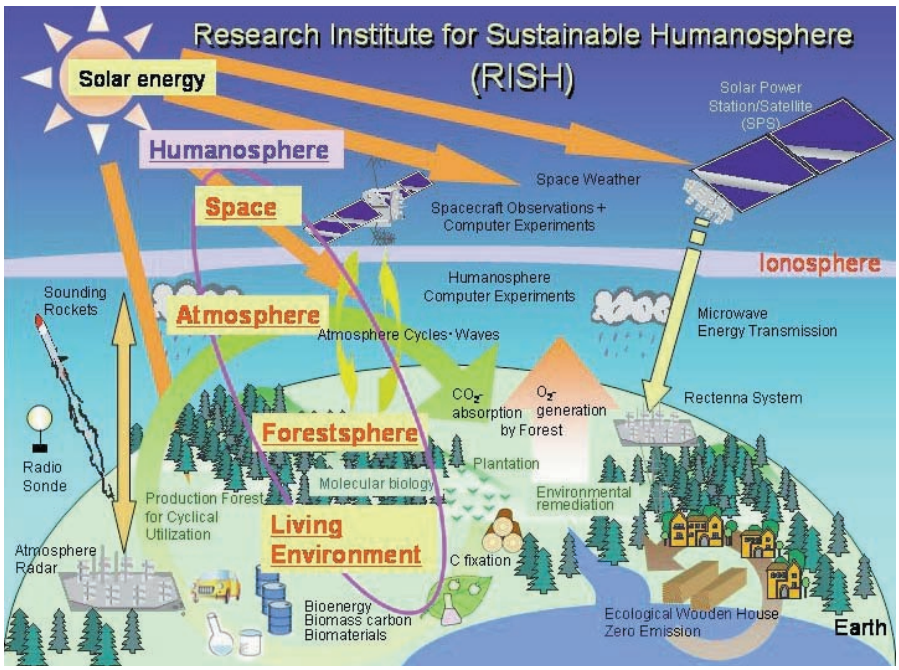
Toward the Realization of a Society Sustained by Clean Solar Energy

Prof. Misato Norimoto
Program Coordinator, WRI, Kyoto University

The Wood Research Institute (WRI) was established in May 1944 with the three research sections of wood physics, wood chemistry and wood biology. Between 1963 and 1984, three more research sections were added: composite wood, lignin chemistry and high performance wood products. In April 1991, WRI was reorganized and expanded into nine research sections and a visiting research section. In addition to the ongoing research, new studies in the fields of gene expression in woody plants and wooden architectural structures were initiated. Thirteen years have now passed since the reorganization, and in that time, research studies in WRI have been performed with the concept of establishing both conservation of the environment and sustainable utilization of wood resources. In the past few years, a plan for the incorporation of Japanese national universities was proposed and refined. After numerous discussions, the law was approved in July 2003. With this as a turning point, both the staff of WRI and the Radio Science Center for Space and Atmosphere (RASC), located at the same Uji campus, WRI had long and intense debates about the consolidation of the two organizations beginning in August 2002. In September 2002, the councils of both WRI and RASC decided to consolidate the two organizations, and then the consolidation was authorized by the council of Kyoto University in June 2003. The new institute was named the Research Institute for Sustainable Humanosphere (RISH). The figure, constructed in collaboration by the combined efforts of all WRI and RASC staff members, shows the outline of RISH. The research fields of WRI cover the zones of forestry and life, while those of RASC cover the zones of atmosphere and space. By connecting respective adjacent zones,



these four zones can be recognized as a humanosphere. Enormous consumption of fossil resources has brought serious negative impacts on the global environment due to the increase in the atmospheric concentration of carbon dioxide, accompanied by a number of pollution problems. By deepening the sciences with which each of the organizations has been concerned and by creating new sciences concerning mutual zones through the organic coupling of both the organizations, RISH is intended to solve serious problems which imperil the existence of mankind in the 21st century. Just at the occasion of the incorporation of the national universities in April 2004, RISH will be officially established and begin research toward the realization of a sustainable industrial society based on clean solar energy instead of a society dependent on the consumption of fossil resources.

