(SS30) Late Cretaceous and Tertiary Woods. Ecological, Systematic, and Biogeographic Insights from the Fossil Wood Record

Date: August 27
Place: Room 5234 (oral), Room 6310 (poster)
Organizers: Kazuo Terada & Elisabeth Wheeler
Contact email address: k-terada@dinosaur.pref.fukui.jp
Purpose: Variations in growth ring structure and features of tracheary elements provide information about environmental conditions. Analyses of Late Cretaceous and Tertiary woods of both the Southern and Northern Hemisphere yield data important for understanding the responses of woody plant structure and distribution to environmental changes. Careful determination of the systematic affinities of fossil woods to extant plants is important to biogeographic studies in revealing past distributions of woody plants.

Oral Presentation

Aug. 27 [AM2] Room: 5234

Chairs: Elisabeth Wheeler, Kazuo Terada

10:50-11:10 **Eocene petrified wood from Parnell Draw: towards a more complete understanding of the diversity and paleoenvironment of the Green River Formation in southwestern Wyoming, USA** SS30-O01 (43)

Nareerat Boonchai, Steven R. Manchester, Terry A. Lott

11:10-11:30 **A diverse assemblage of Leguminosae woods from the Neogene of Mexico** SS30-O02 (128)

Luis A. Flores-Rocha, S.R.S. Cevallos-Ferriz, L. Calvillo-Canadell

11:30-11:50 **Silicified legume woods from the Neogene of Bengal Basin with remark on distribution and paleoenvironment** SS30-O03 (458)

Illora Sen, Subir Bera

Chair: Elisabeth Wheeler

11:50-12:10 **Fossil wood flora of western India and its palaeoecological and phytogeographical significance** SS30-O04 (475)

Anumeha Shukla, Rakesh C. Mehrotra

Aug. 27 [PM2] Room: 5234

Chair: Elisabeth Wheeler

14:30-14:50 **Vegetational changes during the Late Cretaceous-Tertiary interval across Antarctica and South America, based on the fossil wood record** SS30-O05 (520)

Kazuo Terada, Imogen Poole, Harufumi Nishida

Chairs: Elisabeth Wheeler, Kazuo Terada

14:50-15:10 **Southern vs. Northern Hemisphere: *Antarctoxylon* from the Upper Cretaceous of Antarctica and *Spiroplatanoxylon* from the Tertiary of Europe** SS30-O06 (446)

Jakub Sakala

15:10-15:30 **Silicification in wood: Seeing the fossil forest and the trees** SS30-O07 (151)

Carole T. Gee, Chris Ballhaus, Sashima Läbe, Jo Hellawell, Thorsten Nagel

15:30-15:50 **Angiosperm wood floras from the southern Western Interior, North America: new data and interpretations** SS30-O08 (120)

Emilio Estrada-Ruiz, Garland R. Upchurch Jr., Elisabeth A. Wheeler, Greg H. Mack

Aug. 27 [PM3] Room: 5234

Chair: Kazuo Terada

16:20-16:40 **Cretaceous angiosperm woods and APG III. What orders and families are represented?** SS30-O09 (569)

Elisabeth A. Wheeler, Pieter Baas

16:40-17:00 **Late Cretaceous and Tertiary woods from southern Africa** SS30-O10

Marion K Bamford

Poster Presentation

Aug. 27 [PM1] Room: 6310

13:30-14:30 **Coniferous and dicotyledonous fossil woods from the Dim dinosaur locality (Zeya-Bureya Basin, Russian Far East)** SS30-P01 (5)

Maxim Afonin

Wood specific gravity estimation based on wood anatomical traits: inference of key ecological characteristics in fossil assemblages SS30-P02 (315)

Hugo I. Martínez-Cabrera, Emilio Estrada-Ruiz, Carlos Castañeda-Posadas, Deborah Woodcock

Miocene *Ilex* wood from the Shimane Prefecture in Japan: First description of *Ilex* wood from Asia SS30-P03 (213)

Eun Kyoung Jeong, Kyungsik Kim, Mitsuo Suzuki

Miocene wood assemblages of Korea and Japan with special reference to the East Sea opening SS30-P04 (214)

Eun Kyoung Jeong, Kyungsik Kim, Mitsuo Suzuki, In Sung Paik

New insights into the Eocene Western Antarctic forests: fossil woods from La Meseta Formation SS30-P05 (418)

Roberto R. Pujana, Sergio Santillana, Sergio A. Marenssi

A new Malvaceae wood from the Middle Miocene Cucaracha Formation in the Panama Canal SS30-P06 (434)

