Abstracts

S. HAYASHI and K. SHIMAJI: **List of Species Represented by Wood Specimens in the Xylarium, Wood Research Institute, Kyoto University (KYOw) (1) KYOw No. 1-No. 4000,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 174 (1983) (in Japanese)

The wood collection (KYOw) was newly established in 1980 as an attached facility of the Research Section of Wood Biology, on the basis of ca.2000 wood samples which had been accumulated since 1944 when the Wood Research Institute was founded. Our foreign wood collection is rapidly expanding by the exchange of authentic wood samples with institutional wood collections all over the world. Collections of domestic wood samples and their herbarium vouchers are also proceeding extensively, and the total number of our wood samples ammounts to ca.9000 at present. This list consists of the botainical names of KYOw samples No. 1 to No. 4000 in the alphabetical order of the families, genera and species, containing 117 families, 545 genera and 1440 species. Exchange is available for fairly large numbers of domestic samples. Small blocks for sectioning are also available for almost all samples.

S. HAYASHI, K. SUMIYA and T. NOMURA: **Anatomical Characters of Thirty-six Cultivars of *Cryptomeria japonica* D. DON,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 81 (1983) (in Japanese)

Average annual ring width, proportion of late wood, tracheid length, fibril angle and microscopical features are observed for 36 cultivars of *Cryptomeria japonica* which grown in Kyushu district. The test specimens are taken from only one juvenile tree to one cultivar, and the results could not be typically compared with matur cultivars. For example, tracheid length shows only 6–8th annual ring's average that increasing region in juvenile wood. Some cultivars such as Ayasugi, Tomisu No. 1 and Bokasugi that showed large plastic region have shorter tracheid length and flatter fibril angle. The specimens are all juvenile wood and have extremely wide annual rings and many false rings. In these false rings, there are many resin cells. Some abnormal characters are observed, too.

T. ITOH and R.M. BROWN, Jr.: **The Assembly of Cellulose Microfibrils in Valonia macrophysa Kütz,** Planta **160**, 372 (1984)

The assembly of cellulose microfibrils was investigated in artificially induced protoplasts of the alga, *Valonia macrophysa* (Siphonocladales). Primary-wall microfibrils, formed within 72 h of protoplast induction, are randomly oriented. Secondary-wall lamellae, which are produced within 96 h after protoplast induction, have more than three orientations of highly ordered microfibrils. The innermost, recently deposited

microfibrils are not parallel with the cortical microtubules, thus indicating a more indirect role of microtubules in the orientation of microfibrils. Fine filamentous structures with a periodicity of 5.0–5.5 nm and the dimensions of actin were observed adjacent to the plasma membrane. Linear cellulose-terminal synthesizing complexes (TCs) consisting of three rows, each with 30–40 particles, were observed not only on the E fracture (EF) but also on P fracture (PF) faces of the plasma membrane. The TC appears to span both faces of the bimolecular leaflet. The average length of the TC is 350 nm, and the number of TCs per unit area during primary-wall synthesis is 1 per μm^2. Neither paired TCs nor granule bands characteristic of *Oocystis* were observed. Changes in TC structure and distribution during the conversion from primary- to secondary-wall formation have been described. Cellulose microfibril assembly in *Valonia* is discussed in relation to the process among other eukaryotic systems.

T. ITOH, S. HAYASHI and K. SHIMAJI: **Tree Species of Building Wood Excavated from Kitoragawa Relics.** Report on the 7th Excavation of Relics, Kitoragawa 3, The Cultural Properties Association of Higashi-Oosaka City ed., 55 (1984) (in Japanese)

303 samples of building wood excavated from the relics, Kitoragawa, covering B.C.1–A.D.1 centuries in Higashi-Oosaka City were examined for identification of tree species. Each of these samples was identified as one of the 37 species covering a wide range of temperate taxa: *Cephalotaxus drupacea, Torreya nucifera, Pinus spp.* (Diploxylon), *Abies firma, Cryptomeria japonica, Chamaecyparis obtusa, Salix* spp., *Castanopsis* spp., *Quercus* spp. (Cyclobalanopsis), *Quercus acutissima, Quercus serrata, Aphananthe aspera, Celtis sinensis* var. *japonica, Zelkova serrata, Morus bombycis, Euptelea polyandra, Cercidiphyllum japonicum, Cinnamomum camphora, Machilus thunbergii, Prunus* spp., *Prunus zippeliana, Picrasma quasioides, Daphniphyllum macropodum, Rhus trichocarpa, Aesculus turbinata, Hovenia dulcis, Actinidia arguta, Camellia japonica, Cleyera japonica, Eurya japonica, Cornus controversa, Vaccinium bracteatum, Diospyros kaki, Symplocos myrtacea, Styrax japonica, Ligustrum obtusifolium* and *Paulownia tomentosa.* The building wood was classified as pillars, posts, scrap wood and pillars or posts used for wooden pavement. *Abies firma* and *Quercus* spp. (Cyclobanopsis) and *Quercus serrata* were used as pillars in high frequency. Coniferous wood were rarely used, while *Castanopsis* spp. and *Quercus* spp. (Cyclobalanopsis) as well as *Cleyera japonica* were used frequently as posts. 4 samples among scrap wood were identified as *Paulownia tomentosa.* The home of the species is briefly dissussed.

T. ITOH and K. SHIMAJI: **Identification of Wooden Pillars Excavated from the Relics of Ancient Palaces and Local Government Buildings,** IAWA Bul-

letin n.s. **5**, 160 (1984)

Wood species of 274 buiiding-pillars and related samoles excavated from Fujiwara (late half of 7th century) and Heijyo (8th century) palace sites, and from local govenmetn relics in Dazaifu (8–10th century) and Mikogaya (early half of 8th century-early half of 9th century) were identified.

Chamaecyparis obtusa was used for buliding-pillars in 60% out of 150 samples and 75% out of 85 samples in Heijyo palace and Mikogaya government buliding, respectively. These results coincide with the suggestion of a legendary god described in the classic historical literature ' Nihonshoki ' (720 A.D.). It is striking that *Sciadopitys verticillata* was used for building-pillars in 36% out of 150 samples in Heijyo palace, 57% out of 14 samples in Fujiwara palace and 100% of the 6 samples in Dazaifu government building. The Mikogaya relic was characterised by the use of *Podocarpus macrophylla*, instead of *Sciadopitys verticillata,* in 15% out of 85 samples. Other species such as *Abies firma, Tsuga sieboldii, Pinus* sp. (Diploxylon), *Cryptomeria japonica, Taxcus cuspidata, Quercus* sp. (Cyclobalanopsis) and *Castaopsis* were slao used on rare occasions for ancient buildings and related pillars.

The utilisation of both *Sciadopitys verticillata* and *Podocarpus macrophylla* for ancient buildings and related pillars is discussed in relation to their natural distribution and the location of ancient palaces and local government buildings.

T. Itoh, R. O'Neil and R.M. Brown, Jr.: **The Assembly of Cellulose Microfibrils in Selected Siphonocladalean Algae,** J. Cell Biol., **97**, 416a (1983).

Numerous protoplasts were produced in the giant algal cells of *Valonia macrophysa* and *Boergesenia forbesii* after wounding. Protoplasts synthesize large, highly crystalline cellulose microfibrils. Linear terminal synthesizing complexes (TCs) are associated with microfibrillar impressions. TCs occur on both EF and PF faces of the plasma membrane of protoplasts. The direction of microfibril synthesis is random during primary wall formation and highly ordered during secondary wall synthesis. The average distribution of TCs is 0.8 TC/μm^2 in *V. macrophysa* and 1.7 TC/μm^2 in *B. forbesii.* The average length is 350 nm and 490 nm, respectively. The TC of each species consists of 3 rows of subunits, and each subunit is 9–12 nm in diameter. The structure and arrangement of TCs are very similar between *V. macrophysa* and *B. forbesii;* however, the larger TCs of *Boergesenia* produce correspondingly larger microfibris (29 nm for *Boergesenia* vs 20 nm for *Valonia).* The effect of Calcofluor (or Tinopal LPW) on cell wall formation of *Boergesenia* protoplasts has been investigated with fluorescence microscopy and freeze-fracture replica observations. The threshold level of Calcofluor is between 0.00016% and 0.0008% (W/V), below which normal microfibril production occurs. TCs are not observed when protoplasts are incubated

in Calcofluor concentrations greater than 0.01%. TCs disappear from 4–6 hr-old protoplasts within 15 min after Calcofluor treatment. Recovery of TCs does not occur until 30 min after washing these cells free of Calcofluor. Thus, the reaggregation of TC subunits requires a longer time than their disruption by Calcofluor treatment. The appearance and disappearance of TCs is closely related to the presence or absence of cellulose microfibril synthesis.