International Symposium on Sustainable Utilization of *Acacia mangium*

Dr. Toshiaki Umezawa
WRI, Kyoto University

We have held the International Wood Science Symposium every second year since 1996 and thus the IWSS was not held in FY2003. However, it is important to continue to share up-to-date information among scientists from Japan and Southeast Asian countries. Also, because more than 7 years had already passed since the start of the Core University Program in the Field of Wood Science, it was good time to overview the Core University Program for the past 7 and a half years and determine the future research targets in the field of wood science and technology.

In this context, a special symposium on the sustainable utilization of one of the most important, multi-purpose fast growing tree species, *Acacia mangium*, was held October 21-22, 2003, at Wood Composite Hall, Wood Research Institute, Kyoto University, with the following aims and scopes.

The objective of the symposium was to provide a scientific forum for discussing the latest research progress in the studies of fast growing trees, especially *Acacia mangium*, and more than 20 invited speakers gave presentations related to the many aspects of *Acacia mangium* research and development.

First of all, Prof. Misato Norimoto, the director of WRI and the coordinator of the Core University Program, gave an opening address. Then, Mr. Tsuyoshi Enomoto, the head of Southeast Asian Programme, JSPS, presented an invited lecture. He overviewed the current status and the future of JSPS projects, which was very informative for the members of the core university program.

Conference room

Mr. Tsuyoshi Enomoto (JSPS) giving an opening speech

Following the opening ceremony, 28 invited lectures were given, which were subdivided into the following 7 sessions: Overview of *Acacia mangium, Acacia mangium* wood formation, biotechnology of *Acacia mangium,* pulping of *Acacia* spp., *Acacia mangium* bark utilization, Wood-based materials from *Acacia mangium,* and biological deterioration of *Acacia mangium.*

In the evening of the first day, a banquet was held in the newly-opened cafeteria of the Uji Co-op Building. The party was really enjoyable, and the participants enjoyed the talk and Japanese-Western style cuisine.

At the opening of the 21st century, it is critically important to establish sustainable production and utilization of forest resources. In addition, establishment of basic science and technology dealing with tropical fast growing trees is urgently needed to promote the wood industry of Indonesia and other Southeast Asian countries. In this context, this symposium was timely and useful, and the International Academic Exchange Comittee members really hope that the symposium will promote science and technology in this field, and thus accelerate the establishment of a sustainable humanosphere.

Between the sessions

Satellite spots were connected by SCS

Impression of the International Symposium on Sustainable Utilization of *Acacia mangium*

Dr. Hiroyuki Yano
WRI, Kyoto University

In September of FY2003, I had the privilege of traveling to a huge *Acacia mangium* plantation in the southeastern part of Sumatra, Indonesia, operated by PT. Musi Hutan Persada. There I saw an excellent example of a well, designed and managed *Acacia mangium* plantation of 200,000 hectares. Because of its size, it took four hours to travel from the entrance to a guest house located in the middle of the plantation. On the way to the guest house, piles of acacia logs were seen on both sides of the road waiting for transport to a pulp factory. We met trucks, one after another, carrying logs. In the pulp factory, which we visited next day, *Acacia mangium* logs were continuously fed from huge stock yards into a massive digester which processes 2.4 million tons per annum. The immense scale of the operation was so impressive that I forgot the sweltering tropical heat.

12-year-old Acacia mangium *with a diameter of 48 cm in breast height*

One month later, a special symposium on the sustainable utilization of *Acacia mangium* was held in WRI, Kyoto University. The objective of the symposium was to provide a scientific forum for discussing the latest research progress in various studies relating to fast growing trees, especially *Acacia mangium*. One of the main topics was whether a large-scale *Acacia mangium* plantation could be a key strategy for establishing a sustainable society by fixing carbon dioxide in harmony with the global environment and with the local people community.

