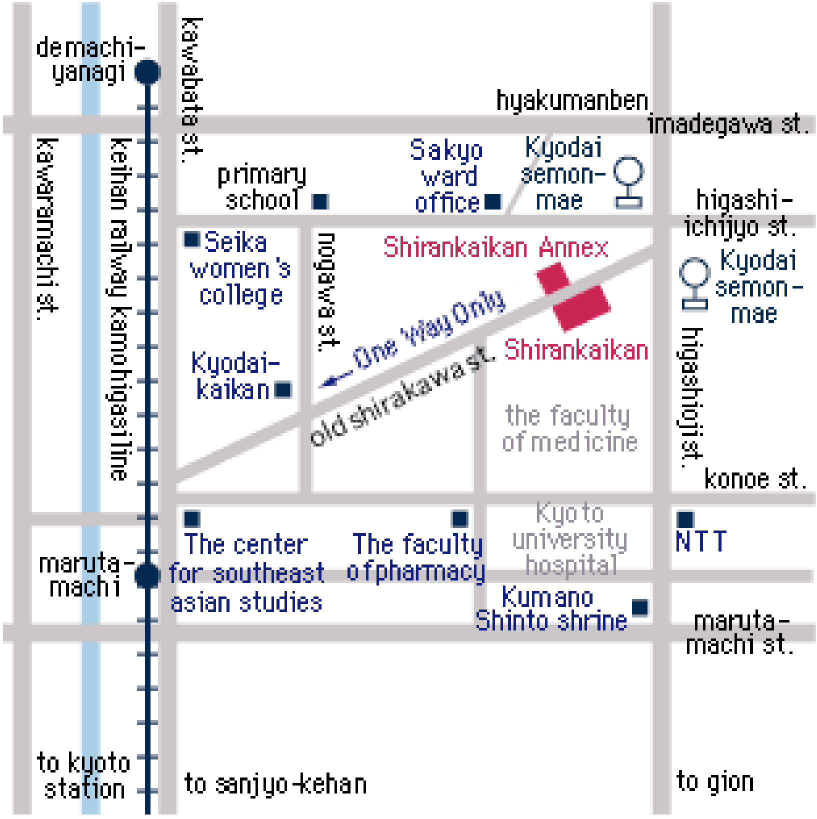
General Information

Venue

Shiran Kaikan Annex
Address: 11-1, Yoshida-Ushinomiya, Sakyo, Kyoto 606-8302, JAPAN
Phone: 075-771-0958



Social Events

Friday. 26th October. 18:30-21:00 Banquet
Saturday. 27th October. 9:00 – 18:00 Excursion

Group Photo

Group photograph will be taken on Thursday, 25th October, soon after the academy lecture at the entrance of the venue.

Dress

For banquet, smart casual dress will be recommended.

Name Badges

The badge is necessary for admission to all scientific and social events. Please wear your badge at all times during the conference.

Registration Desk

The registration desk is open at the first floor of the conference venue. It is open from 12:00 to 17:00 on Thursday, 25th October, and from 9:30 to 17:00 on Friday, 26th October.

Any Problems and Questions

If you have any problems, or if you need any help, please visit the registration desk and contact the member of organizing committee.

Oral Presentation

Organizing committee prepare the PC projector in the meeting room. The speakers are requested to bring your own computer for the oral presentation. The committee will prepare the windows machines with Windows XP and Vista for the convenience of speakers. The speakers who are not able to bring their own computer should record the file on a CD or a flash memory. The speakers, who wish to present their papers by a slide projector or a transparency, are asked to contact us.

Excursion

Excursion is held on Saturday, 27th October. We will visit **Higashi Honganji Temple** (a famous Buddhist temple in Kyoto), **Suntory** (a famous whisky distillery in Japan) and **Kitayama** (traditional log production in Kyoto).

Organizing committee

Fumiaki NAKATSUBO (Chairman, Kyoto University), Minoru FUJITA (Kyoto University), Akira ISOGAI (The University of Tokyo), Shu-ichi KAWAI (Kyoto University), Keiji TAKABE (Kyoto University), Toshiaki UMEZAWA (Kyoto University)

Local organizing committee

Tatsuya AWANO (Kyoto University), Takefumi HATTORI (Kyoto University), Hiroshi KAMITAKAHARA (Kyoto University), Yoshimasa KISHIMOTO (Kyoto University), Toshiyuki TAKANO (Kyoto University), Kenji UMEMURA (Kyoto University), Arata YOSHINAGA (Kyoto University)

IAWS 2007 Schedule

25-Oct

		Chairperson	Speaker	
12:00-13:30	Registration			
13:30-13:40	Opening ceremony	Keiji Takabe	Xavier M. Deglise	Message from IAWS
13:40-13:45	Welcome address		Fumiaki Nakatsubo	Welcome to IAWS2007 held in Kyoto
13:45-14:55	Academy lecture	Xavier M. Deglise	Kazumi Fukazawa	Histochemical studies in wood
14:55-15:00	Group photo			
15:00-15:30	Coffee break			
15:30-15:50	Presentation	Ryo Funada	Sri Nugroho Marsoem	Properties of Sukun Wood (*Artocarpus communis* FORST) Grown in Community Forest in Yogyakarta
15:50-16:10			Uwe Schmitt	Mechanical stress may cause structural and chemical alterrations in walls of wood xylem cells
16:10-16:30			Robert Evans	Informatics, Wood Science and SilviScan
16:30-16:50		Keiji Takabe	Noritsugu Terashima	Ultrastructural Assembly of Lignin and Polysaccharides in Ginkgo Wood Cell Walls
16:50-17:10			Hiroyuki Yamamoto	Characterization of physical properties of gelatinous layer in tension wood fiber