A.T. HOTCHKISS, Jr., E.M. ROBERTS, T. ITOH and R.M. BROWN, Jr.: **Microfibril Assembly Among Selected Algae of the Zygnematales,** J. Cell Biol., **97**, 415a (1983).

The mechanisms of microfibril assembly in several members of the Zygnematales were examined by freeze-etch techniques. The patterns of microfibril assembly suggest that mechanisms of wall formation may be phylogenetically conserved. In *Closterium* and *Spirogyra*, terminal complexes (TC's) are associated with synthesis of bands of wall microfibrils. As previously reported in *Micrasterias*, we find that the TC's consist of a symmetrical array of rosettes on the PF leaflet of the plasma membrane. In *Cosmarium*, bands of wall microfibrils are present but TC's have not yet been observed. Preliminary investigations suggest that *Mougeotia* differs from othermembres of this order in that: (1) it lacks bands of microfibrils; and (2) impressions of globular TC's, perhaps similar to the globular TC's in higher plants, have been observed on the EF surface. Thus, with the possible exception of *Mougeotia*, the mechanism of microfibril assembly seems to be consistent within the order Zygnematales.

H. KURODA and K. SHIMAJI: **Distribution of Coloring Substances in Sugi Heartwood,** Holzforshcung, **37**, 225 (1983)

The various xylem cells in Sugi (*Cryptomeria japonica* D. Don) heartwood were directly analyzed by microspectrophotometry, and their visible spectra were compared with the heartwood color-tone measured by diffuse reflection attenuance.

The tracheid double cell walls showed no characteristic absorbance-curve because the walls were too thin to detect absorption in the visible region. Ray parenchyma cells in the heartwood showed the spectra almost regarded ss a general absorption curve. Axial parenchyma cells in the heartwood gave spectra with absorption maxima at 460–490 nm, and suggesting considerable transmission of red light. The color-tone of Sugi heartwood was similar to the spectra of the axial cells but not to those of the ray cells. These findings lead to a conclusion that axial and ray parenchyma cells produce different major components respectively, and that being differently responsible for the development of Sugi heartwood color. The axial parenchyma cells seem to synthesize main color-source in the no rmal heartwood (i.e. red

pigments), while the ray parencyhyma cells seem to be responsible for the dark shade of Sugi heartwood-color. Thus, both parenchyma cells have different functions during Sugi heartwood formation.

H. KURODA and K. SHIMAJI: **Distribution of Sugi Heartwood Colors--Comparison of the Normal and Discolored Heartwoods--**, IAWA Bull. n.s., **4**, 7 (1983)

Summary of the IUFRO Division 5 Conference at Madison, Wisconsin USA in 1983. The xylem elements of the red- and black-Sugi-heartwoods were compared by means of microspectrophotometry. The found spectra suggest that the axial parenchyma cells contribute to the red heartwood color, even in the black-heartwood. On the other hand, the ray parenchyma cells seemed to contribute to darkness or value of the heartwood, because the black-heartwood accumulated darker pigments than the normal red-heartwood did. In other words, an extraordinary behavior of the ray cells seems to produce Sugi black-heartwood.

The extractives, milled wood lignins (MWLs), and lignin-carbo-hydrate complex (LCCs) were chemically isolated from both of the heartwoods. The spectral patterns of the extractives reflected those of red- and black-heartwood blocks, respectively: the extractives of red-heartwood showed spectra with a shoulder similar to that of axial parenchyma contents, while black-heartwood ones showed general absorption-curve. The color of red- and black-heartwoods were also bound to respective MWLs and LCCs. As a results of colorimeter, red substances were bound to both MWL- and LCC-fractions, while black substances were mainly in LCC-fractions. These findings suggest that red substances might be distributed through the tracheid walls and that black substances might be distributed in the secondary walls of the tracheids. Such distribution might be common in both red- and black-heartwoods, although the level of the substances is olw in the former one.

H. KURODA and K. SHIMAJI: **Analyses of Fiber Length by a Microcomputer**, IAWA Bull. n. s., **5**, 161 (1984)

A system for the measurements of fiber length was developed and applied to analyzing a pattern of conifer tracheid-length across more than thirty annual rings. Projection of fiber images: The fiber images were magnified and projected by a handmade projector on a digitizer which was connected with a 8-bit microcomputer by a RS232C cable. Calculation of fiber length: A computer program was designed for reading data from digitizer, calculating fiber length, processing the data obtained, and writing the data on a disk memory. The microcomputer recognizes each digitizer-coordinate, when the cursor traces fiber images on the digitizer. The central processing unit is able to process all coordinates at ca. ten points per second, and

curved images are also able to trace correctly. Utilization of this system: Thirty-six-year old Sugi tracheids were analyzed for all annual rings at breast height. Besides the reconfirmation of Sanio's lst law for fiber length, the variance of the length increased with age.

K. KURODA and K. SHIMAJI: **Computerization of Hardwood Identification,** IAWA Bulletin n.s., **5**, 161 (1984)

The procedure of hardwood identification is time-consuming and laborious even to the well-experienced wood anatomists. In order to save such difficulties, a computerized system was programmed.

This identification system uses Fujitsu FACOM OS IV/F4 installed in the Data Processing Center, Kyoto University connected with our NEC PC 9801 terminal through telecommunication equipment, and is also applicable to microcomputers. The programs for (1) Database making, and (2) Wood identification were written in PASCAL. Data of anatomical characters for each species were coded following the standard list published by a committee of IAWA.

To identify unknown specimens, users are only to reply to the questions from computer after calling program (2). The code of the conspicuous character is to be inputted one by one by multiple entry system. The names of remaining possible species can be listed up whenever the user requests on the way of identification.

K. KURODA and K. SHIMAJI: **Wound Effects on Xlyem Cell Differentiation in a Conifer,** IAWA Bull. n.s., **5**, 295 (1984)

Modified xylem cells formed around a minute injury in the stem of *Piuns taeda* were observed periodically in order to study the mechanism of xylem cell differentiation in conifers. Ray parenchyma cells in the mature xylem as well as in the cambial zone were strongly activated. They not only proliferated in the wound gap, but also invaded into some mature tracheids through the pinoid pits to form tylosis-like structures. Then they reticulately thickened and lignified their wall earlier and more excessively than the normal ray parenchyma cells. Immature ray tracheids, which also divided several times abnormally in the cambial zone, differentiated into ray tracheids without differentiating into any other elements. Immature axial tracheids near the injury differentiated normally even though some sporadic transverse of radial division occurred. Only exceptionally, some peculiar groups of small bordered pit pairs were formed between them. It was clear that a shift from differentiating direction on the way of cell maturation, for instance from immature tracheid to parenchyma cell, was never induced by injury. Cambial initials, both ray and fusiform, were very stable. Ray cell derivatives, although they resemble so-called tracheary elements induced in cultured callus, were interpreted as cells that have only undergone

an accelerated ageing process resulting in early death, without differentiating into any other element or into meristematic cells.

