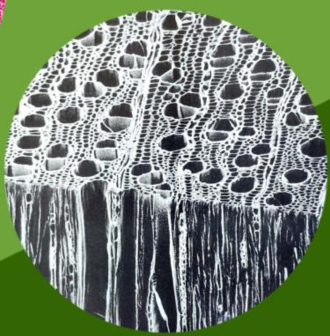
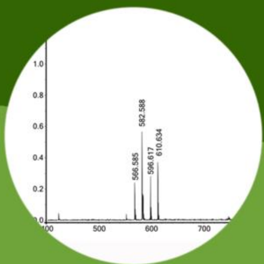
IAWA-IUFRO International Symposium

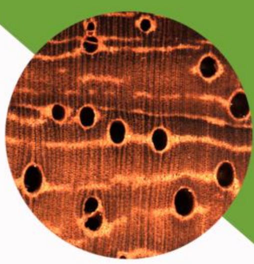
Challenges and Opportunities for Updating Wood Identification

May 20-22, 2019, CHINA



PROGRAM & ABSTRATS





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Challenges and Opportunities for Updating Wood Identification

IAWA-IUFRO International Symposium 2019

Program & Abstracts

Sponsors:

International Association of Wood Anatomists (IAWA)
International Union of Forest Research Organizations (IUFRO)
Chinese Academy of Forestry (CAF)

Organizer:

Research Institute of Wood Industry (CRIWI), State Key Laboratory of Wood Science and Technology, National Forestry and Grassland Administration (NFGA), China
US Forest Products Laboratory (FPL)

Sheraton Chaobai River Hotel, China
May 20-22, 2019

Preface

The IAWA-IUFRO International Symposium: Challenges and Opportunities for Updating Wood Identification will be held on May 20-22, 2019 in China. The symposium is co-organized by the Research Institute of Wood Industry, Chinese Academy of Forestry, China, and the Forest Products Laboratory, Forest Service, USA.

The symposium will provide an international forum for experts to exchange the latest related research advances and experiences, as well as to further discuss current focus problems, challenges and opportunities for newly developed wood identification technology.

We would be delighted to invite you to attend this symposium. We hope IAWA-IUFRO symposium would be a good chance for all the participants to understand the topic of wood identification.

Professor Jianxiong LYU

Excutive Deputy Director
Research Institute of Wood Industry
Chinese Academy of Forestry
May 6, 2019

Sponsors

The International Association of Wood Anatomists (IAWA)

International Union of Forest Research Organizations (IUFRO)

Chinese Academy of Forestry (CAF)

Organizers

Research Institute of Wood Industry, Chinese Academy of Forestry

Forest Products Laboratory, Forest Service, USDA

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Prof. Jianxiong LYU, Research Institute of Wood Industry, Chinese Academy of Forestry, China

Prof. Yafang YIN, Research Institute of Wood Industry, Chinese Academy of Forestry, China

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Prof. Bin XU, Anhui Agricultural University, China

Secretary

Dr. Lichao JIAO (+ 86 151 1696 8560)

Mr. Tuo HE (+ 86 156 5256 9292)

Scientific Program

May 20, Monday	
09:00-18:00	**Registration** In the Lobby of Hotel
18:00-20:00	**Welcome Reception** Meeting Hall 2
May 21, Tuesday	
09:00-09:20	**Opening Ceremony** Moderator: **Mr. Jianxiong LYU** Executive Deputy Director, Research Institute of Wood Industry (CRIWI), Chinese Academy of Forestry (CAF) Room: Meeting Hall 3
09:00-09:20	**Remarks by Representatives** International Association of Wood Anatomists (IAWA) International Union of Forest Research Organizations (IUFRO) US Forest Products Laboratory (FPL) German Federal Ministry of Food and Agriculture (BMEL) Chinese Academy of Forestry (CAF) China National Forestry and Grassland Administration (NFGA)
09:20-09:30	**Group Photo** The Lawn outside the Hotel Lobby
09:30-12:00	**Keynote Lectures** Moderator: **Mr. Biao PAN** Room: Meeting Hall 3
09:30-10:00	K-1: Wood anatomy - The role of macroscopic and microscopic wood identification to combat illegal logging and trading **Gerald KOCH** Thünen Institute of Wood Research and Thünen Centre of Competence on the Origin of Timber, Germany
10:00-10:30	K-2: Application of DNA forensic technology developed by Forest Research Institute Malaysia (FRIM) for timber tracking **Soon Leong LEE** Forest Research Institute Malaysia, Malaysia
10:30-11:00	**Tea Break** Outside Meeting Hall 3
11:00-11:30	K-3: Wood anatomy research at the USDA Forest Products Laboratory **Michael WIEMANN** Forest Products Laboratory (FPL), USA
11:30-12:00	K-4: The challenge of wood identification in China: from traditional anatomy to new auxiliary methods **Yafang YIN** Research Institute of Wood Industry, Chinese Academy of Forestry, China
12:00-13:30	**Lunch & Poster Session** Meeting Hall 2

13:30-14:45	**Technical Sessions I General introduction of wood identification** Moderator: **Mr. Jianxiong LYU** Room: Meeting Hall 3
13:30-13:45	O-1: Global Timber Tracking Network: A Sarawak's experience through Sarawak Timber Legality Verification System (STLVS) and identification of woods **Annya AMBROSE** Sarawak Forestry Corporation, Malaysia
13:45-14:00	O-2: The spectrum & power of timber tracking tools - a state of the art **Nele SCHMITZ** Thünen Institute of Forest Genetics, Germany
14:00-14:15	O-3: Wood identification research and its importance in Japan **Haruna AISO-SANADA** Japan Society for the Promotion of Science, Forestry and Forest Products Research Institute, Japan
14:15-14:30	O-4: Primary works on wood species identification of Nanjing Forestry University **Jiangtao SHI** Nanjing Forestry University, China
14:30-14:45	Questions and discussion
14:45-16:00	**Technical Sessions II Fiber and microstructure** **Moderator: Mr. Michael WIEMANN** Room: Meeting Hall 3
14:45-15:00	O-5: Identification of Asian timbers in pulp, paper and fiber boards **Immo HEINZ** Thünen Institute of Wood Research and Thünen Centre of Competence on the Origin of Timber, Germany
15:00-15:15	O-6: Diversity and distinction of the fibers in two historical papers known as *Doulatabadi* and *Termeh* in the manuscripts dated to the 5th century AH **Kambiz POURTAHMASI** University of Tehran, Iran
15:15-15:30	O-7: Microstructure analysis of *Syzygium album* **Xin GUAN** Fujian Agriculture and Forestry University, China
15:30-15:45	O-8: Charcoal identification with 3D-reflected light microscopy-techniques **Valentina ZEMKE** Thünen Institute of Wood Research and Thünen Centre of Competence on the Origin of Timber, Germany
15:45-16:00	Questions and discussion
16:00-16:15	**Tea Break** Outside Meeting Hall 3
16:15-17:30	**Technical Sessions III Imaging analysis and database establishment** **Moderator: Mr. Gerald KOCH** Room: Meeting Hall 3
16:15-16:30	O-9: Microstructural characterization of bamboo using the digital image analysis method **Pannipa CHAOWANA** Walailak University, Thailand

16:30-16:45	O-10: Study on softwood retrieval system **Jian QIU** Southwest Forestry University, China
16:45-17:00	O-11: Deep-wood: Automated wood species identification using convolutional neural networks **Tuo HE** Research Institute of Wood Industry, Chinese Academy of Forestry, China
17:00-17:15	O-12: Xylorix: An AI-as-a-Service platform for wood identification **Yong Haur TAY** Xylorix Division, Agritix, Malaysia
17:15-17:30	Questions and discussion
17:30-18:45	**Technical Sessions IV Chemical methods** **Moderator: Mr. Immo HEINZ** Room: Meeting Hall 3
17:30-17:45	O-13: Wood identification based on DNA barcoding and gas chromatography-mass spectrometry **Shengquan LIU** Anhui Agriculture University, China
17:45-18:00	O-14: Phenolics profiling for distinguishing of some *Vireya Rhododendron* species from Indonesia by LC/MS-IT-TOF **Mohamad RAFI** Bogor Agricultural University, Indonesia
18:00-18:15	O-15: Timber identification of CITES listed *Pterocarpus santalinus* and non-CITES listed *P. tinctorius* by DART-FTICR-MS and GC-MS: comparison of different treated samples **Maomao ZHANG** Research Institute of Wood Industry, Chinese Academy of Forestry, China
18:15-18:30	Questions and discussion
18:30-20:30	**Conference Banquet** Meeting Hall 2
May 22, Wednesday	
08:30-09:30	**Technical Sessions V DNA methods and applications (I)** **Moderator: Mr. Soon Leong LEE** Room: Meeting Hall 3
08:30-08:45	O-16: Adoption of DNA technologies by industry for supply chain transparency **Eleanor DORMONTT** University of Adelaide, Australia
08:45-09:00	O-17: Disentangling species ID within a genus and verification of timber origin with DNA methods **Céline BLANC-JOLIVET** Thünen Institute of Forest Genetics, Germany
09:00-09:15	O-18: DNA extraction from ebony (*Diospyros celebica* Bakh.) dry wood samples collected using pickering punch **Iskandar Z. SIREGAR** Bogor Agricultural University/IPB University, Indonesia
09:15-09:30	Questions and discussion

09:30-10:30	**Technical Sessions VI DNA methods and applications (II)** **Moderator: Mr. Shengquan LIU** Room: Meeting Hall 3
09:30-09:45	O-19: Supporting sustainable forest management and timber industry with DNA barcoding wood species identification system: FRIM's experience **Chai Ting LEE** Forest Research Institute Malaysia, Malaysia
09:45-10:00	O-20: Identification of *Dalbergia odorifera* T.chen and *Dalbergia tonkinensis* **Ruoke MA** Guangxi University, China
10:00-10:15	O-21: Developing high-resolution DNA barcodes for discrimination of timber species using the complete chloroplast genome **Lichao JIAO** Research Institute of Wood Industry, Chinese Academy of Forestry, China
10:15-10:30	Questions and discussion
10:30-10:45	**Tea Break** Outside Meeting Hall 3
10:45-11:45	**Technical Sessions VII Wood identification and policy implementation** **Moderator: Mr. Jian QIU** Room: Meeting Hall 3
10:45-11:00	O-22: China's exploration and practices to establish timber legality verification system **Haiying SU** Research Institute of Forestry Policy and Information, Chinese Academy of Forestry, China
11:00-11:15	O-23: Towards the implementation of the reviewed concept of the GTTN service providers directory and reference database in a multi-method platform based on TREEGENES **Jo Van BRUSSELEN** European Forest Institute, Finland
11:15-11:30	O-24: Comprehensive approach to building and scaling wood ID tools **Meaghan PARKER-FORNEY** World Resources Institute, USA
11:30-11:45	O-25: Regulatory and policy requirements on wood identification in global market **Xiaoqian CHEN** Beijing Forestry University/ European Forest Institute, China
11:45-12:00	Questions and discussion
12:00-12:15	**Closing Ceremony** Room: Meeting Hall 3
12:15-13:30	**Lunch & Poster Session** Meeting Hall 2
13:30-19:00	**Technical Tours** BBMG Tiantan Wooden Furniture Company The Temple of Heaven Park
19:00-21:00	**Conference Banquet (GTTN)** Meeting Hall 2

9:00-18:00 May 23, Thursday, GTTN-IAWA APPLICATION DAY

Poster	
P-1	Juvenility characteristics of agarwood (*Aquilaria malaccensis* Lam.) from three different growing sites **Lina KARLINASARI** IPB University, Indonesia
P-2	Assessment of illegal logging in Peusangan - Jambo Aye-Tamiang landscape, in Aceh-Indonesia **Essy HARNELLY** Syiah Kuala University, Indonesia
P-3	Variation on the chemical composition of wood cell walls from sapwood to heartwood of *Catalpa bungei* C.A.Mey **Suhong REN** Research Institute of Wood Industry, Chinese Academy of Forestry, China
P-4	Variation on xylem ray parenchyma vitality in different vertical height and radial direction of *Catalpa bungei* C.A.Mey **Liping DENG** Research Institute of Wood Industry, Chinese Academy of Forestry, China
P-5	Paulownia wood introduction **Yaya XU** China Paulownia Research Center, Chinese Academy of Forestry, China
P-6	Comparison of microstructural characteristics between heartwood and sapwood of Chinese fir clones **Ru JIA** Research Institute of Wood Industry, Chinese Academy of Forestry, China
P-7	Influence of surface sanded on wood species identification by near infrared spectroscopy **Xi PAN** Research Institute of Wood Industry, Chinese Academy of Forestry, China
P-8	HPLC fingerprint characteristics of agarwood from different origins **Qian WANG** Research Institute of Wood Industry, Chinese Academy of Forestry, China
P-9	Forestry for sustainable development and impact of deforestation on biodiversity in Nigeria **Anyabulu JOHN** University of Abuja, Nigeria
P-10	The challenges and opportunities of forests and enhancement of forestry for updating wood identification in Nigeria **Obi innocent ONYEDIKACHI** Agricultural & Ecological Development Foundation, Nigeria
P-11	The role of conservation sustainable management of forests and enhancement of forestry **Sampson A.O.** Agricultural & Ecological Development Foundation, Nigeria
P-12	Use of wood characters in the identification of selected timber species in Nigeria **Iyanda Abiolak Kazeem OLUGBADE** University of Ilorin, Nigeria

Technical Tours (Afternoon, May 22, Wednesday)	
13:30	Meet at the lobby of Sheraton Chaobai River Hotel Departure (In two groups, by bus) The lists of group members are shown in below
13:50	Arrival at BBMG Tiantan Furniture Co., Ltd.
13:50-14:50	Visit BBMG Tiantan Furniture Co., Ltd. (In two groups)
15:00-16:30	Go to Temple of Heaven Park (In two groups, by bus)
16:30-18:00	Visit Temple of Heaven Park (In two groups)
18:00-19:00	Return to Sheraton Chaobai River Hotel
Note: Please bring your ID card or passport with you (请随身携带您的护照或身份证).	