26-Oct

10:00-10:20	Presentation	Toshiaki Umezawa	Junji Sugiyama	Wood collections link science and culture
10:20-10:40			Iris Bremaud	A database relating physical and cultural aspects of the uses of woody species' diversity in musical instruments of the world
10:40-11:00			Takashi Watanabe	Production of biofuels from wood biomass using white rot fungi and thermochemical
11:00-11:20			Thomas W. Jeffries	Biorefining wood into fuels and fibers
11:20-11:40		Junji Sugiyama	Vincent Bulone	Understanding cellulose biosynthesis in plants: challenges and solutions
11:40-12:00			Tuula T. Teeri	Cellulose biotechnology -to break or to refine?
12:00-13:30	Lunch			
13:30-13:50	Presentation	Fumiaki Nakatsubo	Akira Isogai	Cellulose nanofibers prepared by TEMPO-mediated oxidation of native cellulose
13:50-14:10			Hiroyuki Yano	Composites reinforced by cellulose nanofibers
14:10-14:30		Shu-ichi Kawai	Nobuaki Hattori	Life Cycle Assessment in Japanese Wood Industry
14:30-14:50			Shigehiko Suzuki	Wood-based material in Japan
14:50-15:10			Masahiro Sakamoto	Molecular Biology of Bamboos -What regulates bamboo shoot elongation ?-
15:10-15:30			Christopher Risbrudt	Overview of Forest Products Laboratory Research Programs and Opportunities for International Collaboration
15:30-16:00	Coffee break			
16:00-17:30	Business meeting	Xavier M. Deglise		
18:30-20:30	Banquet	Toshiyuki Takano		
20:30-20:40	Summaries		Shu-ichi Kawai	Summaries of IAWS2007 Annual Meeting
20:40-20:50	Closing ceremony		Xavier M. Deglise	Message from IAWS

DETAILED PROGRAM

THURSDAY, OCTOBER 25

12:00-13:00 **Registration**

13:30-13:40 **Opening Ceremony** Message from IAWS

Xavier M. Deglise, University Henri Poincaré, France

13:40-13:45 **Welcome address**

Fumiaki Nakatsubo, Kyoto University, Japan

Academy lecture

Chair: Xavier M. Deglise

13:45-14:55 Histochemical studies in wood

Kazumi Fukazawa, Hokkaido University, Japan

14:55-15:00 Group photo

15:00-15:30 Coffee break

Presentation

Chair: Ryo Funada

15:30-15:50 Properties of Sukun Wood (Artocarphus communis FORST) Grown in Community Forest in Yogyakarta

Sri Nugroho Marsoem, Gadjah Mada University, Indonesia

15:50-16:10 Mechanical stress may cause structural and chemical alterrations in walls of wood xylem cells

Uwe Schmitt, BFH, Germany

16:10-16:30 Informatics, Wood Science and SilviScan

Robert Evans, Ensis / CSIRO, Australia

Chair: Keiji Takabe

16:30-16:50 Ultrastructural Assembly of Lignin and Polysaccharides in Ginkgo Wood Cell Walls

Noritsugu Terashima, Nagoya University, Japan

16:50-17:10 Characterization of physical properties of gelatinous layer in tension wood fiber

Hiroyuki Yamamoto, Nagoya University, Japan

FRIDAY, OCTOBER 26

Presentation

Chair: Toshiaki Umezawa

10:00-10:20 Wood collections link science and culture
Junji Sugiyama, Kyoto University, Japan

10:20-10:40 A database relating physical and cultural aspects of the uses of woody species' diversity in musical instruments of the world
Iris Bremaud, Kyoto Prefectural University, Japan

10:40-11:00 Production of biofuels from wood biomass using white rot fungi and thermochemical pretreatments
Takashi Watanabe, Kyoto University, Japan

11:00-11:20 Biorefining wood into fuels and fibers
Thomas W. Jeffries, U.S. Forest Products Laboratory, USA

Chair: Junji Sugiyama

11:20-11:40 Understanding cellulose biosynthesis in plants: challenges and solutions
Vincent Bulone, Royal Institute of Technology, Sweden

11:40-12:00 Cellulose biotechnology -to break or to refine?
Tuula T. Teeri, Royal Institute of Technology, Sweden

12:00-13:30 Lunch break

Presentation

Chair: Fumiaki Nakatsubo

13:30-13:50 Cellulose nanofibers prepared by TEMPO-mediated oxidation of native cellulose
Akira Isogai, The University of Tokyo, Japan

13:50-14:10 Composites reinforced by cellulose nanofibers
Hiroyuki Yano, Kyoto University, Japan

Chair: Shu-ichi Kawai

14:10-14:30 Life Cycle Assessment in Japanese Wood Industry
Nobuaki Hattori, Tokyo University of Agriculture and Technology, Japan

14:30-14:50 Wood-based material in Japan
Shigehiko Suzuki, Shizuoka University, Japan

14:50-15:10 Molecular Biology of Bamboos -What regulates bamboo shoot elongation ?-
Masahiro Sakamoto, Kyoto University, Japan