K. KURODA and K. SHIMAJI: **The Pinning Method for Marking Xylem Growth in Hardwood Species,** Forest Sci., **30**, 548 (1984)

The pinning method was tested with poplar and black locust, in order to establish its reliability for marking xylem growth in hardwoods. Immature xylem cells in the primary wall zone enlarged and proliferated abnormally around the gap formed by pinning, thereby gradually closing the gap in this area. Meanwhile, the stripes of wall residue of immature cells which had been crushed and packed together on both flanks of the gap were brokne by cambial divisions. The broken end to the stripe marked the site of cambial initials at the time of pinning. This broken end was always easily detectable because the stripe of wall residue remained otherwise unbroken. The site of secondary wall initiation at the time of pinning also was detectable because the gap initially remained open inward from that site and then filled with parenchyma cells. The present work suggested that the pinning method works as well or better with hardwoods, compared to previous observations with softwoods.

K. KURODA, K. SUZUKI and T. YAMADA: **Anatomical Observations on the Disease Development of the Pine Wilt after Inoculation,** 95th-Nichirinron, 471 (1984) (in Japanese)

Anatomical observations were made periodically after the summer inoculation of the pine wood nematode in *Pinus thunbergii*. The results were discussed in relation to the symptoms visible to the naked eye and the incresae of nematodes in the stem.

Partial discoloration of leaves began 2 weeks after the inoculation in the both specimens of 3 and 6 years old. There found no cell level abnormalities in the stem prior to this phenomenon. Ray parenchyma cells and epithelial cells gradually changed color to yellow thereafter. By the end of fourth week, phloem and xylem cells including acmbium were almost dead, and nematode had increased suddenly. Even in this period, the resin leakage from resin canals to neighboring tracheids was not so conspicuous as to prevent the water flow in the stem especially in the 6-year-old specimens. Therefore resin leakage does not seem to be the causal factor of the death of pine trees.

K. SHIMAJI: **Approaches to the Factors of Reaction Wood Induction—Especially on the Compression Wood of Conifers—**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes) No. 18, **1** (1983) (in Japanese)

The history of the physical and biochemical experiments for approcahing to the factors of compression wood induction in conifers was briefly reviewed.

K. SHIMAJI and S. HAYASHI: **On the Tree Species of Excavated Wood Charocals**. Report on the Excavation of Relics along Shichimi-Taikoyama-Takaoka Projected Line (2), Educational Committee of Toyama Pref. ed., **34** (1983) (in Japanese)

20 charcoal samples out of charcoal kiln No. 4 (the first half of 8th century) in Toyama Pref. were examined for identification of tree species. 18 samples were identified to *Hovenia dulcis* and 2 were *Acer* sp. *H. dulcis* was dominant for this kiln, but there seemed to be no intentional selection of tree species for charcoal sources as reported formaly.

K. SHIMAJI and S. HAYASHI: **Identification of Wood Species Excavated from the Relics of Settsu Takatsuki Castle,** Educational Committee of Takatsuki City ed., Report on Research into Cultural Properties, Takatsuki City, No. 14, 102 (1984) (in Japanese)

135 wood samples excavated from the relics of Takatsuki castle (Heian Era, 16th century, Osaka Pref.) that used for construction were examined for identification of wood species. 62 samples were softwoods belonging to 4 species, and 73 were hardwoods belonging to 16 species. As to softwood, 58 specimens were identified to *Pinus* sp. (Diploxylon). *Castanopsis cuspidata* var. *sieboldii, Quercus acutissim* and *Symplocos myrtacea* were dominant in hardwood. It was obvious the right species were used in the right place.

N. YOSHIZAWA, T. ITOH and K. SHIMAJI: **Helical Thickenings in Normal and Compression Wood of some Softwoods,** IAWA Bulletin n. s., **5**, 172 (1984)

Compression wood (CW) in softwood species with helical thickenings on their inner surface of normal wood (NW) tracheids were examined. Helical thickenings occur in NW tracheids of *Taxus, Torreya, Cephalotaxus,* and *Pseudotsuga.* They also have been observed in the latewood tracheids of juvenile wood in *Picea* and *Larix.* It has been thought by some authors that the thickenings are an integral part of the S_3 layer in NW and of the S_2 layer in CW, since, according to them, they have the same orientation as the innermost microfibrils in these layers. However, helical thickenings were often found to be oriented at an angle different from that of the innermost microfibrils in the transitional tracheids between NW and CW. Helical checks and thickenings seem to be mutually exclusive in CW of *Taxus, Torreya* and *Cephalotaxus.* In these species, the thickenings run in an S-helix on the S_3 layer in NW, while in a Z-helix with a pitch of about 45° on the S_2 layer in CW. In *Pseudotsuga,* the helical checks and thickenings occasionally occur together in one and the same tracheid transitional from CW to NW. Whether helical thickenings are to be considered as a part of the innermost layer is still a moot question, and it is of interest to study

the nature of the thickenings of NW and CW.

J. AZUMA: **Saccharification of Wood using Microwave Irradiation,** Kagaku To Seibutsu, **22**, 146 (1984)

Effective utilization of microwave energy for saccharification of lignocellulosic materials was reviewed.

J. AZUMA, F. TANAKA and T. KOSHIJIMA: **Microwave Irradiation of Lignocellulosic Materials I. Enzymatic susceptibility of microwave-irradiated woody plants,** Mokuzai Gakkaishi, **30**, 501 (1984)

Microwave irradiation in the presence of water was attempted to improve the reactivity of lignocellulosic materials toward enzymatic saccharification. The reducing-sugar production by enzymatic digestion decreased after attaining its maximum at 223–229°C, while the weight loss still increased above 230°C. The maximal degree of saccharification was estimated to be in the range of 65.9–93.0% of the polysaccharides present in the original lignocellulosic materials.

A. KATO, J. AZUMA and T. KOSHIJIMA: **Lignin-Carbohydrate Complexes and Phenolic Acids in Bagasse,** Holzforschung, **38**, 141 (1984)

Lignin-carbohydrate complex (LCC) which contained ferulic and *p*-coumaric acids was isolated from milled sugar cane bagasse. The carbohydrate portion of LCC is composed of arabinoglucuronoxylan having arabinose and xylose ratio of 1 : 8. Alkali labile ferulic and *p*-coumaric acids were esterified to the different molecular species, polysaccharide and lignin moieties, respectively. Since the linkages between carbohydrate and lignin could be splitted by alkali, lignin was presumed to link through benzyl ester or benzyl ether linkages to arabinoglucuronoxylan in the cell-walls of sugar cane.

J. AZUMA, F. TANAKA and T. KOSHIJIMA: **Enhancement of Enzymatic Susceptibility of Lignocellulosic Wastes by Microwave Irradiation.** J. Ferment. Technol., **62**, 377 (1984)

The enzymatic susceptibility of sugar cane bagasse, rice straw, and rice hulls were markedly improved by microwave pretreatment above 160°C and showed a maximum at 223–228°C. The maximal percentage of reducing sugars was 77–84% of the polysaccharide present in the original lignocellulosic wastes. The increase in available surface of cellulose due to degradation of encrusting lignin and hemicellulose is suggested to be a rate-determining factor for enzymatic saccharification of cellulose in lignocellulosic wastes because of the stability of crystallinity of cellulose, toward microwave irradiation.

T. KOSHIJIMA, T. WATANABE and J. AZUMA: **Existence of Benzylated Carbohydrate Moiety in Lignin-Carbohydrate Complex from Pine Wood**, Chem. Lett., 1737 (1984)

Using the reaction of 2,3-dichloro-5,6-dicyanobenzoquinone which acts on *O*-methoxybenzyl ether to liberate alcohol quantitatively, a part of sugar moieties contained in conifer lignin-carbohydrate complex was confirmed to link to lignin moiety at alpha carbon of phenylpropane units through benzyl ether bond.

F. TANAKA and T. KOSHIJIMA: **Orientation distributions of cellulose crystallites in *Pinus densiflora* woods**, Wood Science and Technology, **18**, 177 (1984)

Pole figures were described for (101), ($10\bar{1}$), (002) and (040) crystallographic planes of cellulose crystallites in opposite, normal and compression woods of *Pinus densiflora*. The orientation functions for these planes were plotted on the equilateral triangular coordinate. The orientation factors were calculated from the functions. It was found that the cellulose crystallites in the S_2 layer contributed to the orientation distribution although those in the other layers also contributed to some extent. From the equilateral triangular coordinate plots it was found that the orientation distributions of cellulose crystallites in wood varied in some kind of regular fashion. This was more clearly confirmed by the variations of the orientation factors.