The list of Group A members					
No.	**First name**	**Last name**	**No.**	**First name**	**Last name**
1	Kofi Bonsu	ABBAN	2	Haruna	AISO-SANADA
3	Annya	AMBROSE	4	Celine	BLANC-JOLIVET
5	Jose	BOLANOS	6	Markus	BONER
7	Jo	BRUSSELEN	8	Pannipa	CHAOWANA
9	Xiaoqian	CHEN	10	Eleanor	DORMONTT
11	Fifi Gus	DWIYANTI	12	Alberta	EBEHEAKEY
13	Alice Korkor	EBEHEAKEY	14	Essy	HARNELLY
15	Sanada	HARUNA	16	Immo	HEINZ
17	Thorsten	HINRICHS	18	Juliwar	IDRUS
19	Lina	KARLINASARI	20	Gerald	KOCH
21	Ophilious	LAMBOG	22	Soon Leong	LEE
23	Chai Ting	LEE	24	Bo	LI
25	Luyi	LI	26	Andrew	LOWE
27	Haibing	MA	28	Narasimha	MURTHY
29	Mark	NUTTALL	30	Affam Jerry	OFFEI
31	Meaghan Eileen	PARKER	32	Erica Jean	POHNAN
33	Kambiz	POURTAHMASI	34	Mohamad	RAFI
35	Siti Hanim	SAHARI	36	Nele	SCHMITZ
37	Iskandar Zulkarnaen	SIREGAR	38	Yong Haur	TAY
39	Michael Carl	WIEMANN	40	Di	XIAO
41	Roger	YOUNG	42	Valentina	ZEMKE
43	Shengcheng	ZHAI	44	Jing	ZHANG
Group leader: Shan LI (Tel. 13161086413)					

The list of Group B members					
No.	**First name**	**Last name**	**No.**	**First name**	**Last name**
1	Cong	CAO	2	Delong	CHANG
3	Yunxia	CHEN	4	Lin	CHEN
5	Jiabao	CHEN	6	Xudong	CHEN
7	Zonghan	DENG	8	Liping	DENG
9	Yunlin	FU	10	Xin	GUAN
11	Ru	JIA	12	Cai	LIU
13	Xiujuan	LIU	14	Shengquan	LIU
15	Jie	LIU	16	Huangfei	LYV
17	Jianxiong	LYV	18	Ruoke	MA
19	Biao	PAN	20	Xi	PAN
21	Wenyu	QI	22	Jian	QIU
23	Suhong	REN	24	Jiale	SHENG
25	Jiangtao	SHI	26	Haiying	SU
27	Yanwei	SU	28	Shijing	SUN
29	Hankun	WANG	30	Ying	WANG
31	Qian	WANG	32	Xinzhou	WANG
33	Jingjing	WANG	34	Bin	XU
35	Yaya	XU	36	Xiaolin	XU
37	Xiaoming	XUE	38	Huajie	XUE
39	Tiantian	YANG	40	Zhong	YANG
41	Wukun	YI	42	Haining	YIN
43	Jiangping	YIN	44	Min	YU
45	Yaoli	ZHANG			
Group leader: Juan GUO (Tel. 15652383443)					

Contents

Symposium Keynote Presentations

Professor Dr. Gerald Koch

Professor Gerald Koch is the Scientific Director of Thünen Institute of Wood Research, Hamburg. He took diploma-study of Wood Science and Wood Technology at the University of Hamburg in 1995, and received his PhD in Wood Science and Wood Technology at the University of Hamburg in 1998. He got habilitation at the University of Hamburg (Department of Biology) and appointment as Adj. Professor (Venia legendi) for the profession "Wood Biology" at the University of Hamburg in 2004. He has been on the Curator of the scientific wood collection (RBHw) and the wood anatomical laboratory at the Federal Research Centre of Forestry and Forest Products since 2004, and Scientific Director at the Institute of Wood Research since 2013. His main research topics is macroscopic and microscopic wood identification of internationally traded timbers, investigation on wood structure, properties and utilisation of lesser known species, and topochemical analyses (UMSP) of wooden tissues on a subcellular level.

K-1: Wood Anatomy - The Role of Macroscopic and Microscopic Wood Identification to Combat Illegal Logging and Trading

Gerald Koch, Immo Heinz, Volker Haag, Uwe Schmitt

Thünen Institute of Wood Research and Thünen Centre of Competence on the Origin of Timber, Leuschnerstr. 91, 21031 Hamburg, Germany
Email: gerald.koch@thuenen.de

Abstract

Illegal logging is one of the main causes of worldwide deforestation and, by releasing green-house-relevant gasses, contributes to climate change. Moreover, trade with illegal timber and wood products creates market disadvantages for products from sustainable forestry. As a contribution to global forest protection international laws and timber regulations are enacted, such as the USA Lacey Act, the European Timber regulation (EUTR) and, the Illegal Logging Prohibition Act in Australia. All these regulations prohibit the import and trade of illegally logged wood and require that timber and timber products have to be produced in accordance with the respective national legislation. Controls are based on a due diligence system which requires the correct declaration of the wood genus/species (botanical name) and origin. The clear identification of internationally traded timber is also of prime importance in enforcing CITES policies regarding protected species, e.g., the entire *Dalbergia* species = Rosewood or *Swietenia* spp. = True Mahogany (Koch et al. 2011).

In the context of these important requirements and new challenges wood anatomy provides the most valuable support for practical wood identification and is routinely applied in the daily control of wood and wood products. Using light microscopic techniques, up to 100 anatomical characters can be used following the internationally standardized IAWA lists of “Microscopic Features for Hardwood and Softwood Identification”. Overall, the microscopic descriptions of about 8,700 taxa of hardwoods are currently available and documented in several computerized databases, e.g., InsideWood or Commercial timbers, macroHOLZdata and CITESwoodID (Delta-Intkey-System), and XyloTron (Richter et. al. 2003, Hermanson & Wiedenhoeft 2011, Wheeler 2011).

By using these important references, the Thuenen Centre of Competence on the Origin of Timber, Germany has executed more than 4,500 official requests (including approx. 50,000 specimens) for microscopic wood identification since the implementation of the European Timber regulation in Germany in March 2013. Such inquiries mainly come from the timber trade and trade monitoring (customs, conservationists) sectors and increasingly from the authorities. Furthermore, private consumers also show an increasing interest in knowing whether they have acquired a

legally manufactured and correctly named wood product.

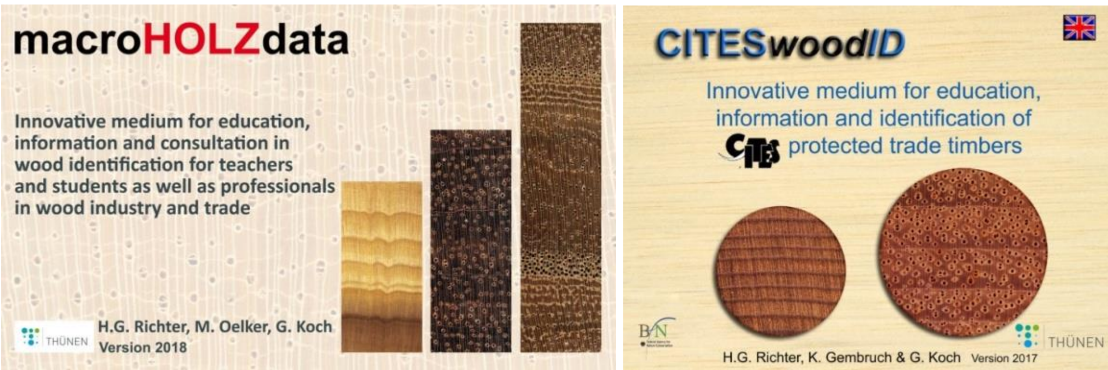


Figure 1: Computer-aided wood identification and description using the databases macroHOLZdata and CITESwoodID

A valuable support to facilitate wood identification of internationally traded and CITES-protected timber based on macroscopic features is already provided by the databases **macroHOLZdata** and **CITESwoodID** (Richter et al. 2003, Koch et al. 2011) developed in the DELTA-INTKEY-System (Fig. 1). Both databases have recently been updated and adapted to the trade of lesser-known species, with special focus on Asian timbers imported into the EU and the newly listed CITES wood species (e.g. *Dalbergia* spp.). The databases are primarily designed for all institutions, companies and individuals involved in international trade and control of wood and wood products. It is also well suited for education and advanced training of students and for timber industry.

References

1. Hermanson, J.C. and Wiedenhoeft, A.C. A brief review of machine vision in the context of automated wood identification systems, IAWA J. 32, 233-250 (2011).
2. Koch, G., Richter, H.G. and Schmitt, U. Design and application of CITESwoodID computer-aided identification and description of CITES-protected timbers. IAWA J. 32, 213-220 (2011).
3. Richter, H.G., Oelker, M. and Koch, G. macroHOLZdata: descriptions, illustrations, identification, and information retrieval. In English and German. Version 2017, www.delta-intkey.com (2003 onwards).
4. Wheeler E.A. InsideWood - a web resource for hardwood anatomy, IAWA J. 32, 199-211 (2011).

Professor Soon Leong LEE

Professor Soon Leong LEE is the head of Genetics Laboratory, Forest Biotechnology Division, Forest Research Institute Malaysia. He received his B.S. majored in Genetics at National University of Malaysia in 1993, and took his PhD major in Forest genetics at the National University of Malaysia in 1998. He has worked as Research Officer in Forest Research Institute Malaysia since 1995. He is interested in the research of development of DNA profiling and DNA barcoding database of important tropical plant species towards conservation and sustainable utilization of forest resources.

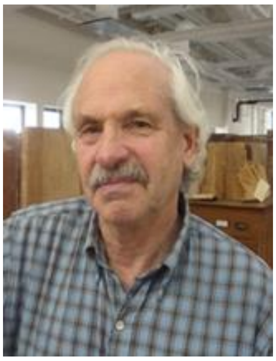
K-2: Application of DNA Forensic Technology Developed by Forest Research Institute Malaysia (FRIM) for Timber Tracking

Soon Leong Lee[1,]*, Chin Hong Ng[1], Lee Hong Tnah[1], Nurul Farhanah Zakaria[1], Kevin Kit Siong Ng[1], Chai Ting Lee[1], Amelia Azman[1], Suhaila Mahruji[1], Zainey Abdul Kadir[1], Khairuddin Perdan[2], Mohd Nizum Mohd Nor[2], Bibian Diway[3], Eyen Khoo[4]

[1]Genetics Laboratory, Forestry Biotechnology Division, Forest Research Institute Malaysia, 52109 Kepong, Selangor, Malaysia
[2]Forest Enforcement Division, Forestry Department Peninsular Malaysia, Jalan Sultan Salahuddin, 50660 Kuala Lumpur, Malaysia
[3]Sarawak Forestry Corporation, Botanical Research Centre Semenggoh, KM20, Jalan Puncak Borneo, 93250 Kuching, Sarawak, Malaysia
[4]Forest Research Centre, KM 23, Labuk Road, Sepilok, 90715 Sandakan, Sabah, Malaysia
Email: leesl@frim.gov.my

Abstract

Illegal harvesting of forest resources poses a significant threat to the sustainability of forest ecosystems. At the Forest Research Institute Malaysia (FRIM), comprehensive DNA profiling databases of *Neobalanocarpus heimii*, *Gonystylus bancanus*, *Koompassia malaccensis*, *Shorea platyclados*, *Aquilaria malaccensis*, *Intsia palembanica*, *Rhizophora apiculata* and *R. mucronata* were developed since 2009 for timber tracking and source of origin identification. A total of 281 populations throughout Malaysia and 8,811 individual samples were used to establish the DNA population and individual identification databases of the eight species. The DNA population identification databases can be used to trace the source of a suspected timber up to population/regional level, whereas the DNA individual identification databases will enables the harvested logs to be matched against the original tree stumps with a high degree of accuracy. For the application of these DNA databases, four standard operating procedures (SOPs) of DNA forensics for wood tracking were developed. The availability of DNA databases of these important tree species together with FRIM's SOP of DNA forensics for wood tracking enhances the capacity of forest officials to curb the problem of illegal logging. Besides, these databases can also be potentially used for timber certification to meet the international and consumer country regulations.



