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Recognizing ecological patterns of wood-decaying polypores on gymnosperm and angiosperm trees in northeast China

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ABSTRACT

Wood-decaying polypores are macrofungi with the capacity to decompose lignocellulose, and hence play essential roles in forest ecosystems. Host (tree species) range and preference are among the most important factors influencing polypore communities. Here, we studied polypore ecological patterns between gymnosperm and angiosperm trees based on data collected from more than 10 yr field investigations in Fenglin and Changbaishan Nature Reserve, northeast China (boreal and temperate zone). Although species richness was similar between the polypores associated with the two tree groups, gymnosperm trees showed: (1) a higher similarity in polypores species; (2) a lower polypore species richness on fallen trunks; (3) a lower polypore species richness in unprotected forests; (4) fewer common polypores but more occasional species; (5) a lower proportion of white rot but a higher proportion of brown rot polypores. In general, our findings supported previous views that different preferences between gymnosperm and angiosperm trees in polypores are probably caused by different structure and content of lignins between the two tree groups.

Introduction

Wood-decaying polypores, referring to basidiomycetes with poroid basidiocarps, are able to decompose wood, and the biology of wood-decay has drawn attention from scientists in several different disciplines such as forest ecology (Lonsdale *et al.* 2008), forest pathology (Asiegbu *et al.* 2005), and biotechnology (Cohen *et al.* 2002). Wood-decaying polypores are polyphyletic (Binder & Hibbett 2002), and the key characters in polypore taxonomy include spore characters, such as colour, size and shape (Parmasto & Parmasto 1987). Variations in spores are significantly correlated with several ecological characteristics, especially to basidiocarp size, nutritional mode, rot type and wood resource (Kauserud *et al.* 2008). Ecologically the size of the woody host also positively affects basidiocarp production in polypores (number and volume) (Urcelay & Robledo 2009), and bigger wood is more likely to host more rare species (Penttilä *et al.* 2004). Furthermore, many studies on species richness of polypores have suggested that polypore diversity depends on substratum, stand, landscape and forest management practice (summarized in Junninen & Komonen 2011). Although most wood-decaying polypores have a broad host range (Lindblad 2000), the tree composition of a forest has an obvious influence on polypore communities. Moreover, host range and preference for certain polypores can be strict to either angiosperm or gymnosperm trees, or even to

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a single tree species. For example, our preliminary investigations have shown that *Melanoporia castanea* and *Poriodontia subvinosa* exclusively colonize *Quercus mongolica* and *Abies nephrolepis*, respectively. Hattori (2005) also showed that the diversity of wood-decaying polypores varies in different vegetation types. However, to the best of our knowledge, no comprehensive studies have yet addressed the ecological patterns of wood-decaying polypores, in respect of presence on gymnosperm and angiosperm trees.

The forests in northeast China represent one of the best preserved boreal and temperate vegetation types in the country, possessing a wide range of natural forests with various gymnosperm and angiosperm trees, and ecological studies on macrofungi have been carried out intensively in this area (Wei & Dai 2004; Wei *et al.* 2010). Many new species of wood-decaying polypores were discovered (e.g. Dai 1998; Yuan *et al.* 2006; Dai *et al.* 2009), reflecting the high species richness, and the economical macrofungi were well studied (Dai & Tolgor 2007). On this basis, the forests in this area serve as an ideal platform for studying the ecological patterns of wood-decaying polypores.

The major goals of this paper are to elucidate the differences caused by gymnosperm and angiosperm trees on the ecological patterns of wood-decaying polypores, including: similarity of polypore communities between gymnosperm and angiosperm trees, polypore richness in various types of woody substrata in reserved forest and unprotected forest, polypore abundance in different host trees, and the proportion of brown and white rot species.