E. MURAKI, F. YAKU and T. KOSHIJIMA: **Enzymatic Degradation of Finely-Divided Wood Meal III; Lauans**, Mokuzai Gakkaishi, **30**, 936 (1984)

In investigating the effect of milling on the enzymatic saccharification of lauan woods the saccharification ratio after ball-milling for three hours and hydrolyzing at pH 4.0 was only 10–20%. This value was much lower than that of Akamatsu which was ball-milled and hydrolyzed under the same conditions. With a 2.5 times greater concentration of enzyme and a pH 4.5, however, the saccharification ratio increased to about the same value as for Akamatsu. Under these conditions, yellow lauan was hydrolyzed to about 55% of the wood (about 90% of wood polysaccharide), and red lauan was hydrolyzed to about 40% of the wood (about 70% of wood polysaccharide). Milling for one to three hours was sufficient to obtain a high saccharification ratio for both yellow and red lauans when the concentration of enzyme was appropriately selected, depending on the wood species.

S. FUJISHIMA, F. YAKU and T. KOSHIJIMA: **Recovery and Reutilization of Cellulases Used for the Hydrolysis of Woods I; Fundamentals**, Mokuzai Gakkaishi, **30**, 560 (1984)

To investigate the recovery of cellulases used for the hydrolysis of woods, it is necessary to know the behavior of the cellulases during the hydrolysis.

We developed a method to determine the quantity of enzyme from the spectrum

of circular dichroism of cellulase without interference due to coexisting lignin and saccharides in solution.

Cellulase Onozuka R-10 from *Trichoderma viride* and Cellulosin AC from *Aspergillus niger* were used for the enzymatic degradation of Akamatsu (*Pinus densiflora* S. and Z.) and their properties were investigated. Cellulase Onozuka R-10 had an intense affinity with wood, and 50% of the enzyme added to the reaction system was adsorbed by the wood powder after 30 minutes, which still kept its activity in the adsorbed state. In contrast with Cellulase Onozuka R-10, Cellulosin AC had little affinity with wood powder and activity remaining in the solution was twice as high as that remaining in the residual wood after enzymatic hydrolysis for for 24 hours. The activity remaining in the solution decreased with an increase in reaction time and a decrease in pH of the solution.

T. KOSHIJIMA, F. YAKU, E. MURAKI and R. TANAKA: **Wood Saccharification by Enzyme Systems without Prior Delignification**, J. Appl. Polym. Sci., Applied Polymer Symposium, **37**, 671 (1983)

Around 80% of the polysaccharides contained in Akamatsu (*Pinus densiflora*) wood was hydrolyzed by using Cellulosin AP originated from *Aspergillus niger* without prior delignification when wood meal had been previously finely divided for 24 h by a vibration-type ball mill. The substrate concentration used in the enzymatic hydrolysis was 1 g/100 mL. It has been found that the hydrolysis rate increases to 86% by using a 1 : 1 mixture of Cellulosin AP and Onozuka R-10 cellulases and wood milled for 2 h. When the hydrolysis is performed at the substrate concentration 4 g/100 mL, however, 2 h of milling allows only a 42.5% hydrolysis rate, and it is necessary to take more than 24 h to degrade 80% of the polysaccharides contained. Milling by a three-roll mill has been found to achieve more effective milling. This consists of three rolls rotating at different speeds. The finely divided woods, previously pasted with liquid paraffin, water, or DMSO, are passed through the rolls. The size of woodmeal particles is reduced to less than 10 μ after milling. By using the three-roll mill for 22 times of repeated roll millings a 90% hydrolysis rate was obtained, even in the substrate concentration of 4 g/100 mL. The reaction rate of enzymatic hydrolysis increased with increasing number of roll millings, thus 22 times of roll milling resulted in a twofold increase in reaction rate of the enzymatic hydrolysis compared with that of no milling. Plotting of the reaction rate V of the enzymatic hydrolysis against substrate concentration [S] showed that V leveled off at 10 g/100 mL of [S] in the 22 times roll-milled wood, and the value was only 4 g/100 mL in case of the untreated wood. The enzymatic hydrolysis rate has been compared for cellulose and wood, both of which were previously milled to different extents. In the case of cellulose, the hydrolysis rate showed a maximum at 24 h of milling, then de-

creased thereafter. This is not the case with woodmeal, where the existence of lignin as a radical scavenger may prevent the radicals formed in cellulose molecules from acting as a retardant for enzymatic hydrolysi of cellulose.

K. INABA, Y. IIZUKA and T. KOSHIJIMA: **Effect of Addition of Sulfite Pulp Waste on Chemical Composition of Mycelium and Fruiting-body Formation of Edible Mushurooms by Sulfite Pulp Waste**, J. Antibac. Antifung. Agents, **12**, 57 (1984)

Growth stimulants for edible mushrooms, LVD and LSD, were isolated from the sulfite waste solid of softwood pulp and of hardwood pulp, respectively.

Lentinus edodes, Pleurotus ostreatus and *Flammulina velutipes* were cultivated on potato extract liquid medium containing LVD or LSD, and the chemical components of the mycelia of these mushrooms were analyzed. As a result, no change in sulfur content was observed, but calcium which was not found in original mushrooms increased to about 6%. The sum total of glucose and mannose amounted to 85–95% of the total carbohydrates in every mushroom. Leucine, isoleucine and tyrosine increased in quantity both in *Lentinus edodes* and *Pleurotus ostreatus* and glutamic and asparaginic acid contents were higher in *Flammulina velutipes.*

A field test for examining the fruit-body formation of *Flammulina velutipes* indicated that the addition of 0.75% LSD to the seed culture medium brought about 24% increase in yield weight and 50% increase in the number of commercially favourable mushrooms when the mycelium grown on the seed culture medium was transferred to the ordinary medium.

E. MAEKAWA and T. KOSHIJIMA: **Properties of 2, 3-Dicarboxy Cellulose Metallic Salts,** Cellulose Chem. Technol., **18**, 31 (1984)

2,3-Dicarboxy cellulose has been prepared in good yields from 2, 3-dialdehyde cellulose obtained by periodate oxidation of cellulose according to a modification of the method described by Hofreiter et al. The 2, 3-dicarboxy cellulose took up various metal ions in an aqueous medium to form precipitate or massive solid. The metals were taken up to the theoretical values estimated as combined in the form of metallic salts of carboxylic acid. 2, 3-Dicarboxy cellulose metallic salts formed by certain metal ions gave viscous, gel-like products, which solidified on standing. The properties of such metallic salts are discussed.

R. TANAKA, F. YAKU and T. KOSHIJIMA: **Enzymatic Degradation of Acetyl Glucomannan II; Fractionation and Structure of Oligosaccharides Containing Acetyl Groups,** Mokuzai Gakkaishi, **29**, 884 (1983)

Acetyl glucomannan prepared from the sapwood of *Pinus densiflora S.* and *Z.* was subjected to enzymatic degradation by using a 1, 4-β-glucanase preparation

made from *Trichoderma viride*. This preparation contained endo-1, 4-β-glucanase activity in addition to those of β-glucosidase, β-mannanase, and weak β-mannosidase. The enzyme systems, however, cannot split off the part of the structure containing the acetyl groups.

The enzymatic degradation products were fractionated by gel-filtration chromatography on a Toyopearl HW-40F column, through which high yields of individual oligosaccharides were recovered. Di-, tri-, and tetrasaccharides fractions were purified by paper chromatography on Whatman 3MM. Two types of mannose oligomers, mannose oligomers of a degree of polymerization ($\overline{DP}$) of 2 to 6 (M_2 to M_6) and glucose-containing mannose oligomers at the reducing end of a $\overline{DP}$ of 2 to 6 (MG to M_5G) were obtained from the enzymatic degradation products. The acetyl groups were contained in oligosaccharides having a $\overline{DP}$ larger than 3. The Rf values of acetylated oligosaccharides were remarkably higher than those without acetyl groups. Particularly, oligosaccharides with a higher $\overline{DP}$ contained more abundant acetyl groups. The presence of tetrasaccharide containing two moles of acetyl groups per molecule (Ac_2M_4, Ac_2M_3G) also was confirmed.