Botanist Dr. Michael Carl Wiemann

Dr. Michael Carl Wiemann is the Forest Products Technologist and Botanist of Forest Products Laboratory, USDA Forest Service. He received his B.S. majored in Wood Technology at Paul Smith's College in 1968, and took his PhD at the Louisiana State University in 1990. He worked at the Louisiana State University, progressing from an Assistant Professor in 1991 to Research Associate Position of Louisiana State University and North Carolina State University in 1994. He is the Forest Products Technologist and Botanist of United States Forest Service since 1999. His research interests is wood anatomy and identification, effects of climate and silviculture on wood anatomy and properties, specific gravity/property relationships, and reduction of discoloration in temperate and tropical woods.

K-3: Wood Anatomy Research at the USDA Forest Products Laboratory

Michael C. Wiemann

Center for Wood Anatomy Research, Forest Products Lab, Madison, Wisconsin, USA
Email: mwiemann@fs.fed.us

Abstract

Wood Anatomy Research has been an important part of the research program of the Forest Products Laboratory (FPL) since it opened its doors in 2010. In its early years, FPL focused on the vast natural timber resource of the United States. That has changed with today's reduced forest area and the global economy. Now the resource of interest at FPL is smaller stems, second-growth, engineered wood products, and foreign (especially tropical) woods.

The first wood anatomist at FPL was Eloise Gerry, who was also the first woman scientist in the US Forest Service. She began her long career upon the opening of FPL and stayed for 44 years. She began to assemble the first specimens of what was to become one of the largest research wood collections in the world, located at FPL's Center for Wood Anatomy Research (CWAR).

Initially, samples in the wood collection were trade samples of US woods, collected without herbarium vouchers. Today the collection does not accession samples that were collected without vouchers. The importance of that policy has been demonstrated by the discovery, through new identification techniques, that many of the older specimens are mis-identified. The size of the wood collection has increased from a few thousand specimens in 1920, 25,000 in 1968, and finally to more than 100,000 in 1970 when Yale University donated their entire wood collection (with associated vouchers) to FPL. Because of size limitations, the vouchers are now housed at the Wisconsin State Herbarium at the University of Wisconsin in Madison.

The study of wood anatomical features was the primary focus of the CWAR for many decades. These features are usually successful in separating wood genera, but much less so in identification to a species. In addition to traditional wood anatomy, FPL now explores new techniques that can be used to separate similar species. Much of the research is now done in collaboration with universities and other research laboratories, which often have resources not available at FPL. Chemical and spectrographic techniques have been especially successful in the separation of closely related species.

In response to international trade agreements, FPL, in cooperation with the Forest Service's International Programs, sponsors wood identification research and training in developing countries. Much of this training is aimed at curtailing the trade in endangered or threatened species and enforcement of the Convention on International Trade in Endangered Species (CITES). In addition to demonstrating traditional and novel techniques to identify wood, training also includes proper methods to collect wood samples with their associated herbarium vouchers.

Professor Dr. Yafang Yin

Professor Dr. Yafang Yin is the Chief of Wood Anatomy and Utilization Department, Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing, China. He received his B.S. majored in Forest Products and Engineering at the Northeast Forestry University, China in 1996, and took his PhD at the Chinese Academy of Forestry in Beijing in 2002. He has worked at the Research Institute of Wood Industry, the Chinese Academy of Forestry since 2002, progressing from an Assistant Professor in 2002 to Professor Position of Chinese Academy of Forestry in 2011. He has been on the IAWA (International Association of Wood Anatomists) Council and the IUFRO Deputy Coordinator of 5.06.00 since 2010, the Deputy Chair of IAWA-China Group since 2014, the IAWA Executive Secretary since 2017 and Elected Fellow of IAWS (International Academy of Wood Science) since 2018.

K-4: The Challenge of Wood Identification in China: from Traditional Anatomy to New Auxiliary Methods

Yafang Yin[1, 2]

[1]Department of Wood Anatomy and Utilization, Chinese Research Institute of Wood Industry, Chinese Academy of Forestry, Beijing 100091, China
[2]Wood Collections (WOODPEDIA), Chinese Academy of Forestry, Beijing 100091, China
Email: yafang@caf.ac.cn

Abstract

Unsustainable and illegal logging, and trade in illegally harvested forest products is contributing significantly to continual deforestation and massive threat to global biodiversity. Though various wood identification methods are developed to be used for timber discrimination along the forest products supply chain, current global identification capacity cannot meet demand.

Timber genus identification based on the wood anatomy has been well established in botany. The most frequently used method is traditional wood identification relied on diagnostic anatomical features observed by the seasoned experts on macro- and microscopic level. However, wood morphology alone is rarely sufficient to reach a species level in most cases. On the other hand, image analysis, genetic methods, phytochemistry with mass spectrometry for wood identification as new auxiliary methods are growing but as-yet not widely deployable technologies for challenges of reality. In recent years, with research progress in artificial intelligence, biotechnology, chemical analysis and establishment of relevant reference libraries, new opportunities for reliably identifying tree species of wood and wood products via wood anatomy with auxiliary discriminating methods together are available and attracted increasing interest in China and other countries to provide practical aids to law implementation and promote legal timber harvest internationally.

Keywords
Wood anatomy, Wood collections, Tree species, Machine learning, Image analysis, DNA barcodes, Chemical fingerprint

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Symposium Oral Presentations

O-1: Global Timber Tracking Network: A Sarawak's Experience through Sarawak Timber Legality Verification System (STLVS) and Identification of Woods

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Abstract

The Sarawak forests covers approximately 63% of the total 12.4 million ha land area that contains over 3000 known tree species. The forest and timber industry has been and continues to be vital to the development of the Sarawak. To address the sustainability of Sarawak's forest, six Forest management Units (FMUs) has been certified under Malaysian Timber Certification Scheme (MTCS) endorsed by The Programme for the Endorsement of Certification (PEFC) Scheme. The State has set target that all long term forest timber license will be certified by 2022. Sarawak Timber Legality Verification System (STLVS) has also been implemented as the verification process of logs and timber products in terms of the tracking and traceability of log movement along the chain of custody from the forest to the mill or export point as a process crucial in preventing movement of illegal trades of logs. Another measure to counter the illegal trade of Gonystylus bancanus listed in the Appendix II of CITES in this region had been achieved through identification of wood by DNA sequence database of wood.

Scientific research on wood identification and collection of reference materials has also been carried out since 1970s. To date Timber Technology Centre, Sarawak Forestry Corporation harbors a wood library that has 16,000 specimens of wood, with about 88 families, 360 genera and 1500 species collected in Sarawak. This paper will highlights the SLTVS in legality verification of logs and works conducted in identification of woods from Sarawak, Malaysia.

O-2: The Spectrum & Power of Timber Tracking Tools- a State of the Art

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Abstract

To be able to tackle the challenges for updating wood identification, we first need to have an overview of the spectrum of methods currently available and their capacities. Such overview was recently produced by the Global Timber Tracking Network. The infographic of timber tracking tools creates the perfect base to discuss the gaps and opportunities for further developments in the field of wood identification.

Some of the limitations are inherent to the methods and can hence not be overcome by further research. Two critical parts of the wood identification process, open for more advancements are the collection of reference samples and the data analysis. With global timber supply chains there is a need for harmonization of procedures to secure the reputation of the different wood identification tools and to facilitate collaborations. Collaborations can take place by exchanging samples (division of tasks to exploit the power of the full spectrum of identification methods) or by exchanging data (combining strengths of the different methods to overcome their weaknesses).

Finally, a common language is essential for any collaboration and hence for further innovations. Therefore, it is important to investigate the current barriers of information flow within the wood identification community.

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O-3: Wood Identification Research and its Importance in Japan

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Abstract

In order to understand the physical and chemical properties of specific pieces of lumber, it is essential to identify the type of tree it has come from. The most common way of doing this is by microscopic observation. In Japan, the study of wood anatomy has a history of 130 years. Over that period of time, the database has grown, and it is now possible to identify wood from almost every type of tree harvested in Japan.

Forestry and Forest Products Research Institute (FFPRI) in Japan accepts wood identification submissions from private businesses, non-profits, or other institutions in need of identifications. Number of wood identification requests submitted to FFPRI is around 50/year in recent years (Fig. 1). Types of clients requesting wood identification were companies dealing with wood products (23%), government agencies (19%), food companies (16%), trading companies (13%), and so on.

However, with this kind of anatomical observation alone, it is often difficult to make positive identification down to the species level. For this reason, other techniques such as those using molecular DNA or chemical analyses are applied. Furthermore, for identifying the wood species of historically valuable wooden artifacts, non-invasive methods are more desirable. This report reviews the current identification methods as well as the ongoing search for identification technologies suited to the needs of contemporary society - for combatting illegal logging, the promotion of wood self-sufficiency, and so on.

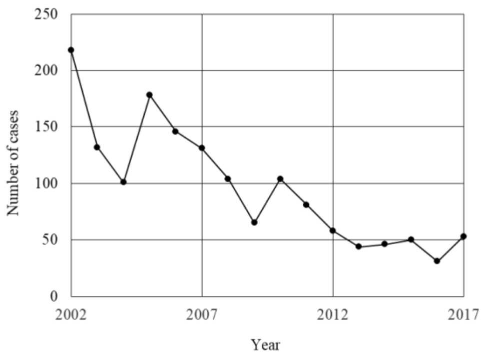

Fig. 1 Number of wood identification requests submitted to the Forestry and Forest Products Research Institute (FFPRI).

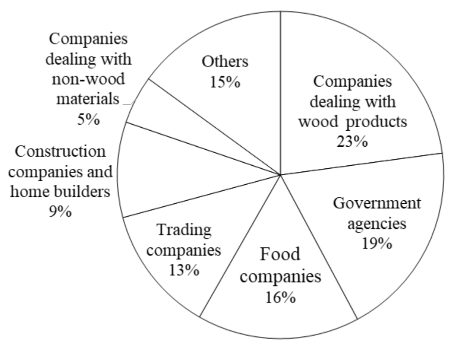

Fig. 2 Types of clients requesting wood identification.

O-4: Primary Works on Wood Species Identification of Nanjing Forestry University

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Abstract

Nanjing Forestry University was founded in 1952 but wood identification and wood specimen collection since from 1902. Up to now, there are more than 28000 pieces of wood specimen belongs to approximately 4000 tree species, which about 1800 and 2200 from foreign and domestic, respectively. At present, there are 9 full-time faculties work on wood anatomical structure multi-scale analysis, wood species identification, archaeological wood identification, and application of modern spectroscopy and DNA technology in wood identification, especially in *Lauraceae* and *Juglandaceae*. All faculties are fellow of IAWA and engage in international exchanges and cooperation with wood anatomists from Japan, United States, Canada, Thailand, Vietnam and other countries.

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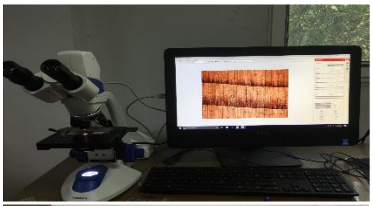
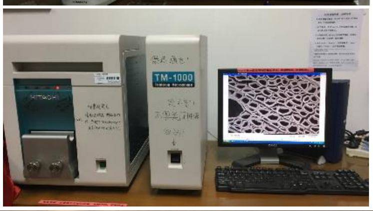


O-5: Identification of Asian Timbers in Pulp, Paper and Fiber Boards

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Abstract

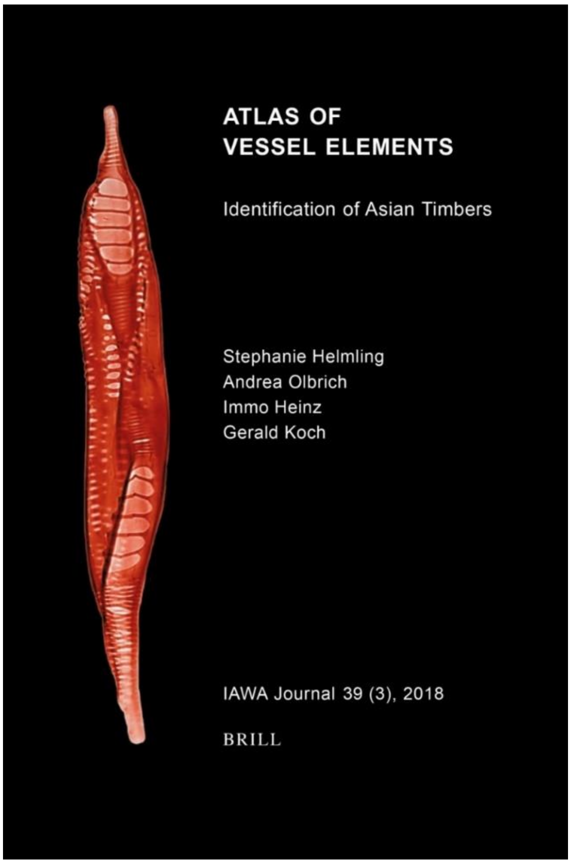
The identification of timbers used in pulp and paper is becoming increasingly important for the implementation of national and international legislations that forbids the use of illegally logged or endangered species, e.g., European Timber Regulation (EUTR) and CITES policies.