Oris Rodríguez-Reyes, Howard Falcon-Lang, Margaret Collinson, Peter Gasson

Eocene petrified wood from Parnell Draw: towards a more complete understanding of the diversity and paleoenvironment of the Green River Formation in southwestern Wyoming, USA

Nareerat Boonchai[1], Steven R. Manchester[2], Terry A. Lott[2]

[1] *Research Center of Paleontology and Stratigraphy, Jilin University, 6 Ximinzhu Street, Changchun 130026, China, n_finix@yahoo.com*
[2] *Florida Museum of Natural History, Dickinson Hall, University of Florida, Gainesville, FL 32611 USA*

Eocene sediments of the Green River Formation are well known for their abundance of fossil plant and animal remains, which have played an important role in reconstructing the paleoenvironment of southwestern Wyoming. Although petrified woods are abundant and anatomically well-preserved, only a few taxonomic investigations have been carried out. Previous studies of the paleovegetation and climate of this formation have focused on leaves and fruits. In this study, we focus on the systematic affinities of the petrified wood from Parnell Draw, one of the many localities in Eden Valley which exposes the Tipton Shale Member of the Green River Formation in southwestern Wyoming. Both gymnosperm and angiosperm woods were found. Of all the collected samples, dicotyledons are the most abundant, especially Platanaceae (~ 18%). Other dicotyledonous woods include representatives of the Anacardiaceae, Annonaceae, Cornaceae, Lauraceae, Moraceae, and Sapotaceae, among others. Only two specimens of monocotyledons, *Palmoxylon* (Arecaceae), have been found, along with three specimens of coniferous wood belonging to the Cupressaceae and Pinaceae. Fossil wood from this site is not only excellently preserved, but is also taxonomically diverse. These findings augment the data from fossil leaves and fruits suggesting that the paleoflora is consistent with other indicators that Eocene climate of this region was subtropical. Taxonomic study on both the generic and species levels of these woods, their ecological affinities, and the climatic implications of this flora continue to be investigated.

Keywords: anatomy, gymnosperm, angiosperm, subtropical, Tipton Shale Member.

SS30-O02 (128)

A diverse assemblage of Leguminosae woods from the Neogene of Mexico

Luis A. Flores-Rocha[1], S.R.S. Cevallos-Ferriz[2], L. Calvillo-Canadell[2]

[1] *Facultad de Ciencias, UNAM, Biologia, Privada de Chimalistac 42 A-103, Colonia Oxtopulco, Delegación Coyoacan, México D.F., 04318, Mexico*
[2] *Instituto de Geologia, UNAM, Department of Palentology, Ciudad Universitaria, Coyoacan, Mexico D.F., 04510, Mexico, scrscfpb@unam.mx*

A large assemblage of woods (ca. different 80 types) collected in the towns of Las Guacamayas, Chiapas (Miocene), Panotla, Tlaxcala (Miocene), and Culiacan, Sinaloa (Pleistocene) includes woods with features characteristic of the Leguminosae (ca. 14 types). These Neogene woods all have simple perforation plates, alternate intervessel pitting, vessel-ray parenchyma pits smaller than intervessel pits, storied structure (vessel elements, axial parenchyma, rays), and aliform, banded, confluent and/or vasicentric axial parenchyma. There is variation in size of intervessel and vessel-ray pits, diameter of vessel elements, number of pores per mm^2 and rays/ mm, ray cellular composition is mostly homocellular, but some have both homocellular and heterocellular rays, woods vary from diffuse to ring porous, vessels are mostly solitary, and some wood types have vascular tracheids. Some samples could represent individuals of the same species, or alternatively may represent different developmental stages of the same species, but most are species of different genera. The

different types include representatives of the subfamilies Caesalpinioideae (genera *Caesalpinia, Haematoxylon, Gleditsia* and *Gymnocladus*), Papilionoideae (genera *Dalbergia, Swartzia, Sophora, Millettia/Lonchocarpu*s and *Holocalyx)* and Mimosoisdeae (genera *Mimosa and Xylia)*. These new records confirm the importance of Leguminosae in Mexico during the Cenozoic, particularly during the Neogene (Miocene and Pleistocene), and contribute information useful in biogeographic studies, as there are some taxa that today are native to South America.

Keywords: wood anatomy, Neogene, Leguminosae, Mexico.