15:10-15:30 Overview of Forest Products Laboratory Research Programs and Opportunities for International Collaboration
Christopher Risbrudt, U.S. Forest Products Laboratory, USA

15:30-16:00 Coffee break

16:00-17:30 Business meeting of IAWS

18:30-20:30 **Banquet**

20:30-20:40 **Summaries** Summaries of IAWS2007 Annual Meeting
Shu-ichi Kawai, Kyoto University, Japan

20:40-20:50 **Closing ceremony** Message from IAWS
Xavier M. Deglise, University Henri Poincaré, France

SATURDAY, OCTOBER 27

9:00-17:30 **EXCURSION**

Histochemical studies in wood

Kazumi Fukazawa, Dr

Emeritus Professor of Hokkaido University, Sapporo, Japan

Qualitative and quantitative chemical analysis of wood microscopic specimen allow for a wide consideration on wood research such as wood formation, wood deterioration, chemical constituents, wood identification and others. Wood has a big variation in its structure and chemical components among tree species. Basically such diversity originates from plant evolution and differentiation for their survival. Therefore, wide knowledge on structural and chemical diversity of wood is useful for efficient wood utilization and research on the dynamic change of cells will be related to genetic improvement in future toward sustainable society.

Histochemistry or cytochemistry had been proceeding rapidly from their original qualitative analysis through the use of chemical specific stain reagents toward quantitative analysis. Therefore, the special microscopes are developing step by step with the technical change of times. Progress in microspectrophotometry concerning with the author's research will be reviewed, showing many photographs. Studies on the mechanism of heartwood formation, wood development such as deposition of cell wall components, cell wall deteriorations by fungi, diversity of lignin distribution and others will be introduced in this lecture. Though full course of study was not half run in my times, mysterious photographs of wood structure will lead us to the world of technical thrill, which might be performing by young scientists.

A biographical sketch of the lecturer

Dr. Kazumi Fukazawa, Emeritus Professor of Hokkaido University, graduated from the Department of Forest Products, Hokkaido University in 1953 and then started his long career in wood anatomy at Gifu University. He received his Doctorate, based on studies in variation of wood quality in *Cryptomeria japonica*, from Hokkaido University in 1967. He later visited McGill University, Montreal, to work for one year with Dr. D.A.I. Goring in 1980-1981. After various positions at Gifu University and Hokkaido University, he was appointed full Professor at Hokkaido University in 1984. In the same year he was elected a Fellow of the Academy (IAWS) and served it as Academy Lecture Committee Member from 1987-1990, and as Board Member from 1992-1995. He was elected also IAWA (International Association of Wood Anatomists) Council Member four times for the periods from 1985-1991 and 1994-2000, and elected an Honorary Member of IAWA in 2002. He educated many students and young scientists in Japan and other countries, was a Visiting professor at Yunnan Agricultural University and Southwestern Forest College in China, and lectured on wood anatomy in Korea. Many of his students are now in important positions in the field of wood science.

In 1995 he retired from Hokkaido University. The last two years he was very busy as Dean of the Bureau of Student Affairs. He is still active after his retirement and has always participated in the International Conferences in Wood Anatomy.

Professor Kazumi Fukazawa has published numerous papers on a wide range of topics in wood anatomy and wood science. His main research focus has been on juvenile wood, heartwood formation, cell wall structure, formation of reaction wood, water distribution in trees, and tree-ring analysis. He has been particularly interested in the histochemistry of lignin, and the heterogeneity of qualitative or quantitative distribution of lignin in the cell wall. He is one of the pioneers who introduced modern methods of microscopy, such as micro-spectrophotometry, into wood anatomy.

Professor Fukazawa belongs to the first generation of Japanese wood anatomists who introduced Japanese research all over the world. When the first attended the International Conference in Wood Anatomy in Amsterdam in 1979, he was the only participant from Japan. Since then, he has greatly contributed to increase the numbers of IAWA members from Asian countries including Japan. (Mainly from the description by Ryo Funada; IAWA Journal, Vol. 23(4), 2002)

Properties of Sukun Wood (*Artocarpus communis* FORST) Grown in Community Forest in Yogyakarta

Sri Nugroho Marsoem* and Harry Feryanto

**Faculty of Forestry, Gadjah Mada University*

Sukun (*Artocarpus communis* FORST) also known as bread fruit tree is a multipurpose tree. The tree is able to grow in many type of soil and is mostly grown for the production of the fruit while the wood from the unproductive trees were usually used for fuelwood.

In an effort to increase the added value of sukun trees grown in community forest, a study on the properties of the wood was conducted by using three sukun trees grown on Karangmojo village, Bantul regency, Yogyakarta

Samples for the study were taken from pith to bark in the North direction of the stem. Physical, mechanical, fiber dimensions as well as its structure were then observed. The properties observed were analyzed by analysis of variance using a factorial experiment in Randomized Complete Block Design.

The result shows that the wood composed of fiber of only 37.91%, while its rays, parenchyma, and vessel are 26.60%, 23.85% and 11.61% respectively. A condition seems to make its green specific gravity (SG) of only 0.27. The wood has green moisture content (MC) of 147.19%. The wood has a rather low total longitudinal shrinkage of 0.282% but a rather high T/R shrinkage ratio. A low SG has also been expressed on its MOR of 338.28 kg/cm^2 and of MOE of 39.12 x 10^3 kg/cm^2. It is interesting to note that the wood has a rather long average fiber length that is 1,65 mm and of fiber diameter of 42,48 μm, lumen diameter of 37,28 μm and cell-wall thickness of 2,60 μm. The wood composed of fiber of only 37.91%, while its rays, parenchyma, and vessel are 26,60%, 23,85% and 11,61% respectively.