K. INABA, Y. IIZUKA and T. KOSHIJIMA: **Influence of the Degree of Substitution and the Molecular Weight of Polysaccharide Sulfonates upon the Growth Acceleration of Edible Mushrooms,** Mokuzai Gakkaishi, **30**, 251 (1984)

Cellulose, starch, pectin, and glucuronoxylan were sulfonated in a variety of degrees and then an investigation was made as to how the degree of substitution influenced the growth of edible mushroom mycelia. For *Lentinus edodes,* Fractions F-2 (2h) (S, 3.85%) and F-2 (3h) (S, 4.61%) of glucuronoxylan sulfonate gave 2.8 and 2.9 times the yields, respectively, of that of the blank test. The best yields of mushrooms were obtained from Fraction F-2 (4h) (S, 4.84%) of glucuronoxolan sulfonate and F-2 (1h) (S, 4.68%) of starch sulfonate when used with *Pleurotus ostreatus,* and also form Fraction F-2 (1h) (S, 4.68%) of starch sulfonate and Fraction F-2 (1h) (S, 6.51%) of cellulose sulfonete when used with *Flammulina velutipes.* Note that except for cellulose, the plysaccharide sulfonates fractions containing 4 to 5 percent sulfur gave the maximum yiedls of mushrooms.

The effect of the molecular weight of the sulfonates on mushroom growing was determined for respective fractions having molecular weights of less than 1000, 1000-2000, 2000-3500 and more than 3500. The fraction with a molecular weight of 1000 to 2000 had the highest accelerating effect for polysaccharide sulfonate or lignin carbohydrate complex sulfonate.

E. MAEKAWA and T. KOSHIJIMA: **Effect of acetate buffer in preparing chlorite holocellulose from woody materials,** Tappi Journal, **66**, No. 11, 79 (1983)

Holocellulose prepared using acetate buffer was obtained at higher yield. The results showed that the amout of Klason lignin in holocelluloses prepared using acetate buffer was somewhat lower at all stages of the acid chlorite treatment. This finding implies that delignification using acetate buffer as a reaction medium is more effective. Furthermore, the increase in holocellulose yield means that a smaller amount of polysaccharides is lost through dissolution in the liquor. These results are also in accord with findings similar with Japanese red pine. Consequently, the modified acid chlorite method is recommended as an improved method of preparing wood holocellulose.

T. HIGUCHI: **Wood and Lignins,** In, "Tennen-Kobunshi (Kobunshi Jikkengaku 8)", ed., Kobunshigakkai (Kyoritsu Shuppan, Tokyo), p. 315 (1984) (in Japanese)

Methods of preparation and characterization of wood meal for analysis and lignin were described.

T. HIGUCHI: **Mechanism of Microbial Degradation of Lignin,** Mokuzai Gakkaishi, **30**, 613 (1984) (in Japanese)

Recent advances in lignin biodegradation by white-rot fungi were reviewed and discussed.

T. HIGUCHI: **Explosion of Wood by Steaming-Application to Biomass Conversion**, Iden, **38**, 32 (1984) (in Japanese)

Characteristics of steam-exploded wood, and enzymatic saccharification and conversion to cattle feed, plastics, and pulp of the exploded wood were reviewed and discussed.

T. HIGUCHI: **Lignin**, In, " Ikagaku Daijiten (Encyclopedia of Medical Sciences) ", ed., T. TAKEMI (Kodansya, Tokyo), p.250 (1984) (in Japanese)

Characteristics and applications of lignin were reviewed.

M. SHIMADA, T. HABE, T. UMEZAWA, T. HIGUCHI and T. OKAMOTO: **The C-C Bond Cleavage of a Lignin Model Compound, 1,2-Diarylpropane-1,3-Diol, with a Heme-Enzyme Model Catalyst Tetraphenylporphyrinatoiron (III) chloride in the Presence of *tert*-Butylhydroperoxide**, Biochem. Biophys. Res. Comm., **122**, 1247 (1984)

The catalytic C-C bond cleavage of a lignin model compound was investigated by use of tetraphenylporphyrinatoiron(III)chloride as a model for enzymic degradation of lignin. The C-C bond of the lignin model compound 1,2-bis(4-ethoxy-3-methoxyphenyl)propane-1,3-diol was oxidatively cleaved by catalysis of iron-porphyrins in the presence of *tert*-butylhydroperoxide or iodosylbenzene at a room temperature. The products formed after complete oxidation of the substrate were

identified as 4-O-ethylvanillin, α-hydroxy-4-ethoxy-3-methoxyacetophenone, 4-O-ethylvanillic acid, 4-ethoxy-3-methoxyphenylglycol, 4-ethoxy-3-methoxy-α-(4-ethoxy-3-methoxyphenyl)-β-hydroxypropiophenone and formaldehyde.

M. TANAHASHI and T. HIGUCHI: **Steam Explosion Process — Application and Development for Forest Biomass**, Polymer Applications, **32** (12), 595 (1983)

Steam explosion process for wood is an efficient pretreatment method for wood refinary. In this report, the structures and the physical and chemical properties of exploded wood were discussed. Applications for wood saccharification, ruminant feed preparation, wood plastics and pulping were investigated. Future deveropment of the steam explosion process of wood was also discussed in relation to total utilization of wood.

M. TANAHASHI: **Conversion and Total Utilization of Forest-Biomass by Explosion Process**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 34 (1983)

Recent investigations on characteristics and applications of exploded wood were reviewed. Future development of the steam explosion process of wood was also discussed in relation to wood saccharification, productions of cattle feed, wood plastics and pulping for total utilization of forest-biomass.

T. MIYAMOTO, Y. TAKAGI, T. SIBATA, H. INAGAKI and M. TANAHASHI: **^{13}C-Nuclear Magnetic Resonance Studies of Cellulose Acetate**, J. Polymer Science, Polymer Chemistry Ed. **22**, 2363 (1984)

^{13}C-NMR spectra of ring charbons and O-acetyl carbonyl carbons of cellulose acetate (CA) in dimethyl sulfoxide-d_6 were analyzed. The CA samples with the degree of substitution (DS) ranging from 0.84 and 1.91 were prepeared by homogeneus acetylation of cellulose with acetic anhydride in a 10% LiCl/dimetyl acetoamide solvent. It was found that the use of these low-DS samples permitted easier assignments not only of the ring carbon but also of the O-acetyl carbonyl carbon signals. The assignments were confirmed by comparing with the ^{1}H-NMR spectra of the samples obtained by complete acetylation of the corresponding CA samples with acetyl-d_3 chloride. Two methods for determining the distribution of O-acetyl groups of CA, i.e., the rerative DS at the three different types of hydroxyl groups, were developed. One is based on the mesurements of the relative intensities of the signals for the ring carbons and the other is based for the O-acetyl carbonyl carbons.

Y. KAMAYA and T. HIGUCHI: **Metabolism of Non-phenolic Diarylpropane Lignin Substructure Model Compound by *Coriolus versicolor***, FEMS Microbiol. Lett., **22**, 89 (1984)

A lignin substructure model, 1-(4-ethoxy-3,5-dimethoxyphenyl)-2-(4-ethoxy-3-methoxyphenyl)-propane-1,3-diol(I), was actively metabolized by a white-rot fungus *Coriolus versicolor* in low nitrogen stationary cultures favouring the ligninolytic activity in the fungus. Cleavage of the dimer I between C_α and C_β of the propanoid side chain was the major degradative reaction by the fungus.