In this symposium, I reported on the utilization of bark, which accounts for 5 to 8% of 10-year-old Acacia trees. This was one of the fruits of our project, "Total utilization of *Acacia mangium*", supported by the JSPS-LIPI core university program. The bark of *Acacia mangium* contains more than 50% tannin, which can be converted into high-quality waterproof wood adhesives. However, most of the *Acacia mangium* bark is not presently being used effectively, and is in fact disposed of. We presented a new idea for collecting tannin-rich bark powder by a mechanical process, a type of mechanical condensation, and demonstrated that the tannin-rich bark powder could be converted directly into a waterproof adhesive by mixing with formaldehyde.

The symposium covering wood formation, biotechnology, pulping, bark utilization, wood-based materials and biological deterioration of wood was extremely beneficial for me by extending my knowledge of *Acacia mangium*, its properties and utilization. Furthermore, the symposium gave me an opportunity to converse with many scientists having different viewpoints and expertise in *Acacia mangium* plantation operation. Topics such as diversity of species, risks of monoculture for huge-scale plantations, and social relationships with the local people on the plantation were amongst those discussed. As a direct result of the very successful symposium, Prof. Kawai (WRI, Kyoto University) and I recognized the importance of a broad and inclusive approach to *Acacia mangium* plantation development and operation based on carbon circulation, which involves the atmosphere above the plantation, the plantation itself and utilization of the plantation wood. We started a new project with Prof. Shiotani, Radio Science Center for Space and Atmosphere, Kyoto University, in co-operation with other scientists with different backgrounds, for example forest soil science, LCA for biomass and tropical forest science.

Acacia *Plantation in Sumatra (PT. Musi Hutan Persada)*

= Reseach Project No. 17 =

Anatomical Characteristics and Wood Quality of Tropical Plantation Trees for Quality Timbers-Towards the Promotion of Indigenous Tree Plantation-

Prof. Tadashi Nobuchi
Graduate School of Agriculture, Kyoto University

Deforestation in tropical areas has been a serious problem in the past few decades. In Southeast Asia the plantation of fast growing tree species has been encouraged since the 1980s. For example, *Acacia mangium, Eucalyptus deglupta* and *Paraserianthes falcataria* are the main species in tropical rain forest areas. In tropical seasonal forest areas with severe dry seasons such as Thailand, *Eucalyptus camaldulensis* has been preferred for the plantation.

Most of the fast growing trees are categorized as exotic species as shown by the example of *A. mangium,* which is indigenous to northeast Queensland (Australia), Papua New Guinea and the western part of Indonesia. These species have high potential for both afforestation and wood utilization. They also, however, have risks because of the exotic species covering a wide area in monoculture.

In *A. mangium* heart rot has been reported in some areas, while in teak and mahogany insect pests and diseases have been the serious problems. We still do not know what factors accelerate the occurrence of pests and diseases. From an ecological view point, however, monoculture is a matter to be reconsidered because the reduction of species diversity or genetic diversity produces conditions favorable for the development and spread of disease pathogen and insects.

From the wood utilization view point, fast growing trees have rather limited end uses although many efforts have been made to develop the possibilities of wide range of utilization.

Based on the above background, we launched a project in 2001 aimed at the promotion of indigenous tree species plantation. Two sites, Indonesia and Malaysia, were selected for our research.

1. Indonesia

In collaboration with the Faculty of Forestry, Bogor Agricultural University (Dr. Imam Wahyudi, Mr. I Ketut N. Pandid), an *Agathis loranthifolia* (*A. dammara*) plantation site in Gunung Walat was selected for the research.

Agathis is a conifer species distributed in tropical Asia. It is widely utilized as a high quality timber for such applications as furniture and flooring. The recovery ratio in sawmills and wood industries, however, is not always high because it sometimes includes compression wood. For the promotion of plantation for timber production of *Agathis*, it is important to study the relationship between tree growth conditions and the formation of compression wood. This is the main purpose of the collaborative research in Indonesia.