Key words: Sukun, bread fruit tree, physical and mechanical properties, fiber dimensions.

Mechanical stress may cause structural and chemical alterations in walls of wood xylem cells

Uwe Schmitt, Claus Frankenstein & Gerald Koch

Federal Research Centre for Forestry and Forest Products
Institute for Wood Biology and Wood Protection
Leuschnerstr. 91, 21031 Hamburg, Germany

Cell walls in woody tissues affected by mechanical stress often display structural and chemical modifications. Electron microscopy and UV-microspectrophotometry were used to study modifications in the secondary xylem caused by wounding and exposure to extreme wind. Wounding of hardwoods initiates wall modifications in already differentiated as well as differentiating xylem. Modifications include atypical wall architecture, increase in lignin content, and partial incorporation of phenolic compounds. In spruce trees, exposure to extreme wind often leads to the formation of so called “Wulstholz” on the compression side of bent trees. Walls of “Wulstholz” tracheids are mainly characterized by thickening of their secondary walls and also by an increasing lignin content. Modification of cell walls, as a response to mechanical stress, are a part of tree survival strategies.

Key words: Tree xylem, wounding, wind exposure, cell wall modification, light and electron microscopy, UV-microspectrophotometry.

Informatics, Wood Science and SilviScan

Robert Evans, Murray Hughes and Fiona Chen

Ensis / CSIRO, Australia

The development of SilviScan for the automated measurement of a wide range of wood fibre properties has required the parallel development of an information management system capable of handling terabytes of data and their interrelationships ranging from nanometres to the global scale. In normal operation, a single 150 mm sample would produce about 0.5 Gbyte and over 250 files. In one year we might collect about ~5Tbyte of uncompressed data. Rather than manipulating millions of individual files, we have chosen to use Hierarchical Definition Files (HDF - developed by NCSA in 1988) and SQL databases in what is becoming an informatics system for wood (variously labelled biofibre informatics, wood informatics or xyloinformatics).

A program is now underway to expand the informatics system to specifically include environmental, silvicultural, genetic information, as well as files from other instruments such as near infrared spectrometers and sonic velocity devices. Comprehensive interrogation and reporting tools are essential ingredients. Some features of the system will be demonstrated, together with applications made possible by this integrated approach to data acquisition and information management.

Ultrastructural Assembly of Lignin and Polysaccharides in Ginkgo Wood Cell Walls

Noritsugu Terashima

Nagoya University

The physical and chemical properties of wood cell wall depend on (a) chemical structures of cell wall polymers (cellulose, hemicellulose, pectin and lignin), (b) higher-order structures of those polymers, and (c) their 3D assembly in the cell wall. Information on (b) and (c) is best obtained by non-destructive approaches such as visualization of successive deposition processes of those polymers in differentiating cell walls using tracer methods and electron microscopy. Observation of cell walls before and after mild selective removal of lignin and polysaccharides also provides useful information on (b) and (c).

Lignification is the last step of the assembly process, and the assembly mode differs depending on the plant species, type of the cell and morphological region of the cell wall. Examination of tracheid walls of living fossil tree, ginkgo, provides information on the most primitive and basic assembly mode of lignin and polysaccharides. The observations below are basically common to lignifying cell walls of most conifers and other tree species.

(1) Prior to lignin deposition, different sizes of cellulose microfibrils (CMFs) (bundles of elementary fibrils) are formed in different morphological regions of the cell wall. (2) In compound middle lamella (CML) and cell corner (CC), CMFs and pectin form a loose 3D network that provides environments for polymerization of monolignols. (3) As the result, 3D aggregates of globular modules of lignin-pectin complex are formed in CML and CC. (4) In the secondary wall (SW), the hemicelluloses hold oriented CMFs and induce formation of bead-like modules of lignin-hemicellulose complex at regular distance on the CMFs. (5) The modules fuse together into super macromolecules so that the cell wall features are kept after removal of CMFs. (6) Higher order structure of lignin macromolecule is regulated by the spatial limitation on the growth of modules. The condensed substructures, 5-5_ biphenyl and dibenzodioxocin structure are frequently formed at the contact boundary of adjacent growing modules. The 3D aggregation of lignin-rich modules in CC and CML generates condensed substructures more frequently than the beads-like lignin-hemicellulose modules on CMFs do in SW. (7) Non-cellulosic polysaccharides play the most important key role in 3D assembly of cell wall polymers.

Characterization of physical properties of gelatinous layer in tension wood fiber

Hiroyuki YAMAMOTO*, Julien RUELLE, Yoshiharu ARAKAWA, Masato YOSHIDA, Bruno CLAIR, Joseph GRIL

School of Bio-agricultural Sciences, Nagoya University
Chikusa, Nagoya 464-8601, JAPAN, FAX: +81-52-789-4152
e-mail: hiro@agr.nagoya-u.ac.jp

Tension wood xylem of arboreal eudicot species often produces unusual wood fiber, called **gelatinous fiber (G-fiber)**. The G-fiber forms a **gelatinous layer (G-layer)** as the innermost layer of the multi-layered cell wall. The G-fiber generates a high tensile growth stress, which enables the hardwood species to perform the negative-gravitropic behaviors in its inclined shoot. However, the tension wood often causes various obstacles when we use the forest resources as the raw material for the timber products. Examples are the processing defects caused by its abnormal growth stress. Other examples are a high longitudinal Young's modulus and a high longitudinal drying shrinkage; their combined effect causes serious processing defects during the lumbering and drying process, e.g., distortion and cleavage of the sawn lumber, and so forth.

