motta, 2002). Depending on elevation, climatic, and edaphic conditions, the monotony of this landscape is mitigated by the patchy occurrence of several forest types of lesser economic importance, many of which play a relevant role for biodiversity conservation and are listed among the EU habitats of interest (European Commission,

* *Corresponding author*. Università degli Studi di Trieste, Dipartimento di Scienze della Vita, via Giorgieri 10, 34100 Trieste, Italy. Tel.: +39 (0)43942894.
E-mail address: junasc@libero.it (J. Nascimbene).
http://dx.doi.org/10.1016/j.funeco.2014.06.006

2003). Grazed larch (*Larix decidua*) woodlands, which are anthropogenic formations related with traditional alpine farming, are increasingly recognized to host several species of conservation concern (Fontana et al., 2013).

Epiphytic lichens are a functionally important and species-rich component of alpine forests, including several species of conservation concern (e.g., Nascimbene et al., 2010). Their dependence on specific host trees (Jüriado et al., 2009; Király et al., 2013) predicts that forests with different tree species composition host different lichen communities (Ódor et al., 2013), enhancing lichen diversity in forest landscapes. This pattern was demonstrated, for instance, in Mediterranean regions (Brunialti et al., 2013), where only a few lichen species are shared among different forest types. This highlights the importance of maintaining forest landscape heterogeneity to enhance lichen conservation. The same view could also apply to Alpine forests, as suggested by previous studies (e.g., Dietrich and Scheidegger, 1997). However, to our knowledge, no study has explicitly examined this issue for the main forest types of the Italian Alps along wide ecological and geographical gradients.

Besides forest type, forest structure and climate may influence lichen diversity patterns in alpine regions. In managed forests, forest structure reflects management practices that depend on forest type and site conditions. These in turn have an influence on tree density, tree size, and stand age, that are among the main drivers of epiphytic lichen diversity (Nascimbene et al., 2013a). For example, oak (*Quercus pubescens*) forests are coppiced with relatively short rotation period, while mature trees in spruce forests are harvested within an age span of 80–200 yr (elevation and soil fertility determine growth rates; AA and VV, 2010).

In mountain areas, energy patterns are strongly related to elevation, while water availability may also depend on gradients influenced by topography. The poikylohydric nature of lichens provides the basis for their sensitivity to both water and energy, which directly control relevant eco-physiological processes, influencing growth rates and species distributions (Insarov and Schroeter, 2002). In particular, lichen physiology is closely coupled to ambient temperature and moisture conditions (Green et al., 2008) that influence thallus water saturation and desiccation. Increasing ambient temperature may negatively affect lichens, due to increased respiratory carbon loss (Schroeter et al., 2000), especially when it is not counterbalanced by a sufficient water availability. Actually, energy availability could interact with water, i.e., in dry mountains the negative effect of high temperature is stronger than in more rainy mountains (modified conjecture of Hawkins et al., 2003; see also Bhattarai and Vetaas, 2003; McCain, 2007).

This study tests the effect of forest type on patterns of epiphytic lichen diversity in a typical Alpine region of Italy, by sampling the ten main forest types occurring in the survey area. We also assessed the influence of factors related to forest structure and climatic conditions. We hypothesized that structural factors controlling light and substratum availability and stability (i.e., forest density, tree size and stand age) could be responsible for differences among forest types. We also expected an effect of climatic conditions, since our sampling encompasses a wide elevation gradient. The analyses were performed in two steps: (1) we built a model with only forest type as the predictor variable, and (2) we built a multiple Poisson regression model also including factors indicative of forest structure and climate. The second model aimed to verify whether the effect of forest type could be attributed to differences in structural parameters and/or climatic conditions. Since we were interested in evaluating the role of forest types for lichen conservation, we contrasted overall species with those of conservation concern.

Materials and methods

Study area and forest types

The study was carried out in the Alpine region of South Tyrol (N Italy; Fig 1) that has an area of 7 400 km^2. The climate is largely influenced by elevation, ranging from humid warm-temperate conditions in the Adige valley area, with mean annual temperature of 11–12 °C, to alpine conditions above 1 700 m, with mean annual temperatures of 2–3 °C. The amount of precipitation is variable across the region (<600–1 400 mm yr^{-1}) according to topography.

The landscape between 600 and 2 100 m is dominated by forests that cover an area of 370 000 ha (AA and VV, 2010). Pure coniferous forests are the most widespread throughout the region (88 % of the forest surface). Spruce forests are the main forest type (55 %) between 900 and 1 900 m, representing the most important forest type for economic exploitation. Larch-stone pine (*Pinus cembra*) forests are the second forest type per area (27 %), ranging between 1 900 and 2 100 m, followed by scotch pine forests (11 %) between 900 and 1 600 m, and silver fir forests (1 %) between 900 and 1 600 m. Traditionally managed, grazed larch forests are scattered in small patches between 1 300 and 1 800 m. Angiosperm forests cover only 5 % of the forest area; mainly beech (*Fagus sylvatica*) forests between 700 and 1 200 m and coppiced oak forests between

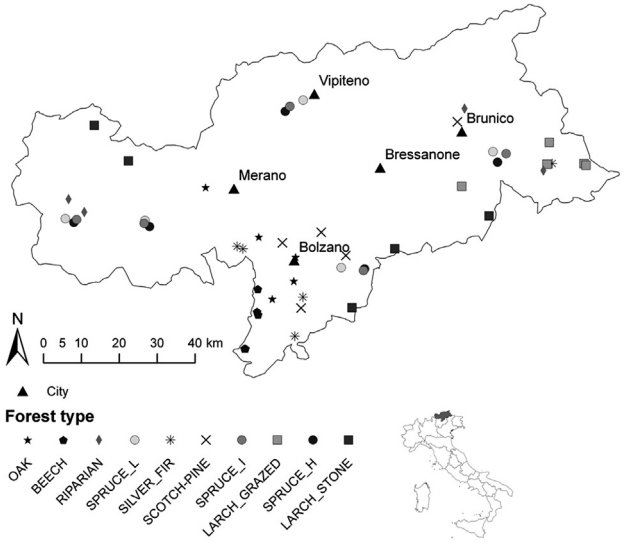

Fig 1 – Map of the study area in South Tyrol (Italian Alps), with the sampling plots. Plots belonging to different forest types are marked with different symbols.