Felling of Agathis *and collection of wood disks at Gunung Walat (West Java, Indonesia)*

Field survey of the plantation stand of Dryobalanops lanceolate *(Sabah, Malaysia)*

2. Malaysia

The Faculty of Forestry, Universiti Putra Malaysia, joined the JSPS Core University Programme as a new member and has been collaborating in our project (Dr. Mohd. Hamam Sahri, Dr. Zaidon Ashaari).

We fortunately could use the plantation stand of *Dryobalanops lanceolata* in Sandakan, Sabah under the cooperation with the Forest Research Center. This species belongs to the Family Dipterocarpaceae, one of the major groups of tropical forest in Southeast Asia.

We have been conducting research on the seasonal characteristics of wood formation. The relationship between anatomical characteristics and wood quality has also been investigated.

As mentioned above, we have just started limited field investigations and experiments for the promotion of the plantation of indigenous tree species. Last December the author had the opportunity to visit the site of the "Multi-Storied Forest Management Project in Malaysia" under the Perak Forestry Department. In this project a single-storied forest of *Acacia mangium* was changed to a multi-storied forest with the combination of, for example, trees belonging to Dipterocarpaceae. These indigenous tree species, such as *Shorea leprosula, S. parvifolia, S. ovalis,* and *Hopea odorata,* showed a considerably good growth rate between the line plantings of *A. mangium*. It indicates high potential for the future plantation of Dipterocarpaceae. In future activities we intend to learn many things from this kind of plantation.

= Reseach Project No. 19 =

Development of Structural LVL from Tropical Wood and Evaluation of Performance as the Strucutural Components of Wooden House

Mr. Yakni Idris
Civil Engineering Department,
Sriwijaya University, Indonesia

I feel very fortunate that, for the second year in a row, I was invited to visit Japan to participate in the Scientist Exchange JSPS-Core University Program in the Field of Wood Science from January 14 to February 2, 2004. I was involved in an international collaborative research project under the JSPS Core University Program, which includes Japan, Indonesia and Malaysia. This collaborative research project was entitled Development of Structural LVL from Tropical Wood and Evaluation of Performance as the Structural Components of Wooden House.

The research was aimed at determining the fundamental properties of structural LVL produced from selected tropical timber, and evaluating the performance of structural components of a wooden house made of these LVL. The members of the collaborative research team from the Japanese side were Prof. Kohei Komatsu (Kyoto University), Dr. Shinjiro Takino (Kyoto University) and Dr. Takuro Mori (Kyoto University). There were 4 members from the Indonesian side: Bambang Subyanto (LIPI), Yakni Idris (Sriwijaya University), Sutadji Yuwasdiki (Res. Inst. of Human Settlements Technology), and Anita Firmanti (Res. Inst. of Human Settlements Technology).

Assembly of LVL truss members

LVL truss loading test and members of the collaborative research team

In January 2003, the first research project was conducted to evaluate the performance of Indonesian LVL, which were supplied by PT.PSUT in Jambi. Basic mechanical properties of LVL were tested. Three trusses, composed of Indonesian LVL joined together with bolts, were fabricated and static loading tests were performed until the trusses failed. Embedment tests, bolted joints tests, and bamboo dowel joints tests were also performed.

In-plane shear test of LVB panels

This year, the second research project was conducted to evaluate the performance of in-plane shear panels of LVB (Laminated Veneer Board) nailed to wood frame floor systems. Nine specimens were used in this project. The specimens were supplied by Uni-Wood Corporation in Osaka. LVB used in the specimens were produced from 3 timber species: Larch, Radiata Pine, and Falcata combined with rubber wood. It was a great pleasure that Mr. Kuniharu Yokoo from Uni-Wood Corporation was also participating in the project as a cooperative researcher.

Participating in these two research projects provided me with unique scientific experiences with advanced equipment, unlimited research resources, a well-equipped laboratory and facilities, and rich technical guidance and assistance, especially from Prof. Kohei Komatsu. The spirit of teamwork of the members of the Laboratory of Structural Function, Dr. Shinjiro Takino and Dr. Takuro Mori, was also invaluable and greatly appreciated.