Wood anatomy currently provides the "exclusive" method for the identification of pulp and paper components as well as those of fiber boards which are also subject to the controls of the EUTR. In comparison to the microscopic identification of solid wood blocks, the number of usable microscopic features is severely reduced in the macerated tissue of pulp and paper. In detail, the separated vessel elements provide the best information for a microscopic identification based on typical features like perforation plates, presence of helical thickenings and shape and arrangement of vessel-ray pits, e.g.

These individual morphological information are already described in the "Fiber Atlas - Identification of Papermaking Fibers" including the wood anatomical characterization of the most important temperate and plantation-grown species used for pulp and paper production (Ilvessalo-Pfäffli 1995). However, the increasing pulp production in Asia involves the frequent use of tree species from these regions and requires a defined morphological description of the tissues.

In order to enable the essential identification of Asian timbers used in pulp, paper, and fiber board production, the morphological characteristics of vessels in macerated material of 38 important timbers distributed in Asia are recently studied by a team of authors from the Thünen Centre of Competence on the Origin of Timber and published (open access) as special edition "Atlas of vessel elements - Identification of Asian Timbers" in the IAWA Journal issue 39 (3).

(http://booksandjournals.brillonline.com/content/journals/10.1163/22941932-20180202).



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O-6: Diversity and Distinction of the Fibers in Two Historical Papers Known as *Doulatabadi* and *Termeh* in the Manuscripts Dated to the 5th Century AH

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Abstract

Historical papers have many cultural and historical values and show the social, cultural, economic and political evolutions in different historical societies. Doulatabadi or Soltani paper is a kind of high quality paper after Khataei Paper. On the other hand, the papers made of thin delicate Termeh in Isfahan are called Termeh papers (due to being firm). This paper is very delicate, thin and firm with uniform regular tissues. These papers with Termeh-i or pistachio green color are easily distinguished. Identification of this plant species is difficult using the fibers in the pulp and it is a technical complicated duty. The purpose of the present research is to examine the diversity and features of the fibers of these two historical papers to show the structural similarities and differences using microscopic analytical methods. For this purpose, both booklets were sampled with three replicas from different pages. To measure the dimensions (biometry) of the fibers and identify the type of the fibers, the separating of fibers was conducted using the standard TAPPI method (T 401 om-93) and Franklin's method (Franklin, 1945).

According to the experimental observations in Hersberg test, the color of the paper fibers was shown to be wine red. Therefore, these fibers don't have any lignin (phenolic polymer compound) and are produced from old fibers of cloths (such as flax, hemp and cotton). Microscopic examinations showed the presence of bast fibers that belonged to non-wooden plants. Cannabis and flax were the main fibers used in the papers of the booklets. In the images taken from polarizing microscope, in addition to the color changes resulting from polarized light on the surface of the fibers, crystals of calcium oxalate were detected in specimens of Doulatabadi and Termeh papers. In the images from SEM in Doulatabadi papers, the size of the fibers was more than 37 µm in kv5.0 magnification and it is similar to the papers offered in 1907, 1963 and 1982 and it includes all fibers of the plants including flax, hemp, nettle and rami. However, in *Termeh* papers, the size of the fibers was at most 21 µm in kv5.0 magnification and the minimum diameter of the fibers was 4 µm, similar to the papers in 1987. And they only included nettle and flax (Bergfjord *et al.* 2010). However, the presence of crystals of calcium oxalate among the fibers proves the use of the fibers of cannabis plant to produce papers of both manuscripts. The size of the crystals in *Doulatabadi*

paper was 19.64 µm in kv5.0 magnification and 1.22 to 1.50 µm in Cashmere paper in kv5.0 magnification. Also, the size of vedalite crystals is reported to be 20 µm (Guggiari *et al*. 2011). EDX analysis confirmed the presence of calcium in the structure of the papers of the manuscript.

Fig.1 Right side, *Doulatabadi* paper and left side *Termeh* paper

Fig.2 Morphology and dimensions of fibers, right side with Optical Microscope (OM) and left side with Scanning Electron Microscope (SEM)

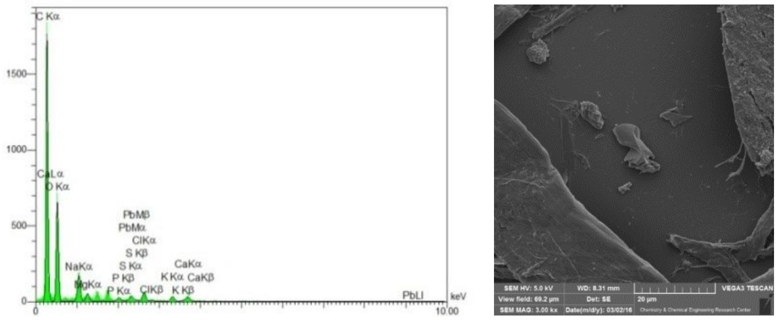

Fig.3 Right side, crystals picture and left side, elements analysis of crystals with Energy Dispersive Spectrometry (EDX)

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O-7: Microstructure Analysis of *Syzygium album*

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Abstract

The microstructures of *Syzygium album*, sampled form Yunxiao, were revealed by optical microscope and environmental scanning electron microscope. It was found that 1) *Syzygium album* was diffuse-porous wood with macroscopic vessels. Individual vessels occurred alone or radial multiples of up to three vessels in a row. Vessels were also arranged in clusters sporadically. Some vessels had gums; 2) there were simple perforation plates. The pits were arranged on the vessel walls alternately. Scalariform pits could be seen once in a while; 3) apotracheal parenchyma was diffuse-in-aggregate, and diamond crystals were seen occasionally; 4) the rays were one to four cells wide and eleven to thirty seven cells high with abundant inclusions. It was of heterocellular rays. In addition, the vessel-ray pits were large and round.

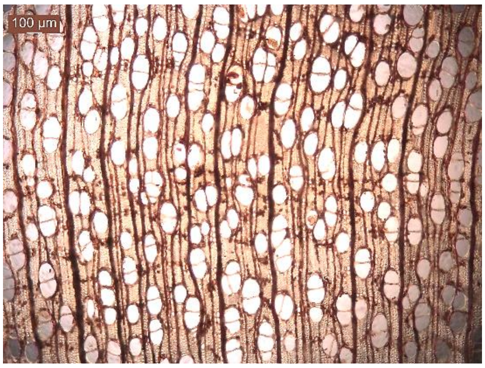

Fig.1 Cross section

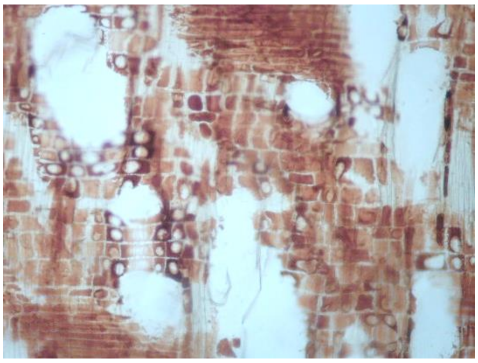

Fig.2 Radial section

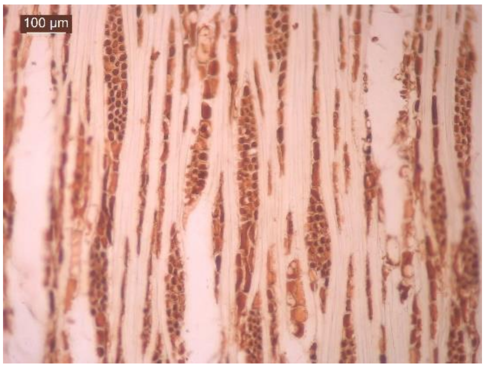

Fig.3 Tangential section

Fig.4 Vessels and perforation plates

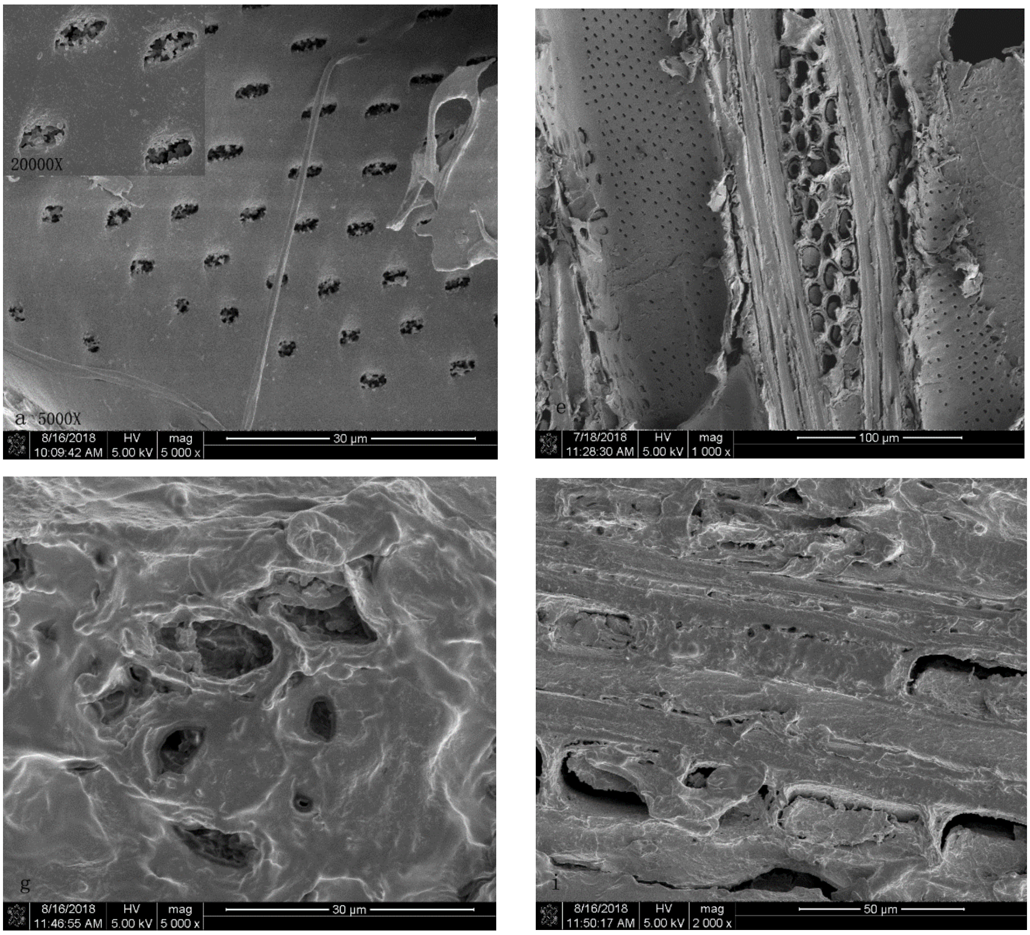

Fig.5 SEM photographs (a) vestured pits in tangential section; (b) alternate pits in tangential section; (c) rays in tangential section; (d) parenchyma in radial section

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O-8: Charcoal Identification with 3D-Reflected Light Microscopy-Techniques

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Abstract

German environmental organizations and media have investigated and reported, that charcoal/-briquettes used for barbecue are not manufactured - as generally assumed - from local forests. About 70% is imported charcoal from other European countries or even from tropical countries on a large scale. The wood used for charcoal production in West Africa and South America is often harvested from natural forests without proof of sustainability or legality. Basic investigations of the Thuenen Institute have shown that many trade assortments are misclassified and regularly contain tropical wood species (Haag et al. 2017). Against this background, it is currently under examination whether charcoal and charcoal briquettes should be also included and controlled according to the European Timber Regulation (EUTR).

Based on the investigation and experience of the Thuenen Centre of Competence on the Origin of Timber the references for the identification of tropical timbers in charcoal need to be extended. Furthermore, the methods for their identification are more difficult as compared to the "classic" anatomical wood identification of solid woods. A successful method using 3D-refelected light microscopy is currently established at the Thuenen Institute and will be applied as part of a research project, which is supported by the German Federal Environmental Foundation (DBU), with the following objectives:

- analyses and description of wood anatomical structures of wood species internationally used for production (Europe, South America, Southeast Asia and Central Africa) on the basis of 3D light microscopy.

- studies of controlled carbonization processes for a systematic detection of artefacts related to the diagnostic anatomical structures of charcoal by using 3D light microscopy.

- preparation of a list of anatomical features for the identification of charcoal and regional classification of boreal-/temperate latitudes and subtropical-/ tropical latitudes of charcoal.

