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Review

Conservation ecology of boreal polypores: A review

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ABSTRACT

Here we quantitatively summarize the conservation ecology of one group of dead-wood-dependent organisms, the polyporous fungi, in boreal Europe. At the substrate scale, the decay stage is the strongest determinant of species richness, with large (>20 cm diameter) downed logs hosting more species than other dead-wood types. At the stand scale, the amount of dead wood is the strongest determinant of polypore species richness; the minimum average amount of dead wood for the occurrence of rare polypores appears to be 20–40 m^3/ha. Species-area analysis shows that in mature boreal forests species accumulation levels off at around 20–30 ha. This leads us to suggest a heuristic 20/20/20 rule of thumb: a 20 ha stand, with an average of 20 m^3/ha of dead wood of which many are logs >20 cm, is likely to be the minimum for the ecologically justified conservation of polypore diversity at the stand scale in boreal Europe. Equally crucial for polypore diversity, however, is the current and historic extent of suitable habitats at the landscape scale. The time lag between the isolation of a habitat patch and the new equilibrium in the number or occurrence of species seems to be around 100–150 years, indicating that an extinction debt is likely to exist in recently isolated fragments. Only a few studies have addressed the ecological efficiency of the new, biodiversity-oriented forest management tools (retention trees, woodland key habitats). Despite this it seems that the traditional large conservation areas are the most effective means of polypore conservation.

Contents

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1. Introduction

The 1992 Convention on Biological Diversity challenged national legislations and policies concerning the management of natural resources. In many countries, forest legislation and management guidelines were modified to increase consideration of biodiversity conservation (Rametsteiner and Mayer, 2004). Traditional conservation means, such as the establishment of protected areas, were revised, and new methods, such as the protection of woodland key habitats and retention trees, were introduced to improve the ecological quality of commercial forests (Lindenmayer and Franklin, 2002). At the same time, research regarding the ecological efficacy of different conservation means increased.

Dead wood is an important substrate for a large number of forest-dwelling species (Jonsson and Kruys, 2001). One group of dead-wood-dependent species that has gained special attention is the polypores (Basidiomycota: Aphyllophorales) (Lonsdale et al., 2008). Functionally polypores are decomposers of woody material, and are distinguished from other wood-decaying fungi by the appearance of their fruit bodies (poroid hymenial surface). Because polypores are dependent on dead wood, they are sensitive to measures that decrease dead wood availability and, consequently, polypores have been regarded not only as great losers in managed forests, but also as good indicators of conservation value (Niemelä, 2005; Nitare, 2000). All these factors have contributed to the popularity of polypores as a subject of biodiversity studies during the 18 years following the Convention on Biological Diversity. With this in mind it is an opportune moment to review the accumulated information.

In this review, we concentrate on boreal Europe (Fennoscandia) from which the majority of the polypore studies come from. This biogeographical delineation was also needed to avoid excess variation in climatic conditions and tree species composition. Furthermore, compared to the rest of Europe, the area of forest cover has remained high in the boreal parts, also in lowland areas, and, apart from only a few plantations of exotic trees, all forests consist of endemic tree species (Östlund, 2004). Additionally, the boreal parts of Fennoscandia share a similar history of forest use (Solbraa, 1996; Tasanen, 2004; Östlund, 2004), and new forestry principles have been adapted during the 1990s (Ericsson et al., 2005; Junninen and Kouki, 2006; Sverdrup-Thygeson, 2002). These factors make it meaningful to quantitatively summarize the ecological requirements of polypores and their response to forest management. The general principles that emerge from Fennoscandia can be applied to polypore communities elsewhere, and will be helpful in designing future studies and developing forest management globally.

In this review, we quantitatively summarize the ecological requirements of polypores at the substrate, habitat (or stand) and landscape scales, and discuss the main related conservation and management implications.

2. Material and methods

2.1. Article selection

We had three *a priori* set criteria for article inclusion:

1. Published in a peer-reviewed scientific journal in English.
2. Focused on conservation biology; purely descriptive "floristic" studies without any statistical inferences, as well as taxonomic or physiological studies, were not included.
3. Data collected in Fennoscandia, including the boreal zone and the boreonemoral (hemiboreal) transition zone between boreal and temperate vegetation zones, as delimited by Ahti et al. (1968).

Articles were found using the ISI Web of Knowledge with the keywords polypore, Aphyllophorales, wood-decaying/-decomposing/-inhabiting fungi, or fung*, combined with boreal forest, biodiversity, diversity, dead wood or woody debris (9 December 2009). The search included the years 1975–2009. In addition, the reference lists of the articles found and the publication lists of several Finnish, Swedish and Norwegian researchers were checked for additional articles. In total, we found 76 articles that met the criteria (Table 1), probably representing all published articles fitting the above criteria. The first articles fulfilling the criteria were published in 1995, i.e. 3 years after the Convention on Biological Diversity.

2.2. Article overview

Of the total of 76 articles, for 29 the data had been collected solely in Sweden, for 27 articles in Finland and for 12 articles in Norway; eight articles included data from two or three Fennoscandian countries or from Russian Karelia belonging to the biogeographical region of Fennoscandia. The studies represent fairly equally all sections of the boreal vegetation zone: in 31 articles, all or part of the data were collected in the northern boreal zone, and in 31, 24 and 26 articles in the middle boreal, southern boreal and hemiboreal zones, respectively, as delimited by Ahti et al. (1968). In 39 (51%) of the studies, the data were collected in spruce-dominated forests, in three studies in pine-dominated forests, and in seven studies in forests dominated by broadleaved trees; 23 studies included many types of forests. In 34 studies all tree species were considered, but in 30 studies, only Norway spruce (*Picea abies*) trees or polypore species growing on spruce were included, four studies considered both spruce and Scots pine (*Pinus sylvestris*), while three studies focused on broadleaved tree species. Thus, geographically our material should give a fairly balanced overview, not biased towards a given country or vegetation zone. It should be noted, however, that spruce and spruce-dominated forests are overrepresented in the material.

There were some difficulties in comparing and combining the data of different studies, because of the variation in standardiza-