Y. KAMAYA and T. HIGUCHI: **Metabolism of 3,4-Dimethoxycinnamyl Alcohol and Derivatives by *Coriolus versicolor*,** FEMS Microbiol. Lett., **24**, 225 (1984)

3,4-Dimethoxycinnamyl alcohol (I) was actively metabolized by a white-rot fungus *Coriolus versicolor* in low nitrogen and high oxygen stationary cultures favouring the ligninolytic activity in the fungus. Substrate I was mainly oxidized to veratrylglycerol (III) which was a mixture of *erythro* and *threo* forms. Both isomers were degraded by cleavage between C_α and C_β of the side chain to give veratraldehyde (VI), and (VI) was then reduced to veratryl alcohol (VII). A part of I was also metabolized via 1-(3,4-dimethoxyphenyl)-propane-3-ol (IV) and 1-(3,4-dimethoxyphenyl)propane-1,3-diol (VIII) by the fungus.

Y. KAMAYA and T. HIGUCHI: **Degradation of d,l-Syringaresinol and Its Derivatives, β-β′ Linked Lignin Substructure Models, by *Phanerochaete chrysosporium*,** Mokuzai Gakkaishi, **29** (11), 789 (1983)

Degradation of β-β′ linked lignin substructure models was investigated with ligninolytic cultures of a white-rot Basidiomycete, *Phanerochaete chrysosporium*. The non-phenolic model, *d,l*-syringaresinol dimethyl ether(**Ib**), was hardly metabolized, but phenolic models, *d,l*-pinoresinol(**VIII**) and *d,l*-syringaresinol(**I**), were polymerized and/or degraded mainly via alkyl-aryl cleavage, probably by the fungal phenol-oxidizing enzymes. Demethylation of the syringyl moiety to produce a catechol structure was also found.

Y. KAMAYA and T. HIGUCHI: **Metabolism of 1,2-Disyringylpropane-1,3-diol by *Phanerochaete chrysosporium*,** Mokuzai Gakkaishi, **30** (3), 237 (1984)

A phenolic diarylpropane (β-1) lignin substructure model, 1,2-disyringylpropane-1,3-diol (**I**), was metabolized rapidly by a white-rot fungus *Phanerochaete chrysosporium*. Syringylglycol (**II**), α-hydroxyacetosyringone (**III**), syringaldehyde (**IV**), and syringyl alcohol (**V**) were isolated and identified as the main intermediary products, suggesting that C_α-C_β side chain cleavage occurs as a primary reaction in the degradation of the phenolic β-1 dimer by the fungus.

T. UMEZAWA, T. HIGUCHI and F. NAKATSUBO: **Difference in $^{18}O_2$ Incorporation Oxygenative Degradation of β-*O*-4 and β-1 Lignin Substructures by**

Phanerochaete chrysosporium, Agric. Biol. Chem., **47**, 2945 (1983)

Degradation of β-*O*-4 and β-1 lignin substructure model dimers under $^{18}O_2$ in a ligninolytic culture of a white rot fungus, *Phanerochaete chrysosporium,* was investigated. $^{18}O_2$ was incorporated into C_α, in the C_α-C_β cleavage of the β-*O*-4 substructure, while $^{18}O_2$ was incorporated into C_β, but not into C_α, in the C_α-C_β cleavage of the β-1 substructure.

T. UMEZAWA and T. HIGUCHI: **Incorporation of $H_2{}^{18}O$ into the C_α but not the C_β Position in Degradation of a β-*O*-4 Lignin Substructure Model by *Phanerochaete chrysosporium,*** Agric. Biol. Chem., **48**, 1917 (1984)

Degradation of a β-*O*-4 lignin substructure model dimer by a white rot fungus, *Phanerochaete chrysosporium,* was investigated using a culture containing $H_2{}^{18}O$, and the following conclusions were made. a) The direct hydrolysis at C_β of the β-*O*-4 dimer was not involved in formation of arylglycerol. b) About half of the oxygen at the benzyl (C_α) position of the glycerol was derived from H_2O ($H_2{}^{18}O$) and the other half was from the oxygen at the benzyl (C_α) position of the substrate β-*O*-4 dimer. c) But, the oxygen at the C_α position of the substrate β-*O*-4 dimer did not migrate to the C_β position of the aryglycerol.

M. NORIMOTO and H. WADA: **Wood Bending of Sugi and Hinoki from the Thinning Operation,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 93 (1983) (in Japanese)

Wood bending of Sugi and Hinoki wood pieces from the thinning operation utilizing microwave heating was investigated. The bending quality was evaluated by the radius of curvature of a bent member. A good correlation was found between bending quality and specific Young's modulus in dry condition.

I. IIDA, M. NORIMOTO and Y. IMAMURA: **Hygrothermal Recovery of Compressed Set,** Mokuzai Gakkaishi, **30**, 354 (1984) (in Japanese)

After test specimens of three different wood species in a wet condition were heated by microwave irradiation, they were compressed in the radial direction and dried under restraint. Then, the compressed specimens were subjected to moisture and heat treatments, and their dimensional changes were measured. Also, using a scanning electron-microscope the changes that occurred in the anatomical structure of the compressed specimens were investigated.

Any failure and separation of the cell walls could not be detected even in the specimen compressed by 68.4%, and the reduction of the cell cavity and the folding of the cell wall in proportion to the amount of compression were recognized in the scanning-electron micrographs of the transverse sections. By moisture and heat treatments, the dimensions and cell shapes of the compressed specimens were almost

restored to their original state.

From the results obtained, an interpretation on the mechanism of drying set is given in terms of the elastic deformation of microfibrils composed of cellulose and the irreversible change between the glassy state and the rubbery state of the matrix composed of lignin and hemicelluloses.

M. NORIMOTO: **Hygroscopicity of Interior Wall Materials and Humidity Conditions,** Kenchiku Zatushi (J. Architecture and Building Science), **99**, No. 1225, 36 (1984) (in Japanese)

Relationship between humidity conditions and the nature of interior wall meterials were reviewed and it was emphasized that wood based materials resulted in superior humidity conditions compared with synthetic and inorganic ones.

M. NORIMOTO, T. ONO and Y. WATANABE: **Selection of Wood Used for Piano Soundboards,** Nihon Reoroji Gakkaishi (J. Society of Rheology, Japan), **12**, 115 (1984) (in Japanese)

In order to improve the yield rate of wood used for piano soundboards, measurements were made of the dynamic mechanical properties for Sitka spruce (*Picea sitchensis*) wood pieces containing reaction wood, sapwood, indented rings, knot, resin streak, and resin pocket, which have been accepted to be defects according to the maker's own selection measure. In the present study the suitability of wood for soundboards was evaluated by using both the values of internal friction and specific Young's modulus in longitudinal direction; low internal friction and high specific Young's modulus were considered to be facorable for soundboards. The pieces containing intense reaction wood had higher value of internal friction and lower value of specific Young's modulus compared with those of slight reaction wood. The one with extremely low value of specific Young's modulus had large average microfibril angle in the cell wall. About half of the pieces containing slight reaction wood showed the acoustical properties comparable to those of defect-free high grade ones. Sapwood pieces had high value of internal friction and high specific Young's modulus. The high friction of sapwood was considered to result from their high moisture content. The acoustical properties of the pieces containg intense indented rings and resin streak were inferior to high grade ones. However, the acoustical properties of the pieces containing slight indented rings, knot, and resin pocket were almost comparable to those of high grade ones; probably these pieces are regarded as being inferior not because of their acoustical properties but because of their appearance. It was suggested that the selection based on the dynamic mechanical measurement is necessary to improve the yield rate of wood for piano soundboards.

M. MORI, S. NAKAZAWA, M. NORIMOTO, T. YAMADA, M. HIRANO, M. TAKAOKA,

and T. MURANAKA: **Measurement of Internal Temperature of Wood Piece during Microwave Irradiation by Fiber-Optical Temperature Sensor**, Mokuzai Kogyo (Wood Industry), **39**, 600(1984) (in Japanese)

The internal temperature of wood during a microwave irradiation was measured using a fiberoptical sensor with electromagnetic immunity. After the sensor was inserted into a small hole bored in the wet wood piece, a microwave of 3 kW was irradiated continuously, and changes of wood temperature were recorded.