Materials and methods

Study area

Two areas were chosen to evaluate the ecological patterns of wood-decaying polypores. One was the Fenglin Nature Reserve, situated in Heilongjiang Province (48°01′–48°09′N, 128°59′–129°15′E), in the Lesser Hinggan Mountains with an altitude range from 300 m to over 700 m above sea level. In the reserve, the common gymnosperm tree genera are *Abies*, *Larix*, *Picea* and *Pinus*, while the angiosperm trees include genera of *Acer*, *Alnus*, *Betula*, *Lonicera*, *Maackia*, *Phellodendron*, *Populus*, *Quercus*, *Salix*, *Syringa*, *Tilia* and *Ulmus*. Two plots at the altitudes of 350 m and 650 m of the reserve were surveyed, and each plot was about 20 ha. Two other plots within the same area and with similar tree species distribution in unprotected forests at the same altitudes were surveyed, too. The other area was within Changbaishan Nature Reserve, located in Jilin Province (41°15′–42°35′N, 127°15′–129°00′E), with altitude between 600 m in valleys to 2 700 m at the highest peak. In this reserve, the gymnosperm tree species of *Abies*, *Larix* and *Picea* have a distribution in higher elevation, while *Pinus* and the angiosperm trees in *Acer*, *Betula*, *Corylus*, *Fraxinus*, *Phellodendron*, *Populus*, *Quercus*, *Tilia* and *Ulmus* were found at lower elevation. Three plots (about 20 ha each) at altitudes of 700 m, 1 000 m and 1 200 m were investigated. Three plots (about 20 ha each) in unprotected forests with similar tree species distribution at the same altitudes were investigated, too.

Sampling strategy

Since 1999, polypores in the 10 plots mentioned above were surveyed for macrofungi systematically during summer and autumn every 2 yr. Visible basidiocarps of polypores were recorded (around 3 050 records), and only one record was documented if more than one basidiocarp for the same polypore species was simultaneously observed on a single substratum. Information for each record on host trees and substratum types was listed. An inventory was designed for the survey to include species or basidiocarps, host trees and substratum types. The host trees included four gymnosperms – *Abies nephrolepis*, *Larix gmelinii*, *Picea jezoensis* and *Pinus koraiensis*, and four angiosperms – *Betula platyphylla*, *Populus davidiana*, *Quercus mongolica* and *Tilia amurensis*. These eight tree species were abundant in the study areas and were the preferred hosts for most wood-decaying polypores. Substrata included living trees, dead standing trees, fallen trunks (the first stage of decay), fallen decorticated trunks (the second and third stage of decay), rotten wood (the fourth and fifth stage of decay) and charred wood. The identification of decay stage followed Renvall (1995). Substrata without basidiocarps ("empty" trunk or wood) were not recorded, so the total number of all types of substrata available for polypore colonization was not measured. The records of species were only considered if basidiocarps were found, but not including non-fruiting mycelia, which may be present in "empty" trunk or wood, because these mycelia are very hard to find and identify. This approach has been widely used (Lindblad 2000; Gilbert *et al.* 2002), although it underestimates the total number of polypores.

Collections were identified to species level with the help of a Nikon Eclipse 80i microscope for some resupinate species. All samples during the investigations were deposited at the herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP).

For analysis of species richness, polypore species collected in the same comparative units, including substrata, forest types, hosts and rot types, were dealt with together ignoring the investigation year. Regarding species abundance, all the records were accounted. Following Dai (2011), a common species means the polypore was recorded more than 15 times during the study period in all plots, an occasional species was recorded 5–15 times, and a rare species was recorded less than five times. Rot type of each species was recognized according to the character of substrata and previous studies.

Data analysis

Value of taxonomic diversity was assessed by species/genera ratio (S/G). Coefficient of community (CC) values of polypores between tree species was assessed by the following equation:

$$CC = 2C/(A + B)$$

where A and B are the polypore species numbers in the two different tree species, respectively, and C is the polypore number common in both tree species.

In the comparison, the polypore species number of each unit on a tree species was transformed to percentage by dividing by the total polypore species number on the tree species. One-way analyses of variance (ANOVA) were performed using SAS 9.1 to