O-9: Microstructural Characterization of Bamboo using the Digital Image Analysis Method

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Abstract

Bamboo is one of the fastest growing plant which abundantly distributes in the tropical regions (Lee *et al*., 1994). The bamboo microstructure can be generally views as a composite material composed of long and aligned cellulose fibers embedded in a lignin matrix. Additionally, the bamboo microscopic level varies along the culm length and culm wall thickness. According to these characteristics, the bamboo culm is a functionally graded natural composite material (Chaowana *et al*., 2015). Bamboo culms have been widely used as a material for construction, furniture manufacture and daily household uses. Many studies have been published on the microstructure features of bamboo which directly affect the physical and mechanical properties (Abd Latif *et al*., 1990; Abd Latif *et al*., 1993; Grosser & Liese, 1971). It is expected that these features may affect the final application of bamboo. Thus, the information on bamboo culm characteristics, considering its microstructures, is required.

This paper presents the microstructure characterization of bamboo culms (*Dendrocalamus asper*), commonly known as "Sweet bamboo", by Digital Image Analysis method. The transversal section of a bamboo culm was observed and photographed in an optical microscope. The image of bamboo cross sections was analyzed with Image Proplus software to investigate the variation of the microstructure. Furthermore, image processing and analysis for fiber distribution determination was developed under a commercial software package Mathematica. The cross section of each sample was viewed under the optical microscope and the image was captured using a digital camera. The volume fraction of fiber was determined.

The results show that bamboo culms in transverse section composed of numerous fibers embedded in the parenchymatous ground tissue. The distribution of fiber shows a specific pattern within the culm, both horizontally and vertically. The parenchyma and conducting cells are more frequent in the inner one-third of the wall, while the percentage of fiber is higher in the outer part of the wall.

The concentration of vascular bundles varies with different height and thickness, as shown in table 1. The result suggests that the concentration (number per area) of vascular bundles increase with increasing height of a culm but the value decrease in culm wall thickness. The variation in vascular bundles size (i.e.; radial length, tangential width and radial/tangential ratio) with different height and thickness. This result suggests that the ratio significantly increases from the bottom to the top of culm and from the inner zone towards the outer zone. It indicates that the vascular bundles near inner part are almost circular while they are more of elliptical shape near the outer part of the culm wall.

Figure 1 shows the variation of the volume fraction of fibers along the culm length and culm wall thickness. The result shows that the volume fraction of fiber linearly increases from the bottom to the top part of the culm. Moreover, the volume fraction of fiber also linearly increases from the inner part to the outer part of the culm.

From the point of view, the variation of microstructure character and volume fraction of fiber in transversal section of *D. asper* can be established through the application of the Digital Image Analysis method.

Table 1. Variation in vascular bundle characteristics along the culm height and culm wall thickness or culm diameter zone.

Culm height	Culm diameter zone	Vascular bundle concentration (n/mm^2)	Radial length (μm)	Tangential width (μm)	R/T ratio
Bottom	Inner	0.70	1,221.56	947.33	1.31
	Middle	0.81	1,340.25	732.15	1.84
	Outer	2.19	957.54	490.57	1.97
Middle	Inner	0.81	1,166.25	933.52	1.26
	Middle	0.95	1,174.44	677.38	1.75
	Outer	2.54	847.23	460.75	1.86
Top	Inner	0.96	1,025.81	981.56	1.06
	Middle	1.02	1,115.56	650.22	1.73
	Outer	2.73	881.37	468.34	1.89

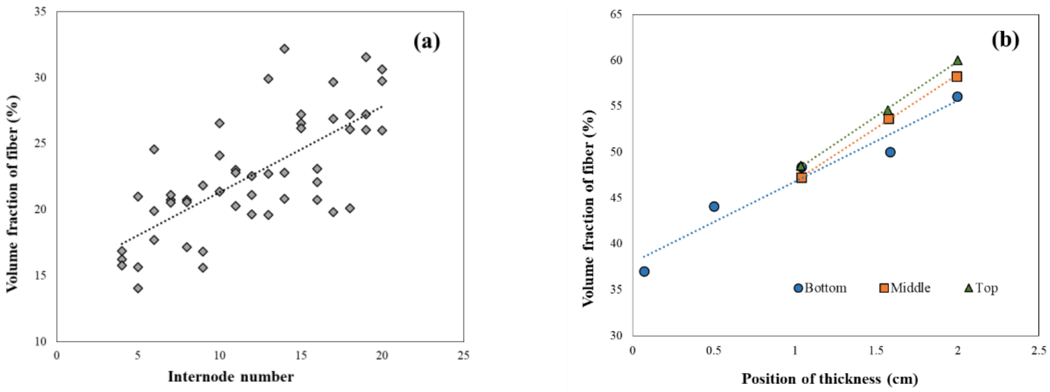

Figure 1. Variation of volume fraction of fibers along the (a) culm height and (b) culm wall thickness.

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O-10: Study on Softwood Retrieval System

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Abstract

Aiming at the lack of softwood retrieval system suitable for widely using, this paper studies the softwood retrieval system. On the basis of scientific anatomy of softwood, this study designed an online softwood retrieval system based on the International Association of Wood Anatomists' *IAWA List of Microscopic Features for Softwood Identification*(IAWA Committee. 2004. IAWA list of microscopic features for softwood identification. IAWA J. 25(1): 1-70.), and attempted to use artificial intelligence technology to further study the microscopic features of softwood and classify them according to tree species, so as to achieve the purpose of fast and accurate identification of softwood species. At present, the information subsystem of the online softwood retrieval system has been realized. The system is developed independently by using the web database access technology based on. NET framework. It has collected more than 140 species of Chinese softwood, including microscopic features and microscopic images. The system trial results show that the information retrieval subsystem of the online softwood retrieval system (as shown Figures 1 to 3) can help wood recognizers quickly retrieve softwood according to the anatomical features, but it still needs further research on the image recognition subsystem combined with artificial intelligence.

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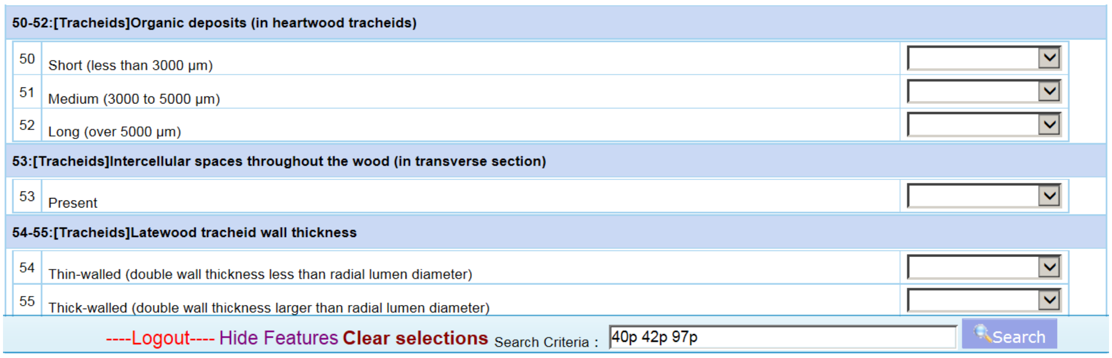

Figure 1. Query page

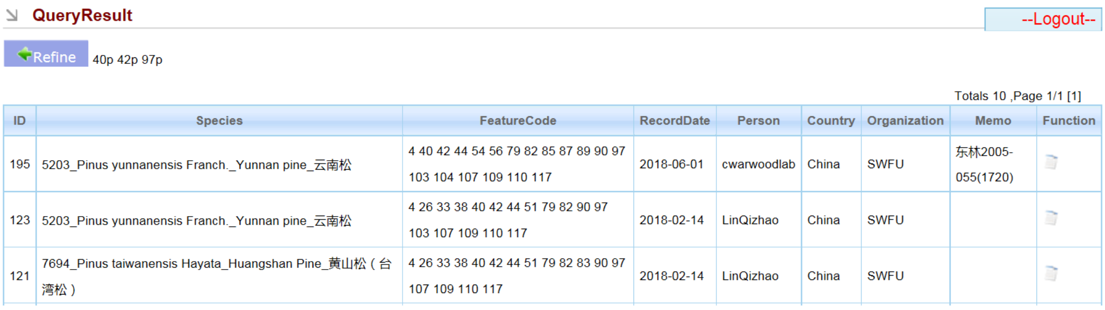

Figure 2. Query result page

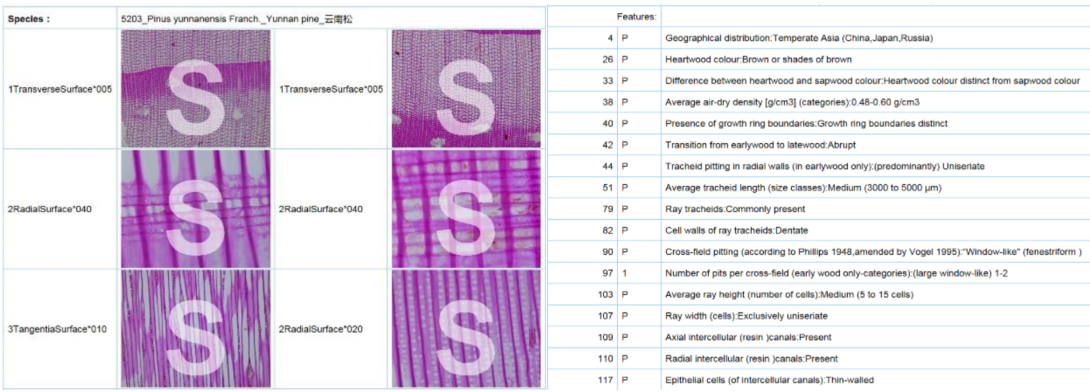

Figure 3. Detail page

O-11: Deep-wood: Automated Wood Species Identification using Convolutional Neural Networks

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Abstract

Tropical forests house over half of the world's plant and wild animal species and play an important role in regulating climate and protecting biodiversity, and have been concerned as one of the main foci of the international community because of the high rates of deforestation in recent decades. Illegal logging and associated trade the main causes of deforestation and subsequent forest loss, imposing massive threats on global biodiversity and ecosystems. The current wood identification relies on experienced practitioners with hand lens, specialized identification keys, atlases of woods and field manuals, which is time-consuming and not compared to the vast international demands for field wood identification. Herein, we developed an automated, reliable and cost-effective field screening method using convolution neural networks for wood species discrimination. The highly effective computer vision models were trained via transfer learning to identify 15 *Dalbergia* and 11 *Pterocarpus* species. We also investigated the optimal number of specimens and images for training the model, and visualize the model to find the accurate wood structural features that the model learnt for classification. The results demonstrated in this study provide a practical tool to combat illegal logging and associated trade. The accuracy of the model for discriminating the 26 species is 99.34%, showing significantly better performance than wood anatomists. A minimum of 10 specimens and 100 images per species is suggested for training the model to achieve relative high accuracy. Feature visualization indicated that the arrangement of vessels and parenchyma is the key feature that the model used for classification of *Dalbergia* and *Pterocarpus* species. The results demonstrated in this study provided an efficient and practical method to combat illegal logging and associated trade, and will contribute to biodiversity conservation.

Keywords: Illegal logging, Convolution neural networks (CNNs), Wood identification, *Dalbergia*, *Pterocarpus*

Acknowledgements

This study was supported financially by the Fundamental Research Funds of the Chinese Academy of Forestry (Grant No. CAFYBB2017ZE003), the China Scholarship Council (Grant No. 2017-3109) and the National High-level Talent for Special Support Program of China (the National "Ten Thousand" Talents Plan) (Grant No. W02020331).

O-12: Xylorix: An AI-as-a-Service Platform for Wood Identification

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Abstract

Recent studies [1] and [2] shows significant results in applying AI in particularly deep learning in wood identification. [2] shows that with the reachability of cloud service bring massive scaling of wood identification service to the world. With proven technology of deep learning and cloud service, wood identification service can be scaled horizontally with customized deep learning model targeting different timber types using macroscopic or even microscopic images.

The key to this scaling process is the flow of building a customized deep learning model in which in Agritix, we proudly present Xylorix, our Artificial Intelligence-as-a- service (AIaaS) product to serve the community in customized model building service.We believe that AI should be simple, intuitive and within reach to any industry.Therefore, we are trying to solve one W, which is "**W**hat is the target data to train custom model" as we provide the **H**ow. The simplified flow is as follows: Collect, Verify,Evaluate and Deploy.