= Reseach Project No. 21 =

Investigation of Physiologically Active Substances from Medicinal Plants and Fancy Woods in Indonesia

Prof. Koichi Ogiyama
Faculty of Agriculture, Yamagata University

Life forms in tropical forests, particularly plants, produce many chemically strange compounds as extracts, indicating significant biological activities. Most of these are so-called phytoalexins, which are exuded from plants and strongly affect to the survival of surrounding life forms such as insects, fungi, plants and finally, mankind, too. Plant extractives exhibit dual properties in relation to human needs. They have been widely used for medicinal purposes, and at the same time, it has been shown that through prolonged contact, extractives from certain industrial and fancy woods bring about allergic effects in humans (Hausen 1981). Chemical characterization and development of the utilization of those compounds are our main purposes in this project. We may find some novel drugs, just as Asprin was conducted from willow bark extracts. Furthermore, these plants and their extracts may be effective for bio-remediation or bio-restoration of deteriorated environments.

In this research project, detection of the physiological activities has been carried out on levels of enzymes by tyrosinase inhibitor activity and by brine shrimp lethality bioassay.

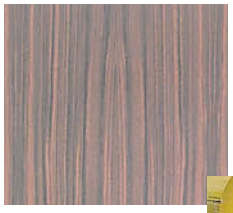
The methanol extractives from different parts of 23 species of wood and medicinal plants collected from east Kalimantan in Indonesia were examined for potential tyrosinase inhibitor compound. These were: *Artocarpus elastics, Terminalia catappa, Anthocephalus chinensis, Gmelina arborea, Eusyderoxylon zwageri, Santttalum album, Peronema canescen, Duabango moluccana, Dyera costulata, Xylocarpus granatum, Aleurites moluccana, Endospermum malabathricum, Kademba, Alstonia scholaris, Acacia mangium, Hybiscus thyliasis, Shorea balangeran, Aquilaria malaccensis, Castanopsis javanica, Pterocarpus indicus, Rambai sungai, Kleinhovia hospital, Piper bettle.*

In the tyrosinase assays of these extracts, the methanolic extract from *Artocarpus elasticus* showed the strongest activity.

In addition, various extracts of 4 fancy woods and 2 industrial woods are being characterized. The former included *Artocharpus heterophylus* (Jackfruit), *Dalbergia latifolia* (Rosewood), *Dyospyros celebica* (Ebony), and *Manilkara kaukii* (Sawo wood), and the latter were *Acacia mangium* and *Acacia auriculiformis.* All woods were collected from Indonesia. The brine shrimp lethality test (BST) adopted by the Ministry of Agriculture, Forestry and Fisheries of Japan was applied for the bioassay of phytoalexins. The methanol extract of *Dalbergia latifolia* was found to be extremely lethal in comparison to that of the methanol extract of *Acacia auriculiformis*. The *n*-hexane and ethyl acetate extracts of *Artocarpus heterophyllus* seem to be relatively very lethal. These findings confirm the high durability of the fancy wood species and suggest the potential for developing agrochemicals or drngs friendly to the natural environment.

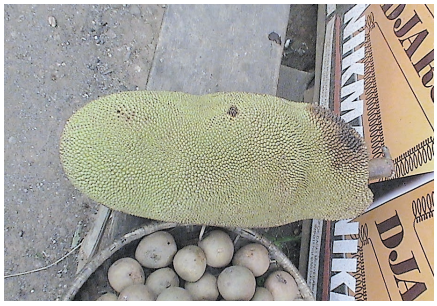
We are now chemically investigating the active substances of the extractives. Further investigations will also be conducted with samples collected in Indonesia in 2004.

We wish to express our sincere thanks to everyone related to this research project and particularly Prof. Sri Nugroho Marsoem (GM Univ.) for his kind cooperative works. Thank you very much !



