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# Fungi in Sarawak: practical use of historical samples in the fungarium of the Forest Department Sarawak

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**Abstract** We have started to re-identify old samples deposited in the fungarium at the Research, Development and Innovation Division of the Forest Department Sarawak since the 1950s. We confirmed that surveys on polypores (Polyporales, Hymenochaetales, and so on) were conducted from 1954 to 2015, and that 1890 polypore specimens from 56 genera were collected from 117 study sites. However, most of the fungal specimens were collected from a national park in the Miri Division (Lambir Hills National Park) and three study sites (Kubah National Park, Santubong National Park, and Matang Wildlife Centre) in the Kuching District. Further field collections, especially in mountain areas, are greatly needed to reveal the geographical variation of polypore species diversity and the spatial distributions of individual species.

**Keywords** Fungal diversity, National parks, Polypore, *Pycnoporus sanguineus*

## Introduction

Fungi are the second most diverse group of living organisms in the world (Hawksworth 2001). They comprise several important functional groups in forest ecosystems, such as decomposers, plant mutualists, and parasites. Polypores, a morphological group of fungi that includes species belonging to the Polyporales, Hymenochaetales, and so on, are among the most important wood decomposers in forest ecosystems. Fruiting bodies of polypores also play an important role in maintaining the diversity of arthropod species by providing food and habitat resources (Yamashita et al. 2015). The large, long-lasting fruiting bodies of polypores are helpful for conducting field studies of polypores in boreal and temperate zones (Stokland et al. 2012).

The diversity of polypore species is high in Southeast Asia (Yamashita et al. 2015). It is claimed that species diversity is affected most strongly by changes in land use, and relatively weakly by climate change (Jantz et al. 2015). Therefore, to make a land-use management plan that will maintain the diversity of polypore species in Sarawak, information on the spatial distributions of polypore species is needed.

The spatial distribution of a polypore species is determined by the ecological traits of the

fungal species and by the type of land use and climatic factors in the habitat. We have already revealed by conducting field surveys that polypore species differ in their patterns of resource use according to the size and decay class of coarse woody debris (Yamashita et al. 2009) and that fungal species richness is higher in primary forests than in secondary forests because there are more types and larger amounts of resources in primary forests (Yamashita et al. 2008). In contrast, the geographical variation in the diversity of polypore species and the spatial distributions of the dominant polypore species at the state level have not been revealed in Sarawak.

Understanding how the spatial distributions of polypores at the state level temporally change will provide highly valuable information for understanding the effects of changes in land use and climatic conditions. Specimens collected in the distant past and kept in natural history museums or research institutes have potentially important information for determining the geographical variation in the species diversity and the spatial distributions of particular species (Graham et al. 2004). However, such research using fungal specimens is limited (Lavoie 2013), and has not been reported from tropical regions.

In Sarawak, more than 5000 specimens of macrofungi have been deposited in the fungarium at the Research, Development and Innovation Division of Forest Department Sarawak since the 1950s. Although the data of these specimens contain potentially important information for studies on fungal flora and diversity in Sarawak, they have been almost completely neglected, possibly because the data of most of the samples collected up until 2010 have not been converted to an electronic form. To form a basis for such kinds of studies in the future, we began the tasks of re-identifying all the old samples deposited in the fungarium to species level, and collecting the data in an electronic form to build an electronic database of the fungi. In this report, we provide basic information on some of the specimens in the fungarium. Because we have just started this study, the results shown here are preliminary.

**Methods**

In August 2015, we checked 422 specimens of polypores kept in the fungarium. We made a database of the specimens by entering the ID number, date collected, species name, and collection location of specimens. If the original identification of the specimen was wrong, we tentatively corrected the species or genus name. We used genus for the index of diversity because re-identification to the species level was not finished yet. We already had an electronic database that contained information on 1468 polypore specimens deposited in the fungarium. We combined the two databases and conducted a descriptive analysis to show the attributes of the specimens in the fungarium.

**Results and Discussion**

Fungal surveys were conducted in Sarawak from 1954 to 2015, with 56 fungal genera recorded from 1890 specimens collected from 117 study sites. A total of 422 specimens were collected between 1954 and 2003 and 1116 specimens were collected between 2004 and 2006 (Fig. 1).

The oldest specimen, identified as *Pycnoporus sanguineus*, was collected back in 1954 (Fig. 2). This species is distributed throughout the tropics, can grow on almost any kind of deciduous wood, and produces conspicuous red or orange fruiting bodies (Ryvarden and Johansen 1980). It is common in open and sunny localities in East Africa (Ryvarden and Johansen 1980). In Sarawak, this species is observed on dead logs in open spaces along roadsides or in large gaps in

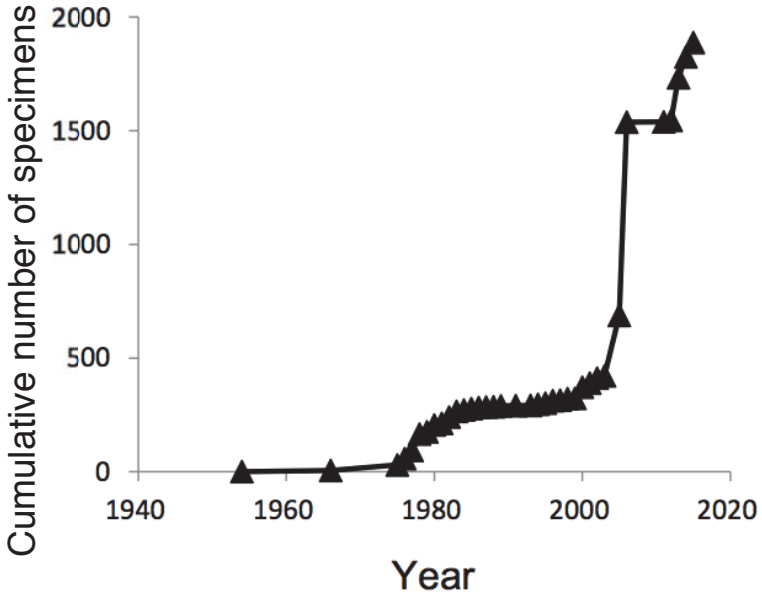


**Fig. 1** Cumulative number of polypore specimens deposited in the fungarium at the Research, Development and Innovation Division of Forest Department Sarawak from 1954 to 2015.