SS30-O03 (458)

Silicified legume woods from the Neogene of Bengal Basin with remark on distribution and paleoenvironment

Illora Sen[1], Subir Bera[2]

[1] *Shri Shikshayatan College, Kolkata, India, senillora@yahoo.co.in*
[2] *Department of Botany, University of Calcutta, Kolkata, India*

A rich fossil wood assemblage has been recorded from the Neogene exposures of Bengal Basin, India and Bangladesh. Seventeen xylotypes belonging to Fabaceae are being described from different fossiliferous sites of Tripura, West Bengal (India) and Bangladesh. Predominance of the members of Fabaceae is quite uniform throughout the Neogene exposures of the Bengal Basin The modern equivalents of the presently recorded fossil taxa of Fabaceae are *Albizia, Bauhinia, Cassia, Isoberlinia, Kingiodendron, Ormosia, Sindora, Pahudia, Millettia and Afzelia- Intsia.* The previous fossil records of *Albizia* are from the different Neogene exposures of India and abroad viz., Gujarat, Himachal Pradesh, West Bengal, Arunachal Pradesh and tropical forests of Myanmar. Fossil records of *Bauhinia* , *Ormosia*, *Isoberlinia* and *Kingiodendron* are few while those of *Cassia, Millettia, Pahudia*, *Afzelia-Intsia* are comparatively more from different parts of India and abroad. *Albizia*, at present occurs as medium sized trees in the warmer parts of the world; *Bauhinia*, a genus comprising of trees, shrubs and climbers are well distributed in the tropical regions of India; different species of *Cassia, Pahudia* and *Afzelia – Intsia* exstensively occur in the warm deciduous forests of India and also stretches across to Bangladesh, Sri Lanka and Myanmar. Several species of *Millettia* are distributed throughout the tropical and subtropical warm deciduous to evergreen forests of Africa, India, Malaysia, China and Australia. *Ormosia* is a genus having about 50 species distributed in the tropics of Asia and America. Reconstruction of past vegetation pattern and the prevailing environmental condition of the present area of investigation during Neogene have been attempted by considering all the previous fossil wood records from the Basin (West Bengal, Tripura and Bangladesh) and the adjoining landmasses including Assam, Arunachal Pradesh, Nagaland in India and the Southeastern countries viz., Myanmar, Thailand, Borneo and Sumatra, as the entire area falls within a tropical belt supported by a uniform climate. The forest types, phytogeographic distribution patterns and climatic requirements of the modern equivalents of all the respective fossil taxa of this entire landmass has been taken as a reliable database to reframe the vegetation of the Bengal Basin during Neogene period. A close survey of the forest types of all the modern equivalents indicate that most of the genera at present occur in tropical to sub-tropical moist evergreen to semi evergreen forests, some in moist to dry deciduous and a few in tidal and coastal swampy forests.

Keywords: xylotypes, Fabaceae, phytogeography, India, Bangladesh.

SS30-O04 (475)

Fossil wood flora of western India and its palaeoecological and phytogeographical significance

Anumeha Shukla, Rakesh C. Mehrotra

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow-226007, India, anu_bsip@yahoo.co.in

Western India includes two states, Rajasthan and Gujarat, which today have a semi-arid to arid climate with low rainfall. Both the states have a complete sequence of Tertiary rocks (Paleocene to Pliocene), with fossil woods more abundant in the Neogene than in the Paleogene. The Paleogene has been considered as the age of major spread and diversification of angiosperm (Lakhanpal, 1970). The Paleogene flora of western India includes these families: Anacardiaceae, Clusiaceae, Combretaceae, Lauraceae, Meliaceae, Myrtaceae and Sonneratiaceae. The Paleogene flora of the region as a whole is tropical in nature and consists of taxa belonging to marine, estuarine, fresh water and terrestrial habitats with both evergreen and deciduous elements. The Neogene flora of western India includes Anacardiaceae, Araucariaceae, Arecaceae, Combretaceae, Dipterocarpaceae, Fabaceae, Lythraceae, Rhamnaceae, Podocarpaceae, Sapindaceae, Sonneratiaceae and Sterculiaceae. The abundance of Dipterocarpaceae and Fabaceae distinguishes the Neogene flora from the Paleogene flora (Guleria, 1992). The Late Tertiary flora of Rajasthan is important to understanding the advent of desert conditions in the region. The increasing number of deciduous and drier elements along with a number of evergreen and semi-evergreen elements in the Neogene flora indicates a gradual decline in the moist conditions in the region during the period. Moreover, the presence of some typical African and Australian elements in the Late Neogene flora is phytogeographically important. The aforementioned changes in the climate of western India from the Paleogene to post Neogene could be the result of a change in the latitudinal position of Indian subcontinent, its collision with the Eurasian plate and uplifting of the Himalayas.