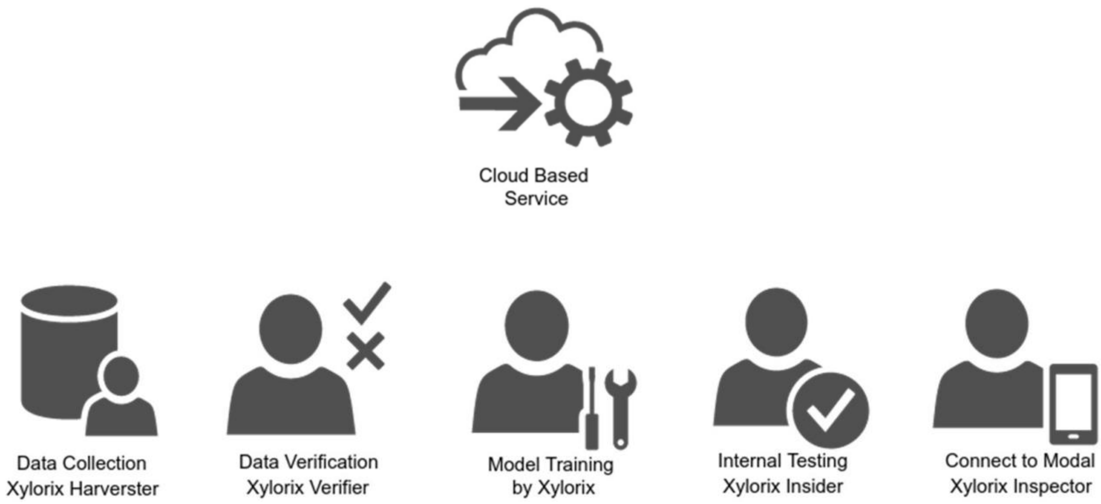

Figure 1: Customized model building flow of Xylorix

Figure 1 shows the flow of creating a customized model with the input from user. From left, the first step of model building requires the collection of target data from the user on What should the model learns to identify. In the case of macroscopic wood identification, images of macroscopic wood are required. Xylorix Harvester, as its name suggests allow user to annotate images and upload to the Xylorix cloud database. To ensure validity and accuracy of annotation, we offer Xylorix Verifier as an extra step to verify collected data.The parallel processes of Harvester and Verifier allows great efficiency of data harvesting in given short period of time.

Next, Xylorix will train and run internal testing of the model given the target data from user. Trained model is deployed to the cloud and user can evaluate the model internal using Xylorix Insider. Automated evaluation test report will be generated to user. With approval from user, the model is now ready to deploy to the cloud to serve end user of Xylorix Inspector. However, the process does not end here as Xylorix promises to provide after deployment service which allows user to monitor and monetize the trained models. After deployment improvement of model is also available to fine-tune the performance of the models.

Xylorix platform has shown practical solutions of wood identification given macroscopic wood anatomy images [2]. By replacing the macroscopic lens with other sensors, Xylorix AIaaS platform can also be deployed to work seamlessly beyond macroscopic wood anatomy domain, e.g. microscopic wood anatomy, near infra-red sensing (NIRS) etc.

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O-14: Phenolics Profiling for Distinguishing of Some *Vireya Rhododendron* Species from Indonesia by LC/MS-IT-TOF

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Abstract

The *Rhododendron* genus is abundant in phenolic compounds that could be used as metabolite marker to discriminate some species in this genus 1. In this study, metabolite profiling using LC/MS-IT-TOF was used to identify the chemical compounds in the twig of seven *Vireya Rhododendron* from Indonesia. We used negative ion mode for detecting the compound. About 44 compounds were detected in all samples belonging to the class of flavan-3-ol, flavanone, flavonol, hydroxybenzoic acid and hydroxycinnamic acid. The metabolite composition in the twig of each species could be used to distinguish between the seven *Vireya Rhododendron* used in this study. These results indicate that an LC-MS-based profiling method is a useful tool for analyzing various metabolites in *Rhododendron* and also for selecting the metabolite marker to distinguish species from the same genus.

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O-15: Timber Identification of CITES Listed *Pterocarpus santalinus* and Non-CITES Listed *P. tinctorius* by DART-FTICR-MS and GC-MS: Comparison of Different Treated Samples

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Abstract

Pterocarpus santalinus and *P. tincorius* are commonly used traded timber species of the genus *Pterocarpus*. *P. santalinus* has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). As a non-CITES species, *P. tincorius* is also indiscriminately labeled as *P. santalinus* due to the similar macroscopic and microscopic features with *P. santalinus*. In order to understand the molecular discrimination between these easily confused species, DART-FTICR-MS (Direct Analysis in Real Time and Fourier Transform Ion Cyclotron Resonance Mass Spectrometry) and GC-MS (Gas Chromatography Mass Spectrometry) were developed and samples from eight treatment conditions of these two species were analyzed to investigate the effects of different treatment on chemical fingerprints for timber identification. Unique chemical profile was observed in the sample of *P. santalinus* and *P. tinctorius,* respectively. The supervised OPLS-DA models of samples from different treatment conditions all exhibited great performance. It has been proved that drying treatments, types of solvent and sample status had major effect on the chemical fingerprint of *P. santalinus* and *P. tinctorius.* The result of air dried wood chips was shown the least influence on the chemical profile of wood for effective species identification. Air dried wood chips were also considered as the optimal samples due to the highest prediction accuracy (100%) and less sample preparation. Furthermore, markers were figured out for the separation of the air dried wood chips of *P. santalinus* and *P. tinctorius* based on multivariate analyses.

Keywords: Wood identification, chemical fingerprints, DART-FTICR-MS, GC-MS, markers screening, xylarium

Acknowledgement: This work was supported financially by the National High-level Talent for Special Support Program of China (the National “Ten Thousand” Talents Plan) (Grant No. W02020331). The authors wish to acknowledge Dr. Alex C. Wiedenhoeft of Forest Products Laboratory, USA, Mr. Di Xiao and Mr. Changyu Xu for their help in collecting the samples.

O-17: Disentangling Species ID within a Genus and Verification of Timber Origin with DNA Methods

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Abstract

Since the last decade, increasing attention has been drawn on the sustainability of forest exploitation. International trade of wood and wood products requires in many countries that the species and country of origin are declared in other to prevent illegal logging. Since most timber tracking systems are based on paper documentation and might be affected by falsification, the use of reliable methods for the verification of species ID and country of origin is needed.

DNA fingerprints presents the advantage over other timber identification methods to adapt to the scale needed for the verification. New DNA-sequencing techniques are very valuable for the development of DNA markers on non-model species and assist in the setting up of cost-effective genotyping assays. We will demonstrate through several examples from different continents how DNA-based identification methods can complement the use of other wood identification techniques on species identification such as wood anatomy, and provide information on geographical origin.

O-18: DNA Extraction from Ebony (*Diospyros celebica* Bakh.) Dry Wood Samples Collected using Pickering Punch

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Abstract

Illegal logging is a major problem in the forestry sector in Indonesia. One of the tree species that has been heavily exploited illegally for its fine streaked timber is Ebony (*Diospyros celebica* Bakh.), which is an endemic species from Sulawesi Island[1] and it timber can be used for carving, inlay, furniture and musical instruments. Recently, the application of DNA markers can be used in a case of illegal logging by comparing the DNA profiles obtained, so that the origin of one sample of wood used as evidence material can be confirmed[2]. In order to construct the DNA profiles, the ability to extract DNA is of primary importance. Therefore, the aim of this study was to develop the most efficient method of obtaining DNA from tissues of dry ebony wood, which collected using pickering punch tool (Agroisolab, UK). In this study, two different homogenization methods were applied to the dry ebony wood and subsequently genomics DNA from all samples were isolated by the modified CTAB method (Figure 1).

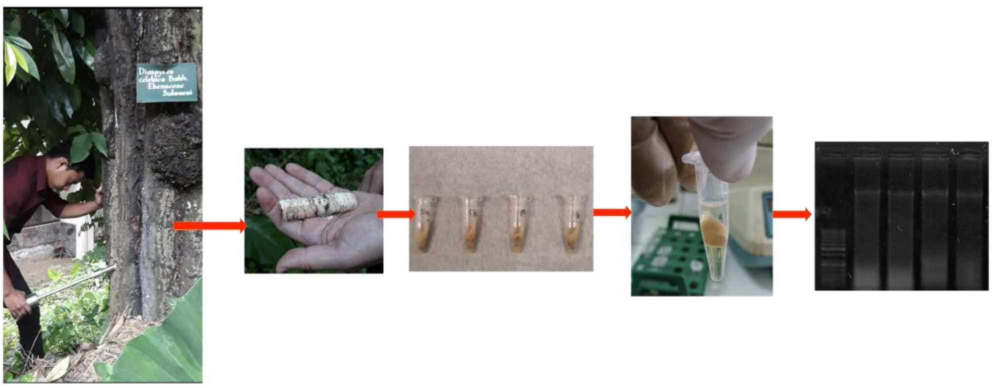

Figure 1. The workflow of sample collection using pickering punch and DNA isolation.

Concentration and quality of the obtained DNA was determined by measuring the absorbance at 260 nm. DNA quality (purity) was measured by calculating the ratio of absorbance at 260-280 nm. UV/VIS spectrophotometer Nanophotometer® (IMPLEN GmbH, Germany) was used for spectroscopic analyses. The result showed that the highest concentration of DNA was using dremel+manual grinding for

sample homogenization in both samples (Table 1). Although the purity of DNA was lower in dremel+manual grinding method than dremel method in both samples, those values were categorized as fairly good. This pattern suggested that dremel+manual grinding for sample homogenization proved to be reliable and it can be recommended as a good alternative when extracting DNA from dry wood.

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Table 1 Presents concentrations and quality of the obtained DNA using two different homogenization methods.

Tree No.	Homogenization Method	DNA Conc. (ng/µl)	Purity ($A_{260}/_{280}$)
1	Dremel	215.25	2.532
	Dremel+manual grinding	335.60	2.011
2	Dremel	166.50	2.595
	Dremel+manual grinding	242.75	2.104

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O-19: Supporting Sustainable Forest Management and Timber Industry with DNA Barcoding Wood Species Identification System Y Stem: Frim's Experience

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Abstract

Wood traceability systems provide a successful way to fight illegal logging, by making sure that timbers are traded from sustainably managed forests. In recent years, DNA technologies are emerging as useful tools to control chain-of-custody in timber trades, complementing the existing identification systems such as wood anatomy, radiofrequency identification (RFID) tagging and isotopic fingerprinting. The utility of DNA barcoding in forensic timber identification is also gaining recognition. At the Forest Research Institute Malaysia (FRIM), we have developed a DNA barcoding system for plant species identification and authentication. A comprehensive DNA barcode reference library has been developed. Currently, the database comprises 400 major tropical wood species, belonging to 26 families, including CITES-listed species. In the system, DNA barcoding technique uses a standard short genomic region that is universally present in target lineages and has sufficient sequence variation to discriminate among species. Besides supporting sustainable forest management, the DNA barcoding wood identification system has also brought positive impact to the timber industry. Since 2016, the FRIM Genetics Laboratory has been providing DNA-based wood species identification and authentication services to relevant stakeholders. The system has been applied to assist wood industry entrepreneurs/ players. In one instance, evidence was lent to a court case involving a business dispute, whereby a company was sued for allegedly replacing Chengal wood with other cheaper timber. The effort to expand the DNA barcoding database to include more traded timber species is on-going.

O-20: Identification of *Dalbergia odorifera* T.chen and *Dalbergia tonkinensis*

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Abstract

At present, there is a common controversy about whether *Dalbergia odorifera* T.chen and *Dalbergia tonkinensis* are the same species no matter in the market of rosewood or botany and wood science. In order to find the differences and connections between these two species, we mainly compared the anatomical structure, DNA barcode and chemical composition. The irregular differences of wood rays in the type and number of are mainly related to the habitat and the sampling position but not species. There are also no variability sites on the psbC-trnS, rbcL, trnL-intro, ropB, ropC1 barcode sequences, and those sequences are completely identical, and it cannot be used as a basis for distinguishing these two species until now, although there are 5 unstable mutation sites on the ITS sequence. The main volatile components of *D. odorifera* and *Dalbergia tonkinensis* are the same. Our preliminary conclusion is that *D. odorifera* and *Dalbergia tonkinensis* belong to the same species.

O-21: Developing High-Resolution DNA Barcodes for Discrimination of Timber Species using the Complete Chloroplast Genome

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Abstract

DNA barcoding, an effective tool for wood species identification, mainly focuses on universal barcodes and often lacks high resolution to differentiate species, especially for closely related taxa within the same genus. Therefore, more highly informative DNA barcodes need to be identified. This study is the first to report a strategy for developing specific DNA barcodes of wood tissues. The complete chloroplast genomes of leaf samples of three *Pterocarpus* species, i.e., *P. indicus*, *P. santalinus* and *P. tinctorius*, were sequenced, and thereafter, the most variable DNA regions were identified on the scale of the complete chloroplast genomes. Finally, wood DNA was extracted from 30 wood specimens of the three *Pterocarpus* species, and DNA recovery rates of the selected regions were tested for applicability to verification on the wood specimens studied. The seven regions with the most variation (*rpl32-ccsA, rpl20-clpP, trnC-rpoB, ycf1b, accD-ycf4, ycf1a and psbK-accD*) were identified from the chloroplast genome by quantifying nucleotide diversity (Pi>0.02), which was remarkably higher than that of the plant universal barcodes (*rbcL, matK* and *trnH-psbA*) and the previously reported barcodes (*ndhF-rpl32* and *trnL-F*) used for phylogenetic analysis in *Pterocarpus*. After comprehensive evaluation of species discrimination ability and applicability, the *ycf1b* region performed well in terms of the recovery success rate (76.7%) and species identification (100%) for wood specimens of the three *Pterocarpus* species and was identified as the preferred high-resolution chloroplast barcode for selected *Pterocarpus* species. It will offer technical support for curbing illegal timber harvesting activities and for conserving endangered and valuable wood species.