Wood temperature began to rise immediately after a microwave irradiation, and it continued to rise linearly up to about 100°C. Wood temperature remained at 100°C level for a while (the 1st plateau) and then it began to rise again up to about 135°C (the 2nd plateau). After it remained constant for 65 seconds, it continued to increase.

When the sensor was covered with an insulating tube, the time interval of 1st plateau was shortened by about one-second.

The fiber-optical sensor proved to be effective for an accurate measurement of wood temperature during a microwave irradiation.

T. HAYASHI and H. SASAKI: **Fatigue Damage of Wood Butt-Joints with Metal-Plate Connectors**, Mokuzai Gakkaishi, **30**, 231 (1984) (in Japanese)

The retention of strength and fatigue life of wood butt-joints with metal-plate connectors after the repetition of pulsating loads as a pre-treatment was observed. The process of fatigue damage of the joints and its effect on the retention of strength were discussed.

The residual strength of the joints decreased slightly with the increasing number of load repetitions. The decrease was only 5 percent of the strength of the non-treated specimens, even when the number of cycles was equivalent to 80 percent of the fatigue life (N).

On the other hand, because of the fatigue damage caused by the pre-treatment load, the residual fatigue-life decreased proportinally with the number of repetitions of the pre-treatment load (n).

The linear damage theory was used to evaluate the residual fatigue-life. The average of the cumulative cycle ratio to failures $\Sigma(n/N)$ of the joints ranged from 0.71 to 0.93. The difference between the values of the first pre-treatment load and the second one, and the order of their application had no effect on the ratio.

The failure mode of the specimens did not depend on the first pre-treatment load, but on the second one. The relationship between the second load and the number of sheared teeth of the connector was the same as that of the non-treated specimns.

S. ISHIHARA, K. TOMARU and S. TOMARU: **Fire Endurance of Wooden Panels. I. Fire Endurance of Laminated Wooden Wall Panels from Thinning and Commercial Wooden Wall Panels,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 146 (1984). (in Japanese).

To serve as basis for establishing acceptance criteria for structural wooden wall panel in housing, fire endurance tests were done on four newly developed wooden wall panels from thinnings and four conventional commercial wooden wall panels by means of JIS A 1301 and 1304. Species of thinning as raw material used were Sugi (*Cryptomeria japonica* D. Don), Hinoki (*Chamaecyparis obtusa* Endl.) and Karamatsu (*Larix leptolepis* Gordon). The fire endurance of the wooden wall panels from thinnings met 1st-2nd class fire resistance by JIS A 1301. The protected commercial wooden wall panels with cement plastering did not met 2nd class fire resistance of JIS A 1301. The fire endurance of the wooden wall panels when tested exterior side by JIS A 1304 had 60 minutes or more fire resistance. The effect of wood species as raw material on fire endurance of the wooden wall panels was very slightlt. Coating of phosphoric-melamine-formaldehyde condensation products imparted the excelleny fire resistant to the wooden wall panels.

S. ISHIHARA: **An Interview Report on Fire Research Institute and Organizations in four Eurpean countries.** Mokuzai Kogyo (Wood Industry) **39**, 148 (1984). (in Japanese)

S. KAWAI and H. SASAKI: **Production Technology and the Properties of Oriented Boards (1),**)Mokuzai Kogyo (Wood Industry) **39**, 9 (1984) (in Japanese)

Both mechanical and electrical methods for aligning particles are reviewed. Factors for controlling the orientation degree of the methods are investigated, and the effect of the orientation degree on the mechanical properties and the dimensional stability of the oriented strand boards is discussed.

S. KAWAI and H. SASAKI: **Production Technology and the Properties of Oriented Boards (2),** Mokuzai Kogyo (Wood Industry) **39**, 65 (1984) (in Japanese)

Both mechanical and electrical methods for aligning wood fibers are reviewed. Factors for controlling the orientation degree of the methods are investigated, and the effect of the orientation degree on the mechanical properties and the dimensional stability of the oriented fiberboards is discussed.

M. MASUDA and S.P. TAKINO: **Fatigue Properties of Wooden Floors Under a Concentrated Load,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 18, 131 (1983) (in Japanese)

Bending fatigue is one of the important factors which must be considered in design-

ing wooden floors. Bending fatigue tests were carried out on strip flooring, particle board subfloor and stressed-skin floor panels respectively under concentrated cyclic load. The function of repeated load was sinusoidal and the minimum load was 5 kgf. Each ratio of the fatigue strength at 10^6 cycles to the static strength for these three kinds floors was more than 40% and the increase of deflection under repeated load was hardly observed.

Z. NAM, S. ISHIHARA, H. SASAKI, A. MACHIHARA and OHTA: **Acidified- and Spray-dried Spent Sulfite Liqour as Binder for Particleboard.** Zairyo, **33**, 266 (1984)

Powdered resins were prepared from softwood and hardwood spent sulfite liquor (SLL) by acidifying and spraydrying, and they were used as binders for particleboard. The strength properties and dimensional stability of the boards were evaluated. The particleboard with SLL powder showed good dimensional stability, but low modulus of rupture and low internal bond. The board with softwood SLL powder was better in both strength properties and dimensional stability than that with hartwood SLL powder.

H. SASAKI: **Research on Composite Wood in the Near Future,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes) No. 19, 26 (1984) (in Japanese)

The proper relation between wood research and wood industry are discussed in connection with the ideal cycle of forest resources. Two destination consciousness that is activation of wood industry and conservation of forest resources have to be harmonized.

From this point of view, research and developments on utilization of forest and industrial residues are especially important.

H. SASAKI: **Development of New Processing Machines and Systems for Domestic logs,** Mokuzai Kogyo (Wood Industry) **39**, (11) 52 (1984) (in Japanese)

Recent developments on processing domestic plantation softwood logs with small diameter are reviewed. 1) Two new types of veneer lathe for peeling small logs such as those provided from thinning operation in softwood plantation are introduced: one with three powered backup-rolls and a roller-bar, the other one with powered toothed thin wheels at the nose-bar. 2) High yield systems for LVL production from small softwood logs are discussed in connection with the continuous laminaters. 3) Newly developed system of oriented strand board production by means of high voltage are introduced.

S.P. TAKINO and H. SASAKI: **Bending Fatigue Characteristics of Prefabricated Floor Panels,** Mokuzai Kenkyu Shiryo (Wood Research and Technical

Notes), No. 18, 141 (1983) (in Japanese)

Bending fatigue test was carried out on floor panel which was composed of particle board and adjustable bolt supports. The function of repeated load was sinusoidal and the maximum and minimum loads were 100 kgf and 5 kgf. In case of air-dried condition, the deflection under repeated load was 2.62 mm, but in case of wet condition, it was 4.28 mm.

M. TAKATANI, R. HAMADA and H. SASAKI: **Testing Method for Cleavage-Fracture Toughness of Glue-Lines in Bonded Wood. I. Value of β in the Sasaki-Walsh's Formula**, Mokuzai Gakkaishi, **30**, 124 (1984) (in Japanese)

For the testing method to determine cleavage-fracture toughness (G_{IC}) with double cantilever-beam type specimens of the wood-glue bond system, the offset value (β) in the Sasaki-Walsh derived formula is discussed by means of a numerical analysis of the displacement of the specimens with various glue line thickness and flexibilities. In addition, experiments were made on several wood species, and G_{IC} was calculated by using these values of β, resulting in

1) β for ordinary wood-glue bond systems, in general, ranges from 1.2 to 1.75.

2) β increases with increasing flexibility of glue lines.

3) The values of β increase with increasing thickness of glue lines when Young's modulus of adherends in the lateral direction is greater than that of the glue line, whereas they decrease in the opposite case.

4) Influences of elastic constants and the anisotropy of adherends on β is not obvious unless a low-density wood such as balsa is used.

5) The error which results from appling 1.4 for β as used in a previous paper is estimated at less than 3 percent, even if extreme thickness and flexibility of glue lines are assumed. In consideration of the significant digits required for the fracture toughness, G_{IC}, this simplification (that is $\beta=1.4$) will be effective for calculating G_{IC} from experimental data that wood-glue bond systems in general use.