Left: Dyospyros celebica *(Ebony)*

Right: Manilkara fruits

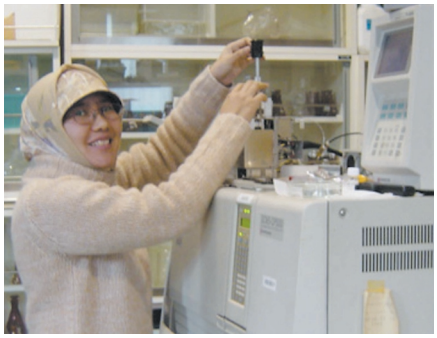


Artocharpus heterophylus *(Jackfruit)*

= Student from Indonesia =

My research activities at WRI as a PhD student

Ms. Ragil Widyorini
Faculty of Forestry, Gadjah Mada University



Since October 2001, I have been working at the Laboratory of Wood Composite, WRI as a PhD student supported by Japan Bank of International Cooperation (JBIC) Loan. As a lecturer in the Forestry Faculty, Gadjah Mada University, Yogyakarta, Indonesia, I am working at the Laboratory of Wood Composite and Adhesive, Forest Product Technology Department.

In order to support the national academic program, the Directorate General of Higher Education (DGHE) Indonesia has implemented a program for Gadjah Mada University (GMU), namely the Implementation Program of Gadjah Mada University Development Project from 1999-2005. By obtaining funding from JBIC, this project focused on strengthening the agricultural and medical education, including that in the Faculty of Forestry. This program aims to improve the quality and increase the supply of professional and research-oriented human resources to meet the requirements of national development. Therefore, with this project, GMU not only aims to increase its laboratory facilities and buildings, but a proportion of the loan is also devoted to enhancing the teaching staff of GMU by sending young lecturers to foreign institutes (Japan) for higher degrees.

Under supervised by Prof. Shuichi Kawai, our research was focused on characterization of the bonding of non-wood lignocelluloce. The effective utilization of fast growing non-wood lignocellulosic materials and agro-wastes has been of great interest, as wood resources are becoming scarce. The search for alternative adhesives has been global, and efforts have been made to develop binderless board by steam explosion, hot pressing treatment and steam injection pressing. The differences in raw materials and manufacturing processes also affects the bonding performance of binderless board.

Our research first concerned kenaf core, which had shown relatively high bonding performance compared than other binderless board. We investigated the degradation of chemical components in kenaf core binderless particleboard and its effect on the bonding performance and dimensional stability of the boards. We also have been searching for the presence and possible effects of phenolic acids in the self-bonding generation of binderless board. During some parts of this research, I also have been working at the Laboratory of Biomass Conversion, under the supervision of Prof. Takashi Watanabe. The second part of our research was focused on the bonding characteristics of other prospective materials for binderless board, such as baggase core.

The WRI has given me unlimited support including chemicals and literature supply to carry out my research. I also had the opportunity to attend and present papers in some international/national conferences. In addition, the professors and other members of the WRI, especially the Laboratory of Wood Composite and the Laboratory of Structural Function continually helped me by giving scientific advice, valuable comments, and untiring support in my research work and also in my daily activities.

Another interesting aspect is that I have had chances to take part in cultural activities, such as Japanese traditional events, and have given performances of traditional Indonesian music together with other Indonesian students.

(from page 8)

also for Japan, as it is possible to use the fungal strain in environmental applications, while the mechanism of enzyme catalysis is being studied at the Laboratory Biomass Conversion. Identifying novel characteristics and enzyme properties are our main purposes.

I was impressed in doing research at WRI by the warm atmosphere among all students, researchers and other members. Advanced instrumental facilities and skillful advice from Prof. Takashi Watanabe and Assoc. Prof. Yoichi Honda are also important factors in helping the cooperative research move forward. The teamwork research system is the clear answer to why the development of science and technology in Japan has become the best in Asia. All my experiences have been very helpful to my teaching and research work in Thailand.

As suggested previously, research in wood science and related fields in Thailand still needs to be developed. Along with our previous experiences in the NRCT-JSPS Core University Program, collaborative research in the field of wood science is valuable as an alternative way to strengthen both the standard level of science and technology and the relationship between Japan and other countries, especially a developing country as Thailand. This will led to the sustainable development of science and technology of the developing countries and ultimately will be helpful in globalizing society.