Keywords: Rajasthan, Gujarat, Paleogene, Neogene, climate change.

SS30-O05 (520)

Vegetational changes during the Late Cretaceous-Tertiary interval across Antarctica and South America, based on the fossil wood record

Kazuo Terada[1], Imogen Poole[2], Harufumi Nishida [3,4]

[1] *Fukui Prefectural Dinosaur Museum, 51-11 Terao, Muroko, Katsuyama, Fukui 911-8601, Japan, k-terada@dinosaur.pref.fukui.jp*
[2] *Dept. Geology & Petroleum Geology, Meston Building, King's College, University of Aberdeen, AB24 3UE, UK*
[3] *Faculty of Science and Engineering, Chuo University, 1-13-27 Kasuga, Bunkyo, Tokyo 112-8551, Japan*
[4] *Graduate School, University of Tokyo, Japan*

The Late Cretaceous to Paleogene wood floras from the Chilean Patagonia of South America have been studied in detail and more than 20 morphotypes (including 12 families and 15 genera) were identified. The results reveal that in the Patagonia region of Chile during the Latest Cretaceous and until the Late Paleocene conifers (Araucariaceae and Podocarpaceae) dominated the vegetation alongside a few dicots. From the Latest Paleocene until the Early Eocene dicots (e.g. Nothofagaceae and Cunoniaceae) began to increase within these conifer-dominated forests. By the Middle Eocene the dicotyledonous element of the vegetation had expanded such that Nothofagaceae-dominated

mixed forests prevailed alongside other dicots (such as Atherospermataceae, Gomortegaceae, Lauraceae, Proteaceae, Aextoxicaceae, Myrtaceae, etc). During the Late Eocene to Early Oligocene interval, conifers gradually increase once more within the Nothofagaceae-dominated forest vegetation. We compare the floras of Chilean Patagonia with that of the Antarctic Peninsula and associated islands over the interval spanning the Late Cretaceous to Paleogene. We find that the Middle Eocene wood flora from Patagonia (the Rio Turbio and Rio Guillermo Formations of Cerro Dorotea) are very similar to those of the Campanian-Maastrichtian vegetation that grew across the Antarctic Peninsula region. This interval from the Late Cretaceous to the Paleogene appears to have been one during which large scale migration took place from Antarctica northwards into South America. The fossil wood floras from the Peninsula region and Cerro Dorotea have helped in the reconstruction of palaeovegetational dynamics and patterns of migration during the Late Cretaceous and into the Paleogene that was probably forced by the general and widespread cooling in the Southern Hemisphere since the Late Cretaceous.

Keywords: fossil wood, Late Cretaceous, Paleogene, Antarctica, South America.

SS30-O06 (446)

Southern vs. Northern Hemisphere: *Antarctoxylon* from the Upper Cretaceous of Antarctica and *Spiroplatanoxylon* from the Tertiary of Europe

Jakub Sakala

Charles University in Prague, Czech Republic, rade@natur.cuni.cz

Two fossil angiosperm woods are presented. The first one was found in the Hidden Lake Formation (Coniacian) at James Ross Island in 2010. It represents a new type attributable to a broadly defined morphogenus *Antarctoxylon*, and as a result it can be considered as one of the oldest evidence of angiosperm in Antarctica. The second wood is from the Oligocene of Moravia (Czech Republic) and shows an overall platanaceous aspect, but the presence of helical thickenings in its vessels is unknown among extant Platanaceae. The wood was therefore attributed to *Spiroplatanoxylon* and tentatively linked to the leaves and reproductive structure of extinct *Platanus neptuni*. This research was supported by the grants MSM0021620855, VaV SP II 1a9/23/07 and GA205/08/0643.

Keywords: fossil angiosperm wood, Coniacian of James Ross Island, Oligocene of the Czech Republic.

SS30-O07 (151)

Silicification in wood: Seeing the fossil forest and the trees

Carole T. Gee, Chris Ballhaus, Sashima Läbe, Jo Hellawell, Thorsten Nagel

University of Bonn, Germany, cgee@uni-bonn.de

Silicified wood bears testimony to the presence of trees in the geological past and appears prominently in terrestrial systems as upright trees standing in growth position in ancient forests, giant horizontal logs, or dispersed chunks of wood. In silicified wood, anatomical structure and even very fine details of the cell walls of the secondary xylem are often well preserved, which provide clues to the tree’s identity and to paleoenvironmental parameters. The key to this cellular

