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The Wood-rotting Fungal Flora of Three Islands in the Yellow Sea, Korea

Changmu Kim[1], Jin Sung Lee[1], Hack Sung Jung[2] and Young Woon Lim[1]*

[1]*Division of Non-Vascular Plants, National Institute of Biological Resources, Incheon 404-170, Korea*
[2]*School of Biological Sciences, Seoul National University, Seoul 151-747, Korea*

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The wood-rotting fungi of three Korean islands in the Yellow Sea, Soyeonpyung-do (SY), Oeyeon-do (OY), and Gageo-do (GG), were investigated from October 2004 to November 2005. During four sampling trips on each island, a total of 46, 44, and 44 specimens were collected from SY, OY, and GG, respectively. The identified wood-rotting fungi from SY included 29 species of 22 genera and nine families; OY had 31 species of 26 genera and 10 families; and GG had 34 species of 27 genera and 11 families. The majority of the fungi were in the Polyporaceae, which was represented by 23 genera and 30 species. *Auricularia polytricha*, *Daedaleopsis tricolor*, *Daldinia concentrica*, *Hymenochaete cinnamomea*, *Hymenochaete yasudai*, *Hyphoderma setigerum*, *Lopharia mirabilis*, *Schizopora paradoxa*, and *Trametes versicolor* were collected from all three islands.

KEYWORDS : Gageo-do, Oeyeon-do, Soyeonpyung-do, Wood-rotting fungi, Yellow Sea

Islands are restricted in terms of area and limited immigration of some species. These attributes have long been recognized by ecologists as important determinants of community composition and diversity, as well as in relation to the nature of interactions among organisms (Cox and Moore, 2000). Therefore, island biogeography is important for species preservation and estimation, and island ecosystems have considerable potential for research on how differences in community composition among habitats may influence processes and properties at the ecosystem level (Wardle *et al.*, 2003). Island biodiversity has been investigated for birds, insects, mammals, and higher plants, but few studies have examined fungi (Battigelli *et al.*, 1994; Berch *et al.*, 1993).

The Yellow Sea in Korea contains many inhabited and uninhabited islands with different characteristics, e.g., annual average temperature, soil texture, and island size. In the present study, the wood-rotting fungal communities of three of these inhabited islands, Soyeonpyung-do (SY), Oeyeon-do (OY), and Gageo-do (GG), were investigated. Wood-rotting fungi are very important because of their saprobic activities as decomposers, particularly in the degradation of cellulose and lignin, which are hardly decomposed by bacteria. Therefore, wood-rotting fungi are major recyclers of litter and woody materials (Gilbertson, 1980). Because wood-rotting fungi often grow on logs, stumps, other dead wood, and living trees, their flora is affected by host plant species diversity. In addition, global warming may affect fungal diversity; in Norway, fungal fruiting has been delayed by 12.9 days since 1980 (Kauserud *et al.*, 2008).

The diversity of soil fungi from the same areas of the three islands examined in the present study was previously determined using molecular methods of F-ARISA and clone sequencing (Kim, 2006), and basidiomycetes of major clones were identified as ectomycorrhizal fungi and basidiomycetous yeast. A few wood-rotting fungi, i.e., *Trechispora* sp., *Sistotrema* sp., and *Basidioradulum radula*, were also detected using this cloning approach. Since molecular approaches cannot yet detect all fungal species, it is also necessary to survey fruiting bodies of wood-rotting fungi to supplement molecular approaches.

The geographical features and concise plant flora of each island are shown in Fig. 1. SY is located in the middle of the Korean Peninsula and the majority of its woody vegetation comprises pines, oaks, and deciduous broadleaf shrubs. OY, located in Boryeong-si, Chnungnam Province, has the richest flora of the three islands, with groves of evergreen trees (Natural Monument No. 136), camellias, silver magnolias, and *Celtis sinensis*, as well as deciduous scrub, oaks, and pines. GG is in Sinan-gun, Jeonnam Province, in the south of the Korean Peninsula, and has a more moderate climate than the other islands. Its forest is evergreen, with camellias and silver magnolias, but few pine trees.