O-22: China's Exploration and Practices to Establish Timber Legality Verification System

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Abstract

At present, the international society has adopted active measures to strike illegal felling and trade. Internationally, the US, EU, Australia, Japan, UK, France, Denmark and other countries have promulgated or will promulgate relevant laws, and legal requirements are proposed in the government procurement policies. From the perspective of the industry, many industry associations and enterprises guarantee the legal timber source by responsible and sustainable procurement and other measures. As for the efforts made by international organizations, non-governmental organizations are proactively encouraging consumers to improve their awareness of buying legal and sustainable timber products and conducting legal timber certification activities. So far, there is no such a feasible mechanism to identify and reject illegal timber from entering consumer market. Implementation of legal timber certification, however, is recognized by international organizations as an important means to control illegal felling and trade.

China has become the forestry product processing center and trading power in the world, and also one of the largest consumers of timber products. The Chinese government attaches great importance on illegal felling and trade issues, regards violation of laws and regulations on forest development and utilization and forest product trade of resource countries and conducts causing damages to forest resources as illegal felling, and lays emphasis on development of legal timber certification methods which are low-cost, easy to operate and suitable for promotion in developing countries, based on the facts of all countries, to solve global issues of illegal felling and trade.

According to the development of international legal timber certification and the actual conditions of China, we stand for establishing legal timber certification system which is government guided, voluntary and due diligence-based to fight against illegal felling, standardize the production of forest products in China, promote international timber trade, meet the global legal timber requirements, effectively expand international market and push forward our forest legality progress.

Standard is the basis of certification which in turn is an assessment process specific to standard. China’s legal timber certification standard system frame includes

system documents and technical specifications. China Legal Timber Standard is the core basis for legal timber certification standard system and certification works. Legal timber standard is the basis for establishing legal timber certification system, reviewing and evaluating timber legality, as well as the basic specification to discuss and propose whether the forest operators and forest product enterprises meet the legal timber requirements. This standard provides standard basis for relevant organizations to conduct legal timber review and assessment.

Through China-US, China-Australia, China-EU, China-Japan, China-Canada, China-India and other bilateral illegal felling striking campaigns and relevant trading mechanisms, we introduced the China’s policies and activities to strike illegal felling and trade, promoted China's timber legality verification system, China’s experience and practice specific to timber legality to enhance mutual trust and expand common grounds. Besides, we facilitated APEC EGILAT to discuss on illegal felling control, strengthening the law enforcement of forest product trade, construction of legal timber guarantee system and other related topics, share information, and promote policy dialogue.

It should be said that some practical results have also been produced over these years around the development of the timber legality verification system.

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O-23: Towards the Implementation of the Reviewed Concept of the GTTN Service Providers Directory and Reference Database in a Multi-Method Platform based on TREEGENES

Jo Van Brusselen[1], Jill Wegrzyn[2], Meaghan Parker-Forney[3], Céline Blanc-Jolivet[4], Peter Richter[2], Sean Buhler[2], Emily Grau[2], Sergey Zudin[1], Simo Varis[1] *et al*.

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Abstract

The Global Timber Tracking Network (GTTN) promotes the operationalization of innovative tools for species identification and for determining the geographic origin of wood to verify trade claims of wood-based products. One of the key GTTN activities concerns the development of a directory of wood identification capacities on the one hand, and of a reference database on the other hand.

The directory of wood identification capacities is designed to help potential users of wood identification services, to find suitable service providers, depending on the assumed tree species, geographical origin, product type and lab location, and facilitates the service enquiry with queried labs.

The reference database is for participating organizations and researchers to store, find and retrieve tree species reference data and samples that are botanically vouchered and georeferenced. The objective of this is to avoid duplication of costly sampling and data development effort, to increase coordination of reference data development activities, and to stimulate the development of wood identification capacities. While the reference database was developed on the basis of TREEGENES, which originated as a tree species genetics information exchange and analysis platform, the GTTN reference database caters for data also from other than genetics-based methods, such as isotopes-based analysis.

The presentation will start with an introduction of the GTTN scope and activities, to continue with the database concepts and metadata structures, data storage and retrieval modalities.

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O-24 : Comprehensive Approach to Building and Scaling Wood ID Tools

Meaghan Parker-Forney

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Abstract

Over the last five years, WRI has taken a comprehensive approach to tackling the barriers which preclude the uptake of wood identification tools in the enforcement and private sector. WRI has worked closely with US government agencies as well as international government agencies and consortium to fund wood ID projects by either investing in the collection and development of reference databases for commercial timber species or investing in the development of wood ID tools, specifically.

Meaghan Parker-Forney will present WRI's strategy for assisting in the global uptake of wood identification tools as well as an overview of WRI's current and past projects working with USG scientists, international private labs, universities and botanical gardens.

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Symposium Poster Presentations

P-1: Juvenility Characteristics of Agarwood (*Aquilaria malaccensis* Lam.) from Three Different Growing Sites

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Abstract

Aquilaria malaccensis Lam. is one of the gaharu-producing species in Indonesia. The increasing demand for agarwood caused *Aquilaria malaccensis* included in Appendix II CITES (the plant is rare in nature). The purpose of this study were to determine the characteristics of juvenile wood and to estimate the transition point of juvenile wood to mature wood based on anatomical properties (fiber length, cell wall thickness, and microfibril angel (MFA)), physical properties (moisture content, spesific gravity, and density), and mechanical properties (compression parallel to grain). Determination of the transition point was based on the parameter values of anatomical, physical, and mechanical properties from pith to bark of agarwood originated from three different growing sites, namely Prabumulih, Bahorok, and Bintan Island in Sumatra island. The segmented regression model approach was used to determine the transition point between juvenile wood and mature wood using PROC NLIN program in SAS application. The results of the PROC NLIN analysis in SAS showed that based on fiber length, mature wood were occurred from 6th segment (Prabumulih), from 8th (Bahorok), and from 11th (Bintan Island). While, based on cell wall thickness, mature wood started from 10th segment (Prabumulih), from 8th (Bahorok), and from 25th (Bintan Island). Based on MFA, mature wood started from 8th segment (Prabumulih), from 10th (Bahorok), from 19th (Bintan Island). Fiber length, cell wall thickness, and MFA can be used as indicators to determine the transition point of juvenile wood to mature wood. The proportion of juvenile wood on agarwood in three growing sites ranges from 50-100%.

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P-2: Assessment of Illegal Logging in Peusangan – Jambo Aye-Tamiang Landscape in Aceh-Indonesia

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Abstract

The landscape of Peusangan-Jambo Aye-Tamiang is one of the watersheds with 1.663.219 ha that plays an important role for a water regulator and water catchment area for 6 districts in Aceh. This landscape is consist of various ecosystem such as mangrove, lake, coastal forest, low land tropical forest and high land tropical forest which are home for four key of distinct species such as Sumatran Elephant (*Elephas Maximus* Sumatranus), Tiger (*Panthera tigris* Sumatrae), Sumatran Rhinoceros (*Dicerorhinus sumatrensis*), Sumatran Orang utan (*Pongo abelii*). This important landscape is now become threatened with damage due to illegal logging activities, even though in 2007 the Government of Aceh has signed the policy of logging moratorium in the province of Aceh until an unspecified time, the forest damage is still uncontrolled. This research was aimed to assess the illegal logging activity in the landscape of Peusangan-Jambo Aye-Tamiang in narrowing to areas that are vulnerable and affected to illegal logging, the main of logged timber, the distribution of illegal logging timber, and identification of illegal logging perpetrator. The main data used in this study was a structured interview of the local people in six districts along the watershed. The result showed that the moratorium on logging in Aceh cannot successfully be implemented. There were four districts which are the loci of illegal logging activities namely, North Aceh, Bener Meriah, Bireun and Central Aceh. The main logged timber belonged to Dipterocarps family, the timber was brought out of the forest by buffalo, motorcycle, and car to the trader container. There are four types of illegal logger; local people, neighbor local people, civil servant, and security forces. We also found that the socialization of moratorium on logging in Aceh is lack due to the political affair and many conflicts of interest among the community, private sector and government.

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P-3: Variation on the Chemical Composition of Wood Cell Walls from Sapwood to Heartwood of *Catalpa bungei* C. A. Mey

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Abstract

Wood cell walls are natural bio-composites made up of stiff cellulose with a soft polymer matrix of hemicellulose and lignin. There exist obvious property differences between sapwood and heartwood due to its difference and complexity in Chemical composition content and distribution. Variation on the chemical composition content and distribution of wood cell walls in *Catalpa bungei* C. A. Mey during the transition from sapwood to heartwood was investigated by using in situ imaging FTIR spectroscopy and Confocal Raman microscopy in this study. The results revealed that the cellulose content (2897 cm^{-1}) of heartwood was decreased by 16% as compared with the sapwood. Compared to the sapwood, the hemicellulose content (1738 cm^{-1}) and lignin content (1508 cm^{-1}) of heartwood was increased by 31% and 17%, respectively. While the hemicellulose content (1738 cm^{-1}) and lignin content (1508 cm^{-1}) of sapwood was almost the same to that of the transition wood. It was concluded that there exist obviously differences in the chemical composition of wood cell walls from sapwood to heartwood of *Catalpa bungei* C.A.Mey.

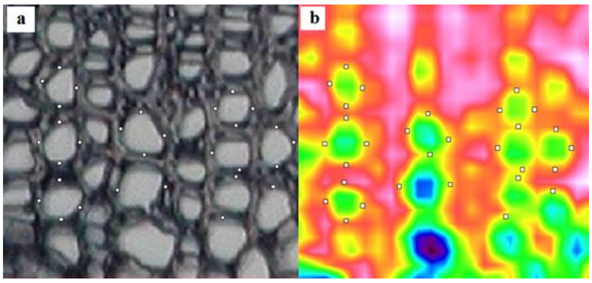

Fig.1 In situ imaging FTIR spectroscopy of wood cell walls. (a) Visible image; (b) A corrected total full-spectral IR image of the scanned area.

Acknowledgement

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P-4: Variation on Xylem Ray Parenchyma Vitality in Different Vertical Height and Radial Direction of *Catalpa bungei* C. A. Mey

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Abstract

The transformation from sapwood to heartwood is an important and complex process in the growth of trees, which results in significant differences of wood structure between sapwood and heartwood. In this paper, a precious hardwood tree *Catalpa bungei* C.A.Mey in China was selected, radial profiles were collected from different vertical tree height. Small wood blocks（$10\times10\times20mm^3$）were taken from sapwood, transition zone, outer heartwood, central heartwood and inner heartwood of each profile. Xylem ray parenchyma vitality was examined by acetocarmine staining for radial sections collected in each block. Cellular ultrastructure of ray cells was observed by transmission electron microcopy. The vitality of ray parenchyma cells was the highest in the sapwood, but lowest in the heartwood. The vitality of ray parenchyma cells was highest at the maximum tree height. Abundant deposits were found in xylem ray cells of inner heartwood. The protoplasts in the cytoplasm, starch granules and oil droplets were gradually degraded from sapwood to heartwood, while in heartwood protoplasts almost completely disappeared in ray cells.

Acknowledgement

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P-5: *Paulownia* Wood Introduction

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Abstract

Paulownia is an important species being planted with crops in farmland for afforestation in the Huanghuaihai plain area and in the middle and low reaches of Yangtze River . Because of its deep roots, *paulownia* does not compete with crops for water and fertilizer, and it put leaves late in spring, which has little impact on crop growth. Planting *paulownia* has two functions. One is to protect farmland, prevent wind and fix sand in the old riverway of Yellow River. And second, to provide timber for industry uses such as making furniture, wall panel, musical instruments, arts and crafts, blinds etc... It has become the main cultivated tree species for making money in China's agriculture forestry system. *Paulownia* trees are mainly planted beside village, around houses, along roadside and by the ditches. It belongs to fast-growing high yielding tree with 2cm year-ring growth. It can be cut during 8 to 20 years after planting.

Paulownia wood is light and even, its air-dry density is between 0.25-0.33g/cm^3. However, *paulownia* has a high ratio of strength to weight. Usually *paulownia* wood has milky white color and silky luster, there is no big difference between the heart and the sapwood; It is difficult for liquid to penetrate the *paulownia* wood, which is the reason of small dry shrinkage and good dimensional stability; low thermal conductivity makes it good for thermal insulation with high ignition point and strong fire resistance.