preservation is permineralization by silica, whereby wood pore spaces are filled in, which can be coupled with replacement, whereby silica is precipitated into spaces formerly occupied by organic matter. The initial step is organic templating by silica, during which the wood is permeated by a silica-rich solution or colloid; wood has an affinity to extract silica complexes (silicic acid) from aqueous solution and form solid precipitates of amorphous silica (opal A) inside of the cell walls. We have conducted as series of experiments on fresh *Pseudotsuga menziesii* wood and *Dicksonia antarctica* stem tissue to simulate silicification in the laboratory using closed-system autoclaves heated to 100ºC and the natural starting materials of ground obsidian glass and water. Our experiments show opal precipitation in wood is driven by a pH gradient between the wood and the volcanic silica source. Amorphous silica was precipitated as microspheres into the xylem cells within 10 days and verified mineralogically by wavelength dispersive X-ray spectroscopy and elemental X-ray mapping using the electron probe microanalyzer. Similar lab experiments on *Dicksonia* stem tissue at a slightly higher temperature (150ºC), as a modern analog to Permian *Psaronius* at Chemnitz under hydrothermal conditions, produced similar precipitation of opal A microspheres within 60 minutes. Microprobe analysis of recent wood in a silica-rich hot spring at Yellowstone National Park shows that considerable silicification can take place within a relatively short period of time (140 ± 33 years dated using ^{14}C) and that the earlywood is more rapidly silicified than the latewood. Our fieldwork on the Miocene forest of Lesvos suggests that trees buried in lahars can be silicified in growth position as silica-rich water is drawn up through the vascular system. However, fieldwork on standing forests in similar, silica-rich lahars at Mt. St. Helens, some buried nearly 3000 years ago, and an intense search for opal A using the microprobe did not corroborate previous reports of incipient silicification in trees buried in the lahars.

Keywords: fossil wood, permineralization, organic templating, amorphous silica, opal A.

SS30-O08 (120)

Angiosperm wood floras from the southern Western Interior, North America: new data and interpretations

Emilio Estrada-Ruiz[1], Garland R. Upchurch Jr.[1], Elisabeth A. Wheeler[2], Greg H. Mack[3]

[1] *Texas State University, USA, emilkgrama@yahoo.com*
[2] *North Carolina State University, and Museum of Natural Sciences, USA*
[3] *New Mexico State University, USA*

Over the past two decades wood floras have been reported from the Campanian to Maastrichtian of Coahuila and Chihuahua, Mexico, Big Bend National Park, Texas, and the Four Corners region of New Mexico, USA. New wood floras from the Campanian Crevasse Canyon Formation and Maastrichtian McRae Formation of south-central New Mexico, U.S.A., provide an abundant record of silicified woods that expands our knowledge of dicot wood diversity during the Late Cretaceous. The Ash Canyon Member of the Crevasse Canyon Formation yields wood belonging to *Metcalfeoxylon* and *Paraphyllanthoxylon*, two genera previously described from the Western Interior Cretaceous. The Jose Creek Member of the McRae Formation has a minimum of 10 types of dicots that belong to both new genera and previously described taxa. Elements of the Jose Creek wood flora include *Ulminium* (Lauraceae), a new genus of magnoliids, *Platanoxylon* (Platanaceae), Celastraceae, Myrtaceae, Malpighiales, and Ericales. Woods of Celastraceae and Myrtaceae constitute the first occurrences of these families in the North American fossil wood record. *Metcalfeoxylon* and *Platanoxylon* are known from *in situ* stumps with maximum basal diameters up to 0.75 m and 0.40 m, respectively. Woods of Celastraceae, Lauraceae, and Ericales have minimum axis sizes consistent with their derivation from trees. Our work indicates that certain taxa, such as *Paraphyllanthoxylon*, *Metcalfeoxylon*, *Platanoxylon*, and *Ulminium*, were important angiosperm

trees from the southern Western Interior and adjacent regions of North America, and that continued study of the Crevasse Canyon and McRae wood floras should yield new Late Cretaceous records of angiosperm genera and families.

Keywords: angiosperm woods, Cretaceous, fossil wood, Campanian, Maastrichtian.

SS30-O09 (569)

Cretaceous angiosperm woods and APG III. What orders and families are represented?