Some researchers consider that characteristic properties of the G-fiber should be attributed to the intrinsic behaviors of the G-layer, while others emphasize the role of other lignified layer because the G-layer is often peeled off the lignified layer in the same direction during microtoming. Lately, Clair et al. revealed that detachment of the G-layer is an artifact that is caused by the stress concentration from the microtome blade, and they concluded that the G-layer is strongly attached to the lignified layer even in the oven-dried specimen. This positively supports the idea that the characteristic behaviors of the G-fiber originate from the property of the G-layer. However, the researchers still have no explanation for the generation mechanism of those G-layer properties.

In our presentation, we focused our attentions on the moisture dependent changes of the longitudinal Young's modulus and the longitudinal shrinkages in two *Quercus acctissima* containing the tension wood xylem. And, we revealed the astonishing difference of those properties between G-layer and the lignified wall (= normal wood cell wall). Based on the obtained results, we propose a model of fine structure of the G-layer (and that of the lignified wall) to explain what is going on the drying G-layer.

Wood collections link science and culture

Junji Sugiyama

Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Kyoto, 611-0011

Wood, the secondary xylem, is the most abundant terrestrial biotic product. From the Stone Age relationship between wood and man has always been intimate, and even unconsciously, wood surrounds us because of its versatility to make constructions, furniture, tools, fibers and paper. Therefore, wood is an important subject to be studied from many different aspects: paleobotany, ethnobotany, archeology, history in addition to the conventional view points such as biology, chemistry, physics and engineering. The wood collection at our xylarium, designated as KYOw, has been serving as basis for the exchange of knowledge and experiences in wood anatomy at national and international levels. Our activity linked to this xylarium are (1) research and education of wood anatomy and identification, (2) original collection of timbers from national cultural heritages, (3) indexing, exchange, home page publishing of wood collections, (4) rendering services on the identification of the taxon of wooden objects, and (5) promotion of cooperative research project. Some of our recent activities will be presented with particular reference to the project, “timbers from the historical wooden buildings”.

A database relating physical and cultural aspects of the uses of woody species' diversity in musical instruments of the world.

Iris BREMAUD[1,2], Bernard THIBAUT[3],and Kazuya MINATO[1]

(Corresponding author: iris_bremaud@hotmail.com)

1 Graduate School of Agriculture, Kyoto Prefectural University, Kyoto 606-822, Japan

2 Laboratory of Mechanics and Civil Engineering, University of Montpellier II, Montpellier, France.

3 UMR « Ecology of Forests of Guyana », BP709, 97379 KOUROU Cedex, French Guyana.

Wood, the main building material of many musical instruments, affects their mechanical and acoustical behaviour. Different parts, instruments and organological families lend to a broad range of material requisites. Considering the lesser-studied instruments of geocultural ensembles other than Western "savant" music shows an even greater diversity of functions-chosen species. This diversity in used species is very little known, while instrument makers over the world are currently facing issues of availability and/or of conservation status of some of their preferred woods. Furthermore, comparable vibrational properties of woods including damping are scarce and highly scattered.

We present here the creation of a new specific relational database conceived as a tool to gather and study these aspects. It contains three main parts. 1) Botanical species (Tree and wood information and conservation; links to uses and properties). 2) World instruments (with the different woody species used for each part). 3) Viscoelastic vibrational properties of wood. Data sources are: our own field and experimental work; literature survey including many hard-to-obtain, non-English-language sources. Up-to-date taxonomy is checked with widely accepted sources.

Summary of data contained at present day: instruments =circa150; "instrument part/ used species" = c850; species with checked botany= more than 500; species used in instruments= c300; species with viscoelastic vibrational properties = c330 (covering about 5500 tests).

Some possible analysis from this databank include: 1) Material variations for a given part of instrument; 2) cross-cultural comparison of material choice; 3) range of variation in vibrational properties for one single wood species, covering several researches; 4) pointing out lesser-known species as viable alternatives to threatened species; etc.

Efforts must also be pursued on: vibrational characterization of wood diversity; collection of wood uses in worldwide instrument making cultures.