M. TAKATANI, R. HAMADA and H. SASAKI: **Testing Method for Cleavage-Fracture Toughness of Glue Lines in Bonded Wood. II. Determination of the Size of the Standard Specimen and Measurement of the Fracture Toughness**, Mokuzai Gakkaishi, **30**, 130 (1984) (in Japanese)

Stress distribution of double cantilever-beam type specimens for measuring the cleavage-fracture toughness (G_{IC}) of the wood-glue bond system containing an unbonded part (that is, an artificial crack, see Fig. 1) was calculated numerically by the finite element method, and a reasonable size for the specimen was determined. The results showed that for standardization a length of more than five times the thickness of the adherend was needed for both the bonded and unbonded parts of

the specimen.

Fracture tests were made on the standard double cantilever-beam specimen with nine adhesives. Fracture toughness, G_{IC}, was calculated resulting in

1) G_{IC} varied from 0.17 to 1.24 kg•cm/cm^2.

2) G_{IC} increased with increasing flexibility of glue lines.

3) Although the influence of the elastic properties of the adherends on G_{IC} was complicated, it is supposed that G_{IC} was improved by using rigid adherends when flexible glue was used and also by using flexible adherends when rigid glue was used.

K. NISHIMOTO, K. FUSHIKI and Y. OTA: **Quantitative Analysis of IF-1000 in Preservative Plywoods**, Mokuzai Kogyo (Wood Industry), **39**, 484 (1984) (in Japanese)

This paper is related to a new technique and its reliability for quantitative analysis of IF-1000 incorporated into urea-melamine or phenolformaldehyde adhesive of plywoods. Red lauan plywood samples were prepared in which a fungicide, an organoiodine compound IF-1000 was added to the glue at the levels of 1,200, 1,000, 800 and 600 g/m^3. The fungicide was extracted with formic acid and toluene (or acetone) and then the extract was subjected to gas chromatography for determining the amount of IF-1000 in the glue.

Recovery rate was satisfactorily high when the newly made plywood samples were tested, and the results suggested the possibility of the extraction technique applicable to the quantitative analysis of IF-1000 incorporated in the glue line. Though extraction time produced the varied results, at least 9 hours' length was required to obtain a constant level of extraction.

M. AYAKI, M. TAKAHASHI and K. NISHIMOTO: **Puff-Cooking Treatment and Its Acceleration of Wood Decay,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes,) No. 18, 66 (1983) (in Japanese)

Effect of puff-cooking treatment on wood was investigated for the resulting acceleartion of wood decay and various chemical changes. This treatment has been successfully used as the pretreatment of grain for production of soya-sauce.

Wafers and meal of beech (*Fagus crenata* BLUME) and pine (*Pinus densiflora* SIEB. et ZUCC.) heartwood were treated and exposed to fungal attack using each two species of brown-rot- and white-rot fungi. Five treating conditions were employed: 4 (kg /cm^2)–20 (min), 4–60, 8–20, 8–60 and 12–60.

At 4–8 (kg/cm^2) treatments, increase of alcohol-benzene (only in beech) and 1% sodiumhydroxide soluble contents, decrease of γ-cellulose, and increase of molecular weight of holocellulose were demonstrated. At 12 kg/cm^2 treatment, increase of α-cellulose/holocellulose ratio and decrease of molecular weight of holocellulose and

lignin content were proved. Acceleration of decay was found in some combinations of wood and fungus, especially in *Gloeophyllum trabeum* and the two wood species. The acceleration occurred at all treating conditions but more greatly at light or medium treating conditions. It was enhanced markedly in pine wood meal. This treatment was considered to be promissing for an utilization of wood waste.

Y. IMAMURA and K. NISHIMOTO: **Decay Resistance of Commercial Particleboards.** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes, No. 18, 162 (1984) (in Japanese)

Decay resistance of commercial particleboards classified by JIS A 5908 was comparatively tested using the sand-block method and the creep-deflection measurement under fungal attack. The former was the standard method designated in JWPA and the latter was newly designed to evaluate the mechanical performance.

Board resistance varied considerably depending on manufacturing conditions and adhesive types as well as the species of decay fungi. The effect of the wood species used seems to be smaller with particleboard than with solid wood. Fine chips with a high content of glue impede the growth of fungi. The adhesives used are of higher importance for the decay resistance, as urea and urea-melamine resins can have a promoting, phenolic resins an impeding effect.

Y. IMAMURA and K. NISHIMOTO: **Termite Resistance of Commercial Particleboards.** Mokuzai Kogyo, (Wood Industry) **39**, 70 (1984) (in Japanese)

Some types of commercial particleboards were exposed to the attack of subterranean termites, *Coptotermes formosanus* SHIRAKI, by two laboratory methods. Those were choice tests when termites could move freely in moist soil and feeding tests in a small vessel. Although particleboards were generally considered to be less susceptible to termites, board's effect on quality seemed to give different degrees of damage and forms of galleries caused by termites. The interior of the board of low density was infested severer than the dense surface of finer particles and higher content of adhesive. It is postulated that the hardness of boards is more important in restricting termite activity than any other factors such as species of wood and the type of adhesive.

Y. IMAMURA and K. NISHIMOTO: **Fractography of Particleboards under Fungal Attack.** Proceedings of Pacific Regional Wood Anatomy Conference, 37 (1984)

Some commercial particleboards and treated ones by glue additive with fungicidal chemicals were subjected to bending creep tests under progressive fungal attack with a brown-rot fungus *Tyromyces palustris* and a white-rot fungus *Coriolus versicolor*. The fractured surfaces were observed by SEM and their characters were discussed in relation to the types of glue and board's effects on qualities.

In UF or UMF resin boards infested by 2 brown-rot fungus, a rapid increase in deflection occured during relatively early stages with little weight loss due to active fungal invasion onto the surfaces of wood particles and consequent glue failure. The boards bonded with PF resin showed the fractured surfaces accompanied with mycelium propagation and destruction of wood cell walls. Deterioration by a white-rot fungus was characterized by gradual increase of deflection and longer incubation term for creep fracture. The incorporation of fungicides in the glue was evidently effective against fungal attack in particleboards because of even distribution of toxicant forms on wood particles' surfaces.

Y. IMAMURA and K. NISHIMOTO: **Bending Performance of Particleboards Exposed to Fungal Attack.** Mokuzai Gakkaishi, **30**, 1027 (1984) (in Japanese)

Laboratory decay tests were conducted on an experimental particleboard made from little-durable spruce chips as well as two commercial boards. To understand the mechanical performance of particleboards in structural use, the boards measuring 50×350 mm $\times$ (board thickness) were subjected to bending-creep tests under progressive fungal-attack with a brown-rot fungus *Tyromyces palustris* and a white-rot fungus *Coriolus versicolor* in a newly-designed apparatus. Deflection of the boards was measured regularly as a criterion of their expected performance. Boards, for, reference, were tested for their static bending-strength after being exposed to fungus cultures for certain periods.

Deflection-time curves for particleboards exposed to decay fungi showed significant patterns which enabled evaluation of strength reduction caused by the action of fungi. A rapid increase of deflection in tested boards during relative early stages was assumed to be due to active fungal invasion onto the surfaces of wood particles and consequent glue failures. The fungal attack, consisting of a mycelial invasion prior to wood decay, was supported by the fact that bending strength losses ranging from 10 to 20% occurred with little or no weight losses in static tests.

Board resistance detected in creep tests while under fungal attack varied depending on the manufacturing conditions and adhesives used as well as the species of fungi. The PF-bonded board lasted longer until fracture and was found to be less susceptible to decay than the UMF-bonded one. A white-rot fungus delayed the time for fracture and caused higher weight losses in sample boards before inducing substantial strength reductions as compared to a brown-rot fungus.

Scanning electron-microscopic observations of the fractured surfaces presented visible evidence of the process of particleboard deterioration which was expected from the mechanical tests.