Elisabeth A. Wheeler[1], Pieter Baas[2]

[1] *North Carolina State University and North Carolina Museum of Natural Sciences, Raleigh, NC, USA, elisabeth_wheeler@ncsu.edu*
[2] *NCB-Naturalis, National Herbarium of the Netherlands, The Netherlands*

Most of the nearly 300 Cretaceous dicot wood types known were described prior to APG III. In this presentation we revisit earlier work on Cretaceous angiosperm woods to determine which APG III orders are represented in the Cretaceous fossil wood record. The bulk of Cretaceous angiosperm woods described to date are Campanian-Maastrichtian in age. The most diverse assemblage of Late Cretaceous fossil angiosperm woods is the one comprised of over 50 wood types and described in a series of papers by V.M. Page in the late 1960's through early 1980's. Most of Page's wood types were not given binomials and she noted that many could not be assigned to a single family. However, some of Page's woods can be assigned to an APG order, e.g., one has features of the Chrysobalanaceae and Clusiaceae of the Malpighiales and three have features of the Symplocaceae, Styracaceae, and Ericaceae of the Ericales. Our preliminary survey suggests for the Cretaceous as a whole woods of the magnoliids (orders Austrobaileyales, Magnoliales, Laurales, and Canellales) are well represented and that more rosid orders (Celastrales, Oxalidales, Malpighiales, Fagales, Myrtales, Malvales) than asterid orders occur (Cornales, Ericales). However, there are many Cretaceous angiosperm woods with features that occur in more than one order, including some woods assigned names implying affinities with an extant family, e.g. *Icacinoxylon*. Evaluating and interpreting the Cretaceous angiosperm wood record is confounded as some fossil woods have been assigned different generic names or recognized as distinct types based on differences comparable to those seen within present-day species-rich clades like the genera *Ilex* and *Symplocos,* and some fossil woods have been assigned different specific names or to different wood types based on differences comparable to those seen within a single extant species or even a single plant.

Keywords: Cretaceous, fossil wood, angiosperm, APG orders.

SS30-O10

Late Cretaceous and Tertiary woods from southern Africa

Marion K Bamford

Bernard Price Instittue for Palaeontology, School of Geosciences, University of the Witwatersrand, P Bag 3, WITS 2050, Johannesburg, South Africa, Marion.bamford@wits.ac.za

Although the Cretaceous and Tertiary fossil wood record for southern Africa is not extensive there is a variety of taxa from sites widely distributed over the southern part of the continent. Early

Cretaceous woods are preserved onshore and offshore along the west coast, and onshore along the east coast. They comprise gymnospermous woods of the Araucariaceae, Cheirolepidiaceae and Podocarpaceae the latter of which there are at least five species. Late Early and early Late Cretaceous woods from the east coast include a variety of Podocarpaceae woods as well as tree ferns of *Osmundacaulis* species. This variety of ferns extends into the Late Cretaceous and the gymnosperm taxa, although still of the Podocarpaceae, are mostly different species from the older taxa. The most common Upper Cretaceous species is *Podocarpoxylon umzambense* Schultze-Motel and it was widespread in southern Africa. Some of these specimens have indistinct growth rings and others have clear rings but variable in width. The climatic implications are explored further. From the Upper Cretaceous Umzamba beds (southern coast) there are fossil logs of Angiosperms: Monimiaceae (*Hedycaryoxylon* and *Protoatherospermoxylon*) and Euphorbiaceae (*Bridelioxylon*, *Euphorbioxylon*, *Paraphyllanthoxylon* and *Securinegoxylon*). Gymnosperm woods of the Araucariaceae (*Agathoxylon*) and Podocarpaceae are also abundant from this locality. Upper Cretaceous woods from the central part of the southern continent include the above gymnosperm taxa as well as *Brachyoxylon.* Tertiary woods are predominantly angiospermous. There is only one known Eocene locality and it has a mix of woods with well defined family affiliations and some indeterminate woods. Oligocene woods are very rare but there are abundant Miocene sites with wood and faunal remains. The common families in the fossil record are still common today and include Anacardiaceae, Burseraceae, Combretaceae, Dipterocarpaceae, Fabaceae, Myrtaceae and Oleaceae. These wood specimens do not have clear growth rings but their taxonomic affinities and wood structure, such as size and density of vessel members, can be used to infer local climate. There are no silicified gymnosperm woods from the Miocene but new records from the Cape region show the continued presence of Podocarpaceae. Today the only indigenous conifers in southern Africa are four species of Podocarpaceae and one of Cupressaceae.

Keywords: Araucariaceae, Podocarpaceae, angiosperm woods, palaeoclimate.