Production of biofuels from wood biomass using white rot fungi and thermochemical pretreatments

Takashi Watanabe

Research Institute for Sustainable Humanosphere, Kyoto Univ., Uji, Kyoto, Japan

Development of conversion systems from lignocellulosics into biofuels and chemicals has received much attention due to immense potentials for the utilization of renewable bioresources. For example, ethanol production from lignocellulosics has been examined by saccharification with acids or cellulolytic enzymes and subsequent ethanol fermentation with yeast or gene-engineered bacteria. Since lignin makes the access of cellulolytic enzymes to cellulose difficult, it is necessary to decompose the network of lignin prior to the enzymatic hydrolysis. Thus, effective pretreatments are needed for enzymatic saccharification and fermentation from lignocellulosics. Biological pretreatment with lignin-degrading fungi in combination with thermochemical or physicochemical treatment is one possible approach. We developed a pretreatment system applicable to a wide range of biomass including softwood, without use of strong acids. We applied a white rot fungus and microwave solvolysis to the pretreatments. A white rot fungus SKM2102 isolated in Japan was identified as a new strain belonging to the genus, *Phellinus* spp. by nucleic acid sequence of ITS region. Cultivation conditions for the pretreatment of Japanese cedar wood were optimized using a small fermentation reactor and various media for *Phellinus* sp. SKM2102. Using a pre-steaming treatment, a large scale solid state fermentation was conducted by suppressing growth of the other microorganisms. A new microwave solvolysis reactor with 2.45 and 5.8 GHz irradiator was developed using a simulation technique for an irradiation cavity. Fungal treatment with *Phellinus* sp. SKM2102 and *C. subvermispora* increased enzymatic saccharification ratio of Japanese cedar wood.

The pretreatments with white rot fungi were applied to methane fermentation of wood biomass. The fungal pretreatments with *C. subvermispora* and *Phellinus* sp. SKM2102 increased yields of biomethane.

Biorefining wood into fuels and fibers

Thomas W. Jeffries,[1] Rita C. L. B. Rodrigues,[2] William R. Kenealy,[1] Carl J. Houtman[1]

[1]*U.S. Forest Products Laboratory, Institute for Microbial and Biochemical Sciences, One Gifford Pinchot Drive, Madison Wisconsin, and* [2]*Departamento de Biotecnologia, DEBIQ, Escola de Engenharia de Lorena, EEL, USP Universidade de São Paulo, P.O Box 116, 12600-970, Lorena, SP, Brazil*

Agricultural and woody residues are potential sources for the production of ethanol, other chemicals and fibers. Biorefining initiatives in the U.S. include six major commercial demonstration projects, new R&D projects to develop better biocatalysts, and the establishment of long-term efforts to create new feedstocks and conversion technologies. One approach to obtaining higher value products is to release hemicellulosic sugars and recover the residual cellulose. Acid, alkali, heat and organic solvents have been examined extensively as pretreatments. Most of these approaches are expensive, or they produce toxic degradation products, so a new generation of efficient pretreatments is needed. Diethyloxalate (DEO) hydrolysis is a mild treatment that releases hemicellulose while avoiding the formation of toxic byproducts. It can be carried out in a vapor phase to reduce the amount of heat required, and it can yield sugars while producing fibers for paper production. DEO pretreatment releases hemicellulosic sugars with xylose as the main component from hardwoods. In recent years, several approaches have been taken to improving the conversion of xylose into ethanol. Yeasts found in the lower intestines of wood-eating beetles can convert xylose to ethanol. One of the best of these is *Pichia stipitis*. Wild-type strains of *P. stipitis* will produce more than 5% ethanol from xylose. Engineered strains will also produce lactic acid, xylitol and other useful chemicals in high yield. In order to improve the production of these chemicals, we have recently sequenced the complete *P. stipitis* genome. This has enabled the discovery of numerous enzymes that this yeast uses to metabolize xylose, mannose, arabinose and cellobiose. We have also used sequence information to conduct genome-wide expression analysis, which has given considerable insight into how this organism regulates its metabolism for xylose fermentation. These findings should enable the development of efficient xylose fermenting yeasts for ethanol production.

Understanding cellulose biosynthesis in plants: challenges and solutions.

Vincent Bulone

Royal Institute of Technology (KTH), School of Biotechnology, Stockholm, Sweden

Cellulose is the major component of plant cell walls and plays a central role in the regulation of the cell volume, the determination of the cell shape and size, the mechanical protection of the plant and its defence against pathogens. Cellulose is synthesized at the surface of the cell and organized into crystalline microfibrils that govern the mechanical properties of the cell wall by their strength and stiffness. Cellulose microfibrils are embedded in a complex matrix of carbohydrates, phenolic polymers and structural proteins, which accommodates a variety of mechanical requirements during plant life. The physical and mechanical properties of cellulose nanocrystals are comparable to those of the best synthetic materials. Learning from nature how cellulose is formed and how its crystallinity is achieved is thus relevant not only for plant development but also for the innovation of environmentally friendly and biocompatible materials with high performance and increased functionality. However, the mechanisms of cellulose biosynthesis and crystallization are still not well understood despite the considerable progress made in the past years in the identification of genes that code for the catalytic subunits of the cellulose synthases and for other proteins potentially involved in cellulose formation. Cellulose synthases are large complexes particularly difficult to study using biochemical approaches because of their high instability inherent to their location in the plasma membrane. In fact, plant membrane extracts usually yield *in vitro* quantities of (1→3)-β-glucan (callose) but no or very little cellulose. Callose is also a polysaccharide of importance as its synthesis is essential in normal plant development and plays a central role in the plant defense response to various stresses. As for cellulose, most molecular mechanisms involved in (1→3)-β-glucan synthesis are not yet fully understood.

This presentation will summarise the major unanswered questions related to the processes of cellulose and callose synthesis. It will also present data on the morphological and structural analyses of the polysaccharides synthesized *in vitro* by detergent-extracted cellulose and callose synthase complexes, as well as some of our latest results on the characterization of the enzymes using a combination of biochemical and biophysical approaches. The significance of our recent discovery that cellulose and callose synthases are located in plasma membrane microdomains similar to lipid rafts in animal cells will also be discussed.