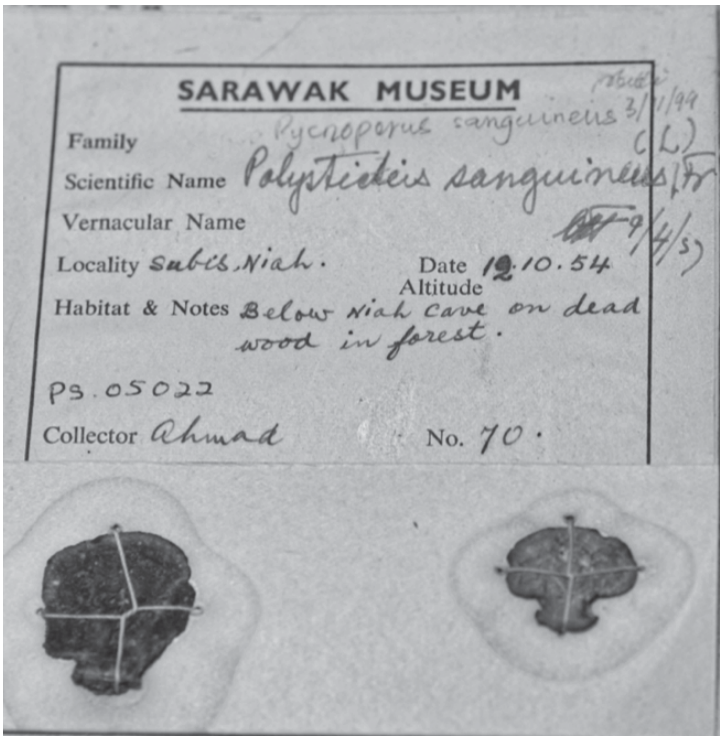


**Fig. 2** The oldest polypore specimen kept in the fungarium at the Research, Development and Innovation Division of Forest Department Sarawak, Kuching. Originally named *Polystictus sanguineus*, its current name is *Pycnoporus sanguineus*.

forests (S. Yamashita, personal observation).

Most fungal specimens were collected from Lambir Hills National Park and three sites in Kuching District. These included 54 fungal genera from Lambir Hills National Park, followed by 16 from Kubah National Park, 13 from Similajau National Park and Matang Wildlife Centre, and 12 from Santubong National Park. We speculate that well-developed research facilities in or near research sites in Lambir Hills National Park and Kuching District strongly promoted intensive studies in these study sites except for Similajau National Park. On the other hand, few specimens were collected from mountain areas except for specimens from a few mountains near Miri (e.g., Gunung Mulu National Park). To obtain reliable maps of polypore diversity and distributions of particular polypore species, further field research is needed in mountain areas.

It seems difficult to use these data to reveal the temporal change in the spatial distributions of polypores in Sarawak because the collections of fungi stored in the fungarium are highly biased to a small number of study sites, such as Lambir Hills National Park and a few sites in Kuching District, and to a small number of study periods. However, because field research has been conducted since 1970 at Lambir Hills National Park and Gunung Mulu National Park, and in the Kuching District, the re-census will help us to estimate how the polypore communities there have changed with time.

The re-census on the specimens in the fungarium demonstrated that the number of genera recorded from a particular study site was significantly positively correlated with the number of specimens from that site ($p < 0.05$). Based on the field surveys from 1995 to 1998 (five field surveys in four years) in Pasoh on the Malay Peninsula, Yamashita et al. (2015) pointed out that a single field survey in a large area will record a larger number of fungal species than will several field surveys in a small area, if the sampling effort (defined by sampling frequency and sampling area) is limited. This suggests that a large number of fungal specimens collected during a one-time survey within a large area will be suitable for obtaining diverse fungal specimens at a particular study site. If we conducted field surveys according to this strategy at several study sites, we would obtain more accurate estimates of the number of polypore species in Sarawak.

Follow-up research according to the latest taxonomy is needed to improve the reliability of data from specimens in the fungarium. Figure 2 shows a good example of such follow-up. This specimen was originally named *Polystictus sanguineus*, but was later renamed *Pycnoporus sanguineus*, which is the current name. We will start to re-identify all of the specimens in the near future. Taxonomy and systematics of polypores have been dramatically changing as information from fungal DNA sequences becomes available (Hibbett 2006; Hibbett et al. 2007). Information from fungal DNA sequencing is becoming important for accurate identification of fungal species, and adopting these molecular techniques for the species identification of the polypore specimens in the fungarium is highly desirable. Samples of fungi collected in the future also need to be preserved for future molecular studies.

To reveal the temporal dynamics of biodiversity in relation to climatic events, data from biodiversity monitoring is very useful, as has been shown with beetles trapped at the canopy towers in Lambir Hills National Park (Kishimoto-Yamada et al. 2010). In the case of polypores and agaric fungi, the temporal dynamics of the appearance of fruiting bodies have been periodically surveyed in Kuching since 2011 (H. Salleh, personal observation). That study will help us to understand the effect of climatic conditions on the appearance of fruiting bodies. There is a great need for further collection of fungal specimens to record fungal diversity in this region,

to evaluate environmental changes in the future.

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