SS30-P01 (5)

Coniferous and dicotyledonous fossil woods from the Dim dinosaur locality (Zeya-Bureya Basin, Russian Far East)

Maxim Afonin

Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Sciences, Russia, afmaxim@inbox.ru

Fossil woods were found together with rare Lambeosaurinae bones by workers of the Institute of Geology and Nature Management of the FEB RAS (Blagoveshchensk) at the Dim dinosaur site. This locality is on the right bank of the Dim River near the Yaroslavka village in the Mikhailovka District, Amur Region, Russian Far East. The fossil woods originate from the upper part of Lower Tsagayan Subformation of the Tsagayan Formation. These deposits are dated as Middle Maastrichtian based on palynology (Markevich et al., 2010). The fossil woods studied are solid, silicified, with distinct growth rings that are visible to the naked eye. They probably are fragments of large branches or trunks. Coniferous woods (*Piceoxylon* Gothan and *Sequoioxylon* Torrey) have been described from the upper part of Lower Tsagayan Subformation of the Astashikha dinosaur locality, Zeya-Bureya Basin (Afonin, 2012; Blokhina et al., 2010). However, fossil plant macroremains have not previously been described from the upper part of Lower Tsagayan Subformation of the Dim dinosaur locality. We recognize two new distinct fossil wood types from the Dim dinosaur locality: *Sequoioxylon* (Taxodiaceae) and *Hamamelidoxylon* Lignier (Hamamelidaceae). The *Sequoioxylon* is characterized by mixed anatomical features of the modern genera *Sequoia*, *Sequoiadendron*, and *Metasequoia*, family Taxodiaceae. The peculiar feature of the fossil wood studied is the presence of

scattered groups of multiseriate rays and very high uniseriate rays (up to 110 cells) with long biseriate (up to 19 cells) and bi-triseriate ranges. The significant similarity in ray structure is observed in the wood of *Taxodioxylon multiseriatum* Ramanujam et Stewart from the Campanian and Maastrichtian of Canada (Ramanujam, Stewart, 1969; Ramanujam, 1972). However, the fossil wood studied differs from the latter in the presence of vertical traumatic resin canals, ray tracheids, pits in the tangential tracheid walls and in the absence of triseriate and tetraseriate pits in the radial tracheid walls. The *Hamamelidoxylon* is characterized by combination of anatomical features of the modern members of the family Hamamelidaceae. The fossil wood studied is very similar to the wood of *Hamamelidoxylon obiraense* Takahashi et Suzuki from the Upper Cretaceous of Japan (Takahashi, Suzuki, 2003). However, it differs from *H. obiraense* in the presence of smaller vessels (20-60 µm in diameter), numerous tyloses in vessels and slightly greater number of bars per perforation plate (up to 60). The research was supported by the Russian Foundation for Basic Research (No. 11-04-01208) and Presidium of the FEB RAS (No. 12-I-P28-01, 12-III-B-06-079).

Keywords: fossil woods, Middle Maastrichtian, Dim dinosaur locality, Zeya-Bureya Basin, Russian Far East.

SS30-P02 (315)

Wood specific gravity estimation based on wood anatomical traits: inference of key ecological characteristics in fossil assemblages

Hugo I. Martínez-Cabrera[1], Emilio Estrada-Ruiz[2], Carlos Castañeda-Posadas[3], Deborah Woodcock[4]

[1] *Université du Québec à Montréal, Canada, huismaca@yahoo.com.mx*
[2] *Texas State University, San Marcos, Texas, USA*
[3] *Benemérita Universidad Autónoma de Puebla, Puebla, Mexico*
[4] *Clark University, Massachusetts, USA*

Specific gravity (SG) is a key functional trait that is linked to life history traits (e.g., growth rate, life spans) and ecological properties (e.g., cavitation resistance, water transport capacity). SG estimation can thus provide key information about ecological characteristics in fossil assemblages. Since SG is also related to wood productivity, which represents a significant amount of the above ground primary production, it can also inform about forest biomass and variation in terrestrial carbon stores over time. Here, we develop a straightforward method to predict SG based on wood anatomical traits frequently measured when fossil samples are described. We modeled the relationship of SG as a function of fiber and vessel traits in three extant Mexican communities (135 spp) and selected the best predictive equations. Fiber wall to lumen ratio was the variable most highly related with SG and was present in all the selected prediction models; this variable, together with vessel diameter, was part of the best model. In the validation datasets, these models provided good estimates of SG at individual sample and average community levels. We applied these models to predict SG in three Mexican and one Peruvian fossil forest that ranged in age from Eocene to Miocene. To determine the reliability of the SG estimates, we compared them to those from other extant communities and geographic regions. The estimates of two of the Mexican paleofloras were relatively high, most likely due to of deficient preservation. In the other two fossil assemblages, El Cien Formation, Mexico and El Bosque Petrificado Piedra Chamana, Peru, the results were consistent with their inferred paleoenvironment and with the current understanding of the vegetation type they represented. The Peruvian paleoflora had relatively low SG suggesting comparatively higher growth rates and wood productivity, and relatively milder conditions compared to El Cien Formation paleoflora.