Cellulose biotechnology – to break or to refine?

Tuula T. Teeri

Swedish Center for Biomimetic Fiber Engineering, Royal Institute of Technology, AlbaNova, SE-10691 Stockholm, Sweden

Cellulose is the most abundant organic polymer on Earth and an important raw material for a number of industrial sectors. The traditional uses of cellulose in e.g. paper and textiles make use of the inherent strength of cellulose microfibrils that constitute the load-bearing component of plant cell walls. The discovery of cellulases in the 1950's and the global energy crisis in the 1970's led to intensive research efforts in order to use enzymes to solubilize cellulose into soluble sugars that could be used as the substrate for ethanol fermentation. During the following decades the primary mechanisms of enzymatic cellulose degradation were resolved, and protein engineering yielded stable and efficient enzymes for industrial biodegradation [1]. However, plant cell walls are intricate composite materials containing hemicelluloses, lignin, proteins and other minor compounds in addition of cellulose. It is apparent that cellulases alone cannot complete solubilize complex substrates such as agricultural, forest industrial and urban waste used for bioethanol production [2]. The selection of optimal enzyme mixtures for different substrates requires more detailed knowledge of the cell wall structure and composition in different plant species. Bottom-up approaches are now emerging to investigate and to eventually modify plant cell wall biosynthesis *in vivo* [3] as well as by using *in vitro* model systems [4]. In addition to enhanced biodegradation, improved understanding of the principles of cell wall composition and assembly will also contribute new ideas on how to utilize plant fibers, bacterial cellulose and cellulose nanocrystals for developing new generations of strong but light-weight biomaterials [5].

References:

[1] Schulein M (2000) *Biochem Biophys Acta* **1543** 239-252

[2] Wyman CE (2007) *Trends Biotechnol.* **25**153-7

[3] Sticklen M (2006) *Curr Opin Biotechnol* **17** 315-319

[4] Chanliaud E et al (2002) *Planta* **215** 989-996

[5] Teeri TT et al. (2007) *Trends Biotechnol.* **25** 299-306

Cellulose nanofibers prepared by TEMPO-mediated oxidation of native cellulose

Akira ISOGAI

Department of Biomaterial Science, Graduate School of Agricultural & Life Science,
The University of Tokyo, JAPAN

When TEMPO-mediated oxidation is applied to native celluloses, significant amounts of carboxylate and aldehyde groups are formed at the C6 primary hydroxyl groups. The original fibrous forms of cellulose as well as the original cellulose I crystallinities are maintained even after TEMPO oxidation and the successive washing by filtration. However, the TEMPO-oxidized cellulose fibers can be converted to individualized cellulose single nanofibers about 4 nm in width and a few microns in length by gentle disintegration treatment, when the amount of carboxylate groups formed reaches a certain level. Thus, highly viscous and transparent cellulose single microfibrils/water dispersions can be obtained. Based on calculation, almost all C6 primary hydroxyl groups of the surface of each cellulose microfibril are needed to be oxidized to carboxylate groups by TEMPO-mediated oxidation for giving the transparent dispersions by disintegration treatment under mild conditions. Applications of these new cellulose nanofibers to functionalized materials will be introduced.

Composites reinforced by cellulose nanofibers

Hiroyuki Yano

Lab. of Active Bio-based Materials, Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Kyoto 611-0011, Japan

Tel:+81-774-38-3669, Fax:+81-774-38-3658

The plant cell wall consists of a 4nm wide by 4nm thick nanofiber called a cellulose microfibril. Since nanofibers are bundles of semi-crystalline extended cellulose chains, their thermal expansion is as low as that of quartz whilst their strength is five times that of steel. However, the industrial utilization of nanofibers is presently quite limited despite their being the most abundant biomass resource on earth. In our laboratory, we are developing high strength and low thermal expansion transparent nanocomposites based on nanofibers for use in automobiles, buildings, portable computers, medical equipment and many other products. For example, we demonstrated that microfibrillated cellulose (MFC), which consists of mechanically disintegrated pulp in nanofibers in a web-like network, shows promise as a reinforcement of composites. MFC sheet-molded phenolic resin composites with 80-90% fiber content exhibited strength equivalent to that of mild steel or magnesium alloy. Furthermore, we have developed a transparent polymeric nanocomposite using a web-like bacterial cellulose (BC) nanofiber network as the mechanical reinforcing agent. Surprisingly, the composite is optically transparent at a fiber content of as high as 70% as well as flexible, with a low thermal expansion coefficient (similar to that of silicon crystal), and mechanical strength five times that of engineered plastics. These significant improvements in thermal and mechanical characteristics of the BC composite make it an excellent candidate for transparent substrate of organic EL (OLED) flexible display.

Life Cycle Assessment in Japanese Wood Industry

Nobuaki HATTORI

Graduate School of Agriculture, Tokyo University of Agriculture and Technology

Life cycle assessment (abbr. to LCA) has been widely used in engineering fields. However, there are a little reports about LCA in the field of wood industry, though many people believe with confidence that wooden products are environmentally-friendly materials. Reliable and usable background data set for Japanese wood industry is very poor compared those for engineering fields.

The recent case studies of LCA relating wooden materials using the reliable background data set in Japan are outlined in this presentation. The reviewed case studies were picked up out of proceedings of the annual meetings of the institute of life cycle assessment and the results who have permit to release among studies conducted by my laboratory.