The biggest defect in the utilization processing of *paulownia* wood is that it is prone to discolor, which is the bottleneck for industry utilization. The current control methods are divided into chemical and physical methods. Enterprises generally use the chemical liquid immersion and water treatment method to solve the problem, but the treated *paulownia* wood color can not keep long and stable, resulting in large color difference. Through years of research, China Paulownia Research Center Comprehensive Utilization Group has successfully found a variety of methods to deal with discoloration under different conditions, and has achieved some results in dealing with the problem of color chromatism.Research team help enterprises solve problems and promote upgrading of *paulownia* products in the process of practice. The research group has helped companies develop high-quality wallboard processing technology depending on the characteristics of paulownia wood.

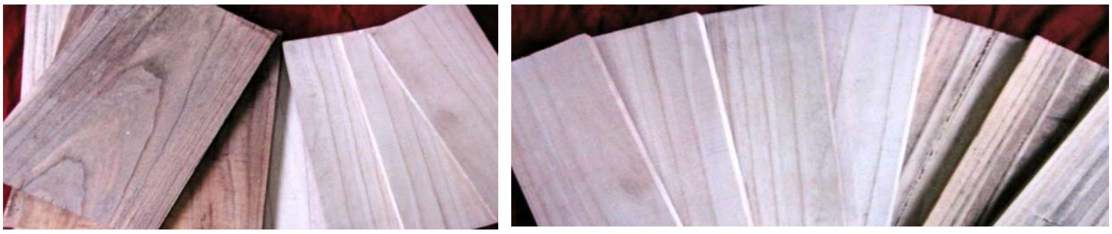

Fig1.contrast before and after decolorization

Fig2.discolored *paulownia* wood

Fig3. furniture

Fig4.wall panels

Fig5. musical instruments

Fig6. wall panels

Fig7.blinds

P-6 : Comparison of Microstructural Characteristics between Heartwood and Sapwood of Chinese Fir Clones

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Abstract

Chinese fir (*Cunninghamia lanceolata*) is the most important fast-growing coniferous species in China, which is widely used in buildings, furniture and ships. Its heartwood formed earlier, and there are obvious difference between heartwood and sapwood. Detection and comparison of chemical composition, cell wall ultrastructure and microstructural differences between heartwood and sapwood of new clones can provide important structural data for evaluating the quality characteristics of heartwood and sapwood. Using Fourier transform infrared spectroscopy, X-ray diffraction, optical microscopy combined with Image J, the chemical composition of cell wall, crystallinity of cell wall cellulose and microstructure of heartwood and sapwood of Chinese fir clone yang 61 were determined in this paper. The average area and area ratio of tracheid lumen was quickly detected by Image J analysis technology, and found that average area and area ratio of tracheid lumen of heartwood was smaller than that of sapwood. That is, heartwood cells have thicker walls and smaller lumens compared with sapwood. It was also founded that the wave numbers of chemical functional groups in FTIR spectra of heartwood and sapwood were basically the same, that is, the main structure of chemical composition was the same. The characteristic peaks of phenols and alcohols (1034cm-1 and 1122cm-1) and Caryl-O stretching vibration (1264cm-1 and 1232cm-1) in infrared spectra of heartwood were higher than those in sapwood. So this showed that the content of extracts and the degree of crosslinking of lignin in heartwood are possibly higher than those of sapwood. At the same time, it was found that the relative content of lignin in heartwood increased by 2% - 4%, the relative content of cellulose decreased by 2%, and the hemicellulose content remained unchanged compared with sapwood by characteristic peak ratio method. By analyzing the X-ray diffraction patterns, it was found that the shape of the diffraction patterns of heartwood and sapwood of Chinese fir were basically the same, but the width of the peak of sapwood was narrower than that of heartwood, and the peak intensity of sapwood was higher at $2\theta=22.5°$than that of heartwood . The relative crystallinity of heartwood is 35.1% and that of sapwood is 43.1%. There is a

significant difference between them at P<0.01. The above research found that FTIR, X-ray diffraction, optical microscopy combined with Image J can quickly and accurately detect the differences of microstructure characteristics between wood heartwood and sapwood of Chinese fir clones. The results can provide theoretical guidance and scientific basis for evaluation of physical and mechanical properties, cell wall modification and efficient utilization of heartwood and sapwood.

Acknowledgement: Funded by National Key Research and Development Program of China (2017YFD0600201).

P-7: Influence of Surface Sanded on Wood Species Identification by Near Infrared Spectroscopy

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Abstract

Near infrared spectroscopy (NIRS) has been shown effective as a tool for wood species identification. NIRS has been studied as a tool to identification many woods with excellent performance. According to literature reported, the wood sample of many studies are come from wood market. It is essential to establish database for the identification of wood species by NIRS. There are abundant and various wood specimens in wood specimen museum, this is an invaluable resource for wood species identification. However, because of the specimens were collected in wood specimen museum for many years, many changes have taken place on the specimen surface, such as oxidized, aged, et al. So, the feasibility of establish NIRS wood species identification database by wood specimens from wood specimen museum are analysis in present work. The spectra of six species (*Pinus griffithii*, *Pinus tabulaeformis*, *Pinus yunnanensis*, *Cinnamomum glanduliferum*, *Cinnamomum camphora*, *Cinnamomum porrectu*) from two genus (*Pinus* and *Cinnamomum)* were obtained by a hand-hold NIRS spectrometer before and immediately after sanding the specimen. Partial least squares discriminant analysis models were developed for each three species of same genus for before and after sand spectra, respectively. Based on a calibration set composed of 40 samples and test set with 20 samples. It was shown that the identification accuracy vary from 90 to 100% with both before and after sanding specimen. Comparing the discriminant result for the samples before and after sanding one can conclude that there is no significant difference in the performance of models. In summary, it is feasibility to build NIRS wood species identification database by wood specimens come from wood specimen museum, and there is no need to send the surface of a specimen to obtain the NIRS spectra.

Keywords: wood specimen**,** species identification, surface sand, near infrared spectroscopy (NIRS), partial least squares discriminant analysis (PLS-DA)

P-8: HPLC Fingerprint Characteristics of Agarwood from Different Origins

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Abstract

In the view of the difference in the quality of agarwood from different origins, and the identification of traditional agarwood origin relies on experience judgment. High performance liquid chromatography (HPLC) characteristics fingerprints of agarwood from different origins were studied, and the feasibility of chromatographic fingerprint analysis technology for traceability of agarwood origin was discussed.

36 batches of agarwood from three origins were analyzed by optimized high performance liquid chromatography. The retention time and area of chromatographic peaks was obtained by the similarity evaluation system of chromatographic fingerprints of traditional Chinese medicines. HPLC fingerprints of agarwood from three different producting regions were established. And principal component analysis (PCA) and partial least squares discriminant analysis (OPLS-DA) was used to establish the discriminant methods of agarwood from different origin.

By analyzing the 85 characteristic peak variables of the HPLC fingerprint of agarwood from three different origins, it was found that the species and relative content of 2-(2-phenylethyl) chromone composition are the most abundant in Guan-Xiang Zone. In Sin-Chew Zone, the peaks of agarotetrol are extremely high and the relative content of the other chromones was relatively low. There were more species of 2-(2-phenylethyl) chromone in the samples of Hoi-An Zone, whose relative content was slightly lower than that in Guan-Xiang Zone and slightly higher than that in the Sin-Chew Zone. According to the geographical distribution of the place of origins, the samples of Hoi-An Zone shows a certain transition characteristics in the three producing origins. PCA analysis showed that the samples could basically be aggregated into three categories according to the origin. The accuracy of OPLS-DA analysis method in identifying the sample origin of training set and test set was 100%.

The composition and relative content of 2-(2-phenylethyl) chromophenone in agarwood from different origins are quite different, showing a certain regional characteristics. The origin of agarwood can be identified by HPLC combined with OPLS-DA.

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P-9: Forestry for Sustainable Development and Impact of Deforestation on Biodiversity in Nigeria

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Abstract

Deforestation, particularly in the developing countries, is a major cause for concern. It has negative consequences on the environment. Its impact on biodiversity in Nigeria was what this work sought to investigate. The research was carried out in four agro-ecological zones of the state. Field inventories (of plant species) and population count of trees were carried out to generate data for biodiversity analysis This paper further attempts an inventory of forest resources in Nigeria, exposes the utility and resourcefulness and highlights the management process and its sustainability. The paper observes that the local communities, private sector and government should cooperate as stakeholders in sharing both the benefits and burden of proper understanding of the central position of forestry in National development and calls for repositioning of forest management in Nigeria.

P-10: The Challenges and Opportunities of Forests and Enhancement of Forestry for Updating Wood Identification in Nigeria

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Abstract

In Nigeria Forestry offers challenging prospects, both for economic growth and social development. Often, however, its many-sided developmental role is appreciated insufficiently. With only 2 per cent of the total area of the country under productive high forests, forestry and forest industries have been and could continue to be an economic power. In addition to the exports of cassava, coconuts, cotton and palm produce, forest products has been the mainstay of the country's favorable balance of payments in the past. Of all the Nigerian exports, wood products command the highest range of international currencies. The forests also provide raw materials which satisfy local consumer demands and investment needs. Forest exploitation and the resulting industries create employment and increased earnings which are essential objectives of economic development policies. However, the forestry economic boom that had occurred was in response to overseas demands while the benefits of value added accrued to foreign-based investors. The recent rapid economic development has generated a great deal of wood-processing activities, particularly at the primary stage of sawmilling. The future of forestry industry development in Nigeria is closely linked with the level processing Wood Products [PWP] Wood –based industries in Nigeria have been undergoing a structural reviewing process for the past years as growth and development is taking place within the Economy. Forest Conversion in Nigeria stared with the use of local simple tool such as axe and cutlass. Development and civilization as brought into use, the method of pit sawing in which band saws were operated by two men, one inside the pit another over a deep pit on which the log was laid. The earliest pit sawing industry in Nigeria is believed to have been in place since 1783 by the Portuguese, using slave labour, somewhere in a bush between Ebute-meta and Yaba [Okigbo.1964]

Reforestation for ecological purposes on a very large scale has become a necessity for many eroded and wind-swept areas of the country. Just as the loss of forest-cover means ultimate destruction of agricultural production, climate, and living

conditions, reforestation is the indispensable starting phase for a new cycle of ecological rehabilitation and the introduction of a new set of human endeavors. Such large-scale plantations for purposes of ecological rehabilitation and sustained yield production of forest resources must include comprehensive measures such as the introduction of business-oriented forest services, provision of adequate and unfettered financial resources, the establishment of modern forest villages through agri-silvicultural practices, and the development of research programmes which would facilitate full and efficient utilization of forest resources

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P-11: The Role of Conservation Sustainable Management of Forests and Enhancement of Forestry

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Abstract

This paper attempts to take a look at forest resources in Nigeria, exposes the utility and resourcefulness and highlights the management process and its sustainability. The Paper observes that the local communities, private sector and government should cooperate as stakeholders in sharing both the benefits and burden of proper understanding of the Central position of forestry in National development and calls for repositioning of forest Management in Nigeria. The various ecological and economical processes is now being discovered. More so, discovery has proved that there are relationships in identifying the forest and forest trees.

Undoubtedly, in large percentage of land area across the world. However, these classifications of tree are relatively under-researched and overlooked in many forest management effort. Most forest management efforts aimed at accessing sustainability is focused on trees under formal forest settings. Furthermore, the definition of 'forest' in Nigeria does not encourage or facilitate the sustainable management of these tree classes to the very least. Nonetheless, at the current and past rate of deforestation and forest degradation, and unsustainable practices in Nigeria coupled with global climate change challenges, if proper measures are not taken the sustainability of our Remaining forest will be severely threatened and environmental Resilience questionable. Conservation initiatives in tropics, Germplasm development and improvement of management strategies, Forestry financial incentives, were singled out. It was concluded that Nigeria has Avery fertile soil for forest sustainability and management of trees outside the forest ecosystem are to be included in sustainability initiatives.

Keywords: Trees outside the forest, Sustainable forest management, Prospect, challenge

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P-12: Use of Wood Characters in the Identification of Selected Timber Species in Nigeria

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Abstract

Ten popular timber species belonging to seven families in Nigeria were identified in the Herbarium. Wood samples of each species were studied anatomically in search of stable taxonomic micromorphological attributes. Characters of the treachery elements, in particular, the vessel; fibre and ray structure; intercellular canal and phloem parenchyma are diagnostic among the species. The invariable presence of non-septate fibres in *Afzelia africana* (Sm.) and *Milicia excelsa* (Welsh. and C. C. Berg.) delimits them from other woods which all posses septate fibres. Occurrence of tyloses in the metaxylem of *Cordia millenii* (Bak.), *Antiaris toxicaria*(Lesch.), *Tectona grandis* (L. F.), *Terminalia ivorensis* (A. Chev.) and *Triplochiton scleroxylon* (K. Schum.) separates them from *Anogeissus leiocarpus* (Guill. And Perr.), *Khaya ivorensis* (A. Chev.) and *Mansonia altissima* (A. Chev.). A detailed study of the wood structure of the commercial Nigerian timber species may provide an invaluable tool for determination, identification of fragments and thereby assisting in promoting quality assurance as well as detecting adulteration in wood trade and detecting camouflage and substitution of CITES-listed trees.

Keywords: timber, character, identi cation, fragmen