= Letter from Thailand =

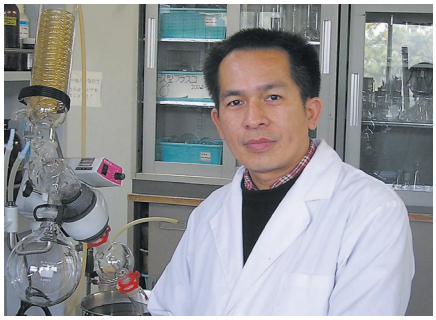
Wood Science Research in Thailand and Collaborative Research with WRI, Kyoto University

Dr. Chartchai Khanongnuch
Faculty of Agro-industry, Chiang Mai University, Thailand

After graduation from Hokkaido University I returned to Thailand and started working as a lecturer in the Biotechnology Department, Faculty of Agro-industry, Chiang Mai University, located in Chiang Mai city, the center of northern Thailand.

Regarding recent wood research, Thailand has a long history in wood utilization, but most research on wood science is still focused on forest plantation and management, as well as solving problems caused by high consumption of wood for housing and furniture production, leading to the critical decrease of forest area in the country. However, some government-supported institutes such as the Faculty of Forestry, Kasetsart University and Asian Institute of Technology (AIT), are conducting research in pulp and paper technology. Many research laboratories are also developing pulp and paper operations using Bamboo and Mulberry. Currently, research and utilization of rubber wood is one target for the country as rubber wood is recognized to be a utilizable by-product of rubber production. Furthermore, research on wood composites and wood biomass utilization technologies is also being conducted.

Since 2000, the bilateral scientific exchange program on thermotolerant microbial resources has been funded and supported by the Japanese Society for Promotion of Science (JSPS) and National Research Council of Thailand (NRCT), with Yamaguchi University and Kasetsart University as representative Japanese and Thai universities, respectively. This program provided me the chance to collaborate with Prof. Takashi Watanabe, WRI, as the head research counterpart in Japan.



The author at work in the Laboratory of Biomass Conversion, WRI

We started to collect the fruit body of wood rotting fungi from the tropical forest in northern Thailand and tried to isolate the fungal mycelium. Under the skillful guidance and suggestions of Prof. Takashi Watanabe via internet communication, various fungal strains from the Chiang Mai and Chiang Rai areas were isolated and some of those fungal strains exhibited high potential for utilization in many fields. One of these fungal isolates was a wood rotting fungus named RC3, a very interesting fungal strain later identified as *Coriolus versicolor*. It is capable of growth at 42℃, unlike general basidiomycete fungi, and both my students at Chiang Mai University and the graduate students in the Laboratory of Biomass Conversion, WRI, are seeking the exploitable properties of this strain.

So far, purification of thermostable laccase, one kind of lignin modifying enzyme, has succeeded, and molecular cloning of the gene encoding this enzyme is the next target of our research. Furthermore, the immobilized fungal cell on foam exhibited excellent performance in decolorization of azo dye (Orange II) in a packed-bed bioreactor system. Extensive research in the practical scale treatment of wastewater from a batik and textile industrial factory in Chiang Mai is in progress. The strain was found to grow well on various kinds of wood meal substrates without addition of any nutrients, suggesting it maybe useful in conversion of wood biomass to higher value compounds such as lignocellulolytic enzymes. At WRI, the utilization of crude laccase produced from *C. versicolor* RC3 was investigated in pretreatment of wood meal hydrolysate before ethanol fermentation by *Pichia stipitis*. The pretreatment with the fungal laccase increased ethanol yield approximately 4 times higher than that obtained with commercial laccase (Daiwa, Japan). We still expect to find other unique properties of the thermostable enzyme from strain RC3, leading to broader applications.

Chiang Mai is surrounded by mountains and forests

All the studies I am involved in are beneficial for both my own country and

(continues to page 7)

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