Wood-rotting fungi were collected on SY, OY, and GG from October 2004 to November 2005. The collected samples were morphologically identified under a microscope in the laboratory. Samples were then completely dried using a warm dryer, and deposited in the herbarium of Seoul National University Fungus Collection (SFC). The microscopic features of specimens were used for spe-

*Corresponding author <E-mail : youngwlim@korea.kr>

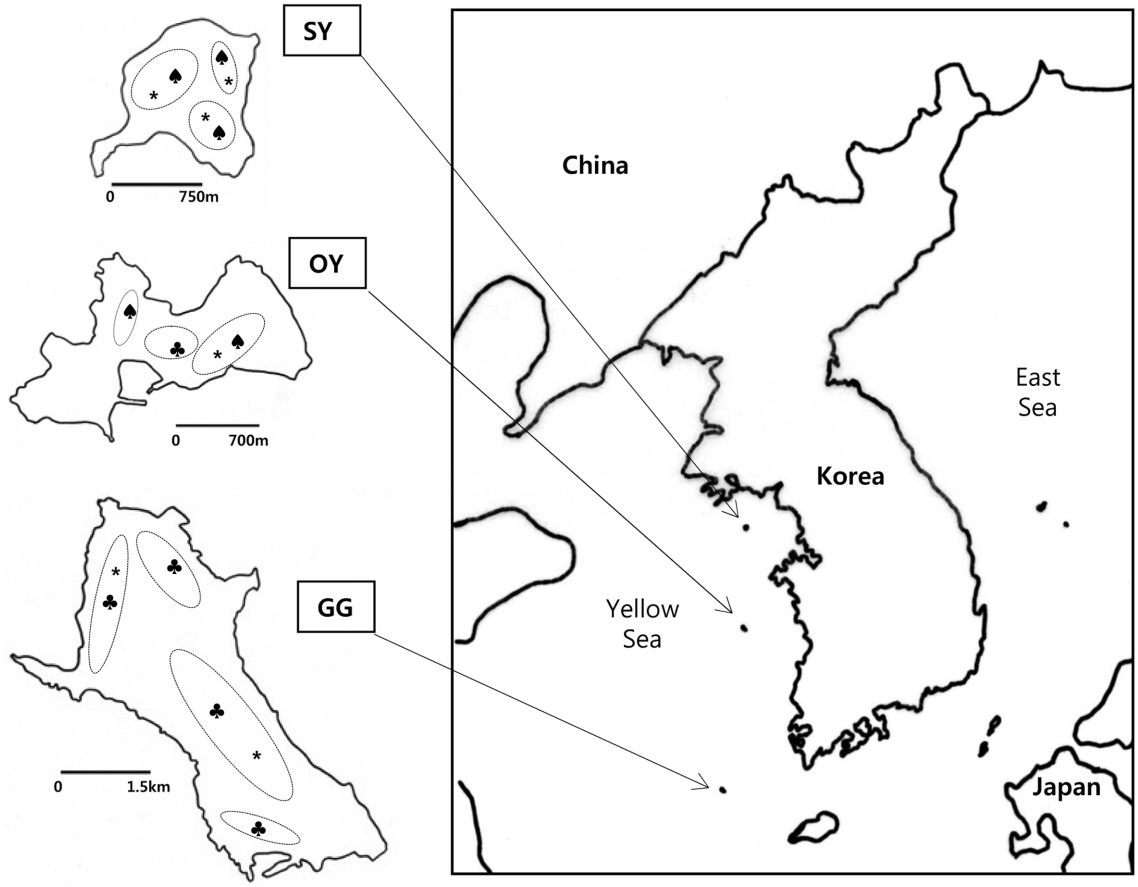

Fig. 1. The maps show the geographical features of three Korean islands in the Yellow Sea. The dotted circles indicate sampling sites in each island and the symbols ♠, *, and ♣ indicate deciduous trees, conifer, and broad-leaved evergreen forest, respectively.

cific identification. The Donkian concept (Donk, 1964) was adopted for general taxonomy of Aphyllophorales. The classification systems of Eriksson (1958), Eriksson and Ryvarden (1973~1976), Eriksson *et al.* (1978~1984), Lim (2001), and Parmasto (1968) were referred to for corticioid fungi. Studies of Gilbertson and Ryvarden (1986, 1987), Ryvarden and Gilbertson (1993, 1994), and Ryvarden and Johansen (1980) were used to identify polypores. Recent classification based on molecular methods was followed (Hibbett *et al.*, 2007; James *et al.*, 2006).