There is no background data of logs produced in Japan, though the data of steel and concrete are available among main building materials. Therefore, we gathered the inventory data on the production stage of Japanese cedar and cypress to quantitatively analyze the environmental loads using LCA methodology. The forests in Ehime and Kochi prefectures were selected as study sites to calculate the environmental loads from the production of log of 1 m3. The results showed that the most significant portion of environmental loads was attributed to the harvesting stage, among other stages, including planting, thinning, mowing, pruning and improvement cutting.

The assessments were achieved for particle boards (PB) in 2005 and wet fiberboard such as hardboard (HB) and insulation board (IB) in 2006 supported by Japan Fiberboard and Particleboard Manufacturers Association, though the first assessment of PB was done in 2000. The environmental loads caused by an adhesive was found to be relatively high. Therefore, the assessments about five adhesives used for wooden panels were conducted in 2002 and published in 2006. It became clear that the environmental loads vary greatly among adhesives and the major reasons are the environmental loads occurred from the production of raw materials for an adhesive.

Several inventory analyses and LCA about detached wooden houses have been achieved using process analysis or input-output analysis, though it is very difficult to assess the environmental loads of a house using process analysis perfectly because a house consists of many parts whose environmental loads are unclear.

Wood-based materials in Japan

Shigehiko Suzuki

Faculty of Agriculture, Shizuoka University, Shizuoka, Japan

Concerning the trend of wood based materials in Japan, two big changes occurred in these two decades must be pointed out for timber products and panel products. For composite timber products, total supply of glued laminated products (GLP) has been increasing. In particular, the supply of GLP for structural grade increased remarkably after the revision of JAS-Glued Laminated Timber in 1986 and the revision of Building Code in 1987. Large glue laminated timber constructions were built after these. Several examples of major timber construction using sugi (Japanese cedar) such as dome and bridge will be introduced. For wood based panels, on the other hand, plywood production decreased drastically. The domestic production of eight million cubic meters in 1980 started to decrease to approximately three million cubic meters, due to the shortage of imported high quality logs. Alternative panels to substitute the five million cubic meters of domestic plywood reduction would be a issue to be discussed in this field. Imported plywood and mat-formed panels are replacing this, and the ratio of softwood plywood is increasing slightly. There are two big issues concerning wood resources in Japan. One is how to use conifers planted widely in our country. Finding effective ways for utilizing these conifers is one of the most important issues in forest management and to the wood industry. Waste wood generated from demolition and construction was the other wood resource we have to find the way to use. It is estimated to be about ten million cubic meters per year and the Construction Recycling Law enforced in 2002 requests to recycle these material. “Thermal recycle or material recycle” is a topic for the wood based panel industry on the usage of this wood resource. Some technical issues for large timber construction and mat-formed panel products using these materials are discussed.

Molecular Biology of Bamboos
- What regulates bamboo shoot elongation ? -

Masahiro Sakamoto

Graduate School of Agricultural Science, Kyoto University

Bamboos are widely distributed in Southeast Asia, Latin America and parts of Africa, and have some unique properties as plants. Especially, it is well known that bamboo shoots grow up rapidly at maximum growth speed about 1 m per day in the case of Moso-bamboo. What regulates the elongation of bamboo shoot ? We have attempted to clarify how bamboos grow up, and which gene has important role during their elongation. At first, we analyzed genes from Moso-bamboo, *Phyllostachys pubescens* Mazel, using microarray system including ca. 9000 clones. The mRNAs were extracted from (1) top of shoots, (2) the upper and (3) the lower part of the 17th internode with culm sheath of juvenile bamboo of 5 m 39 cm height and (4) mature leaves. Microarray analyses revealed that lower part of the 17th internode was very active tissue. We selected 635 clones which expressed with over twofold to other three parts as the lower part specific clones. Especially, 34 clones showed over threefold expression to other tissues. Four sucrose synthases, three aquaporins, three ABA/stress inducible proteins and others. Bamboo shoots is predicted to be a sink organ during their elongation period, suggesting that sucrose metabolism related genes are active. In fact, the results of microarray analysis support this hypothesis. We particularly focused on sucrose synthase (SUS). There are some isoforms of SUS in plants. Until now, it is reported that there are two forms of SUS, soluble and membrane associated. Using antibodies to SUS, membrane associated SUS type is preferentially located in young tissues, top of shoot, the lower part of internode and a growth ring. This results indicated that some clones of SUS contribute to bamboo shoot elongation.

Overview of Forest Products Laboratory Research Programs and Opportunities for International Collaboration

Christopher Risbrudt and R. Sam Williams *

Forest Products Laboratory, Madison Wisconsin USA

As emphasis areas in forest products research are changing at laboratories around the world, the research program at the Forest Products Laboratory (FPL) is also changing. Research still involves wood processing, mechanical testing, moisture and durability, wood preservation, adhesives, economics, traditional composites, and pulp and paper. However, many new emphasis areas are developing that include engineered bio-composites, small-diameter timber, bio-refining, energy and biomass, wood surface chemistry, nanotechnology, deconstruction, and recycling. FPL researchers are forming partnerships with researchers at several universities to advance technology in housing. A brief overview of these programs will attempt to find areas of common interest among researchers from other countries.

* R. Sam Williams will give talk.