Keywords: fossil wood, functional traits, Mexico, Peru, specific gravity, wood anatomy.

SS30-P03 (213)

Miocene *Ilex* wood from the Shimane Prefecture in Japan: First description of *Ilex* wood from Asia

Eun Kyoung Jeong[1], Kyungsik Kim[1], Mitsuo Suzuki[2]

[1] *Chonbuk National University, Republic of Korea, jeongek@jbnu.ac.kr*
[2] *Tohoku University, Japan*

About 90 fossil wood samples were collected from the Miocene deposit along the coast of Ohda City in Shimane Prefecture, Japan. Fifteen taxa were described from these well preserved silicified woods to generic level. Here we described an *Ilex* wood among them. The fossil wood had diffuse-porous wood with distinct growth rings, very small vessel (less than about 50um) with helical thickenings in vessel walls, scalariform perforation plates with ca. 20 bars, scalariform or opposite inter-vessel pits and one to 8 cells wide heterocellular rays. Based on the above features it could be identified as wood with *Ilex* affinity. Extant family Aqiufoliaceae consists of one genus *Ilex* and about 600 species distributed in Asia, Northern Europe, North and South America, and Australia (only one species). The fossil woods with Aquifoliaceae affinity have been described from the Tertiary in Europe. However, no *Ilex* wood has been reported except this one in Asia. Therefore this *Ilex* wood from the Japan is first description in Asia.

Keywords: *Ilex*, fossil wood, Miocene, Shimane, Japan.

SS30-P04 (214)

Miocene wood assemblages of Korea and Japan with special reference to the East Sea opening

Eun Kyoung Jeong[1], Kyungsik Kim[1], Mitsuo Suzuki[2], In Sung Paik[3]

[1] *Chonbuk National University, Republic of Korea, jeongek@jbnu.ac.kr*
[2] *Tohoku University, Japan*
[3] *Pukyong National University, Republic of Korea*

The Japanese Archipelago was separated from the eastern margin of the Asian continent during the Neogene, and presumably from the Eocene to the Middle Miocene. Thus, it is appropriate to suggest that both areas – the Korean Peninsula and the Japanese Archipelago – formed common forest type owing to their close proximity prior to this separation. After separation, they established their own unique current vegetations by different environments due to the formation of a sea between them. At this point, oceanic-type and continental-type vegetations have been recognized in Korea and Japan, respectively. Since both areas have not been influenced by glaciations during the Quaternary, the Miocene epoch is a pivotal period in terms of our understanding of the evolution of current flora in these areas. Therefore, several Miocene strata of both areas were selected for fossil collections, such as the Upper and Lower Coal-bearing formations of the Janggi Basin and tuffaceous Miocene formation in Gampo area, which is not classified so far, in Korea, and in Japan, Miocene deposits of western coast of Japan in the Ishikawa, Shimane and Yamagata prefectures. As a result, 25 taxa and 69 taxa (including literatures) have been recognized in Korea and Japan, respectively. The fossil wood assemblages of both areas are almost same on genus level. In addition *Wataria*, which is extinct wood taxa, and *Cedrela* (*Cedreloxylon*), which is not in both current forests, occur in both

regions. Therefore it can be confirmed that they, Korea and Japan, formed a common forest during the early Early Miocene prior to the formation of East Sea (Sea of Japan). However, from the late Early Miocene Upper Coal-bearing Formation were produced *Aesculus*, *Cercidiphyllum*, *Fagus* and *Distylium* which are inhabited in Japan but not in the Korean Peninsula. Thus it seems that the forest of the Korean Peninsula had changed into the continental-type forest after the opening of the East Sea.

Keywords: Miocene, fossil wood, palaeobotany, East Sea, Korea.

SS30-P05 (418)

New insights into the Eocene Western Antarctic forests: fossil woods from La Meseta Formation

Roberto R. Pujana[1], Sergio Santillana[2], Sergio A. Marenssi[2]

[1] *Museo Argentino de Ciencias Naturales, Argentina, rpujana@macn.gov.ar*
[2] *Instituto Antártico Argentino, Argentina*

The La Meseta Formation outcrops in Marambio (Seymour) Island, in west Antarctica and is well known for the abundance of fossils (including vertebrates, invertebrates, woods, leaves, pollen and a flower). The age of the unit was constrained to the Eocene using palaeontological and isotopic data. A collection of 120 samples of fossil woods from the Early and Midle Eocene allomembers of the formation was analyzed. On most of the woods