A total of 134 wood-rotting fungi were collected from the three islands: 46 from SY, 44 from OY, and 44 from GG. According to the classification systems used, 67 species in 13 families were identified: 29 species of 22 genera in eight families from SY, 31 species of 26 genera in 11 families from OY, and 34 species of 27 genera in eight

Table 1. The collected specimens from three islands were identified and listed in table

Family	Species	No of collection		
		SY	OY	GG
Auriculariaceae Fr.	*Auricularia auricular* (L.) Underw	1	2	
	Auricularia polytricha (Mont.) Sacc.	2	2	2
	Heterochaete delicata (Klotzsch ex Berk.) Bres.	1		4
Corticiaceae Herter	*Cylindrobasidium evolvens* (Fries) Jülich.		3	
	Haplotrichum conspersum (Link) Hol.-Jech.		1	
	Hyphoderma setigerum (Fries) Donk	1	3	1
	Hyphodontia breviseta (P. Karsten) J. Eriksson	1		
	Peniophora quercin a (Fries) Cooke	1		
	Phanerochaete sordida (P. Karsten) J. Eriksson & Ryvarden	2	1	
	Phlebia chrysocrea (Berkeley & M.A. Curtis) Burdsall		1	1

Table 1. Continued

Family	Species	No of collection		
		SY	OY	GG
	Pulcherricium caeruleum (Lam.) Parmasto		1	
Ganodermataceae Donk	*Ganoderma applanatum* (Persoon) Pat.		2	
	Ganoderma lucidum (Curtis) P. Karsten		1	
Hydnaceae Chevall	*Lopharia cinerascens* (Schweinitz) G. Cunn.	1		
	Lopharia mirabilis (Berk. & Broome) Pat.	1	2	1
	Steccherinum rhois (Schwein.) Hongo & Izawa			3
Hymenochaetaceae	*Cyclomyces tabacinus* (Mont.) Pat.			1
Imazeki & Toki	*Hymenochaete cinnamomea* (Pers.) Bres.	1	1	1
	Hymenochaete intricata (Lloyd) T. Ito		1	
	Hymenochaete rubiginosa (Dicks.) Lév.	1		
	Hymenochaete yasudai Imazeki	1	2	1
	Inonotus xeranticus (Berk.) Imazeki & Aoshima			2
	Phellinus baumii Pilát			1
	Phellinus gilvus (Schweinitz) Patouillard			1
	Phellinus laevigatus (Fr.) Bourdot & Galzin		1	
Marasmiaceae Roze ex Kühner	*Lentinus edodes* (Berk.) Singer			1
	Marasmiellus ramealis (Bull.) Singer			1
Pleurotaceae Kühner	*Pleurotus ostreatus* (Jacq.) P. Kumm		1	
Polyporaceae Corda	*Antrodia albida* (Fr.) Donk		1	
	Antrodia heteromorpha (Fr.) Donk			1
	Bjerkandera adusta (Willd.) P. Karst.			2
	Bjerkandera fumosa (Pers.) P. Karst.		1	
	Ceriporiopsis gilvescens (Bres.) Domañski	1		
	Cerrena consors (Beck) K.S. Ko & H.S. Jung		2	1
	Daedaleopsis confragosa (Bolton) J. Schröter	1		
	Daedaleopsis tricolor (Bulliard) Bondartsev & Singer	2	1	1
	Datronia mollis (Sommerf.) Donk		1	
	Fomes fomentarius (L.) J.J. Kickx		1	
	Fomitella fraxinea (Bull.) Imazeki	1		
	Fomitopsis rosea (Alb. & Schwein.) P. Karst.			1
	Gloeoporus taxicola (Pers.) Gilb. & Ryvarden	1		
	Hemitrichia serpula (Scop.) Rostaf.			1
	Irpex lacteus (Fries) Fries	8		1
	Laetiporus sulphureus (Bull.) Murrill	1		
	Lenzites betulina (L.) Fries			1
	Microporus affinis (Blume & T. Nees) Kuntze			1
	Microporus vernicipes (Berkeley) Imazeki			1
	Oligoporus caesius (Schrader) Gilbertson & Ryvarden		1	
	Polyporus alveolarius (Bosc) Fries			1
	Rigidoporus microporus (Sw.) Overeem	3		
	Schizopora flavipora (Berk. & M.A. Curtis ex Cooke) Ryvarden	2		
	Schizopora paradoxa (Schrader) Donk	2	1	2
	Trametes gibbosa (Pers.) Fries			1
	Trametes hirsuta (Wulfen) Pilát	1		
	Trametes suaveolens (Linnaeus) Fries		1	1
	Trametes versicolor (Linnaeus) Pilát	1	2	1
	Trichaptum abietinum (Persoon) Ryvarden	3	2	
	Tyromyces chioneus (Fr.) P. Karst.	1		
Schizophyllaceae Quélet	*Schizophyllum commune* Fries	2	1	
Stereaceae Pilát	*Stereum gausapatum* (Fries) Fries			1
	Stereum ostrea (Blume & T. Nees) Fries			2
	Stereum subtomentosum Pouzar			1
	Xylobolus frustulatus (Persoon) Boidin			1
Thelephoraceae Chevallier	*Tomentella pilosa* (Burt) Bourdot & Galzin		1	
Mycenaceae Roze	*Panellus stipticus* (Bull.) P. Karst.	1		
Xylariaceae Tul. & C. Tul.	*Daldinia concentric* (Bolton) Ces. & De Not.	1	1	1
	Xylaria polymorpha (Pers.) Grev.		2	

families from GG. The collected and identified wood-rotting fungi are listed in Table 1. Considering the short period of samplings, a high number of wood-rotting fungi were collected, and most belonged to the Agaricomycetes of the Basidiomycota (Hibbett *et al.*, 2007). The majority of fungi were members of the Polyporaceae (23 genera and 30 species), Hymenochaetaceae (four genera and nine species), and Corticiaceae (seven genera and eight species). *Auricularia polytricha*, *Daedaleopsis tricolor*, *Daldinia concentrica*, *Hymenochaete cinnamomea*, *H. yasudai*, *Hyphoderma setigerum*, *Lopharia mirabilis*, *Schizopora paradoxa*, and *Trametes versicolor* were collected from all three islands. Only two taxa, *Daldinia concentrica* and *Xylaria polymorpha*, belonged to the Sordariomycetes, Pezizomycotina, Ascomycota.

Different plant substrates provide important biotic factors that contribute to the diversity of wood-rotting fungi. Although the plant populations at the sampling sites of each island differed slightly, we did not find different wood-decaying fungal floras among the three islands. However, we were able to divide the collected wood-decaying fungi into three categories: i) fairly host specific, ii) host preference, and iii) no host preference. *H. yasudai*, first example, was found on dead branches of pine (*Pinus densiflora*), and *Fomitella fraxinea* occurred on *Robinia pseudoacacia*. *Inonotus xeranticus* and *Phlebia chrysocrea* preferred angiosperm hosts, especially oaks. *Gloeoporus taxicola*, *S. flavipora*, and *Trichaptum abietinum* preferred gymnosperm hosts; therefore, these fungi were commonly detected on SY and OY, but were rare on GG because of the lack of pine trees. *Irpex lacteus* and *T. versicolor* are examples of omnivores that occurred on both woody angiosperms and gymnosperms.

GG, located in the south of the Korean Peninsula, may be the northern distribution limit for subtropical wood-decaying fungi such as *Stereum ostrea*. Found in tropical and subtropical zones, *S. ostrea* is very similar to *S. subtomentosum*, which is distributed in the temperate zone. *S. ostrea* is separated from *S. subtomentosum* by its pseudoacanthohyphidia (Eriksson *et al.*, 1984). *S. ostrea* had been reported in mainland Korea, but Lim and Jung (1999) consider it to be a form of *S. subtomentosum*. Otherwise, *S. ostrea* has been reported in the southern Japan. However, global warming may result in this species spreading further north and to the mainland.

Polyporoid and corticoid wood-rotting fungi have been reported in forests and on various wood products and play an important role in recycling carbon in ecosystems (Kim *et al.*, 2005; Lee *et al.*, 2008; Scheffer *et al.*, 1984). Many are widely distributed throughout the world. The wood-rotting fungi recovered in this study were similar to those found on the mainland and Ullung Island in the East Sea, Korea (Jung, 1991a, b, 1992, 1994, 1995, 1996a, b; Lee *et al.*, 2002, 2004; Lim and Jung, 1999, 2000, 2001). Interestingly, a variety of hymenochaetoid taxa were collected. A clone sequencing approach uncovered a few decay fungi (Kim, 2006), but our survey of fruiting bodies might supplement these molecular data to complete identification of the fungal diversity of the three islands.

Recently we applied a new technique, pyrosequencing, to further characterize the fungal communities at these sites (unpublished data). Analysis of a total of 10,166 sequences revealed that many decay fungi exist in the soil. Four of the decay fungi, *Punctularia strigosozonata*, *Hymenochaete corrugata*, *Gloeoporus taxicola*, and *Stecchierinum fimbriatum*, were among the 20 most common Basidiomycota. Common and frequently collected wood-rotting fungi observed in decayed wood were also detected in soil through pyrosequencing.

In conclusion, we performed the first survey of the wood-rotting fungal flora of three islands in the Yellow Sea. Although species diversity was not high, our fungal survey complements cloning investigations of this fungal community. We will use these results, together with molecular data obtained from cloning and pyrosequencing, to further monitor the effects of climate change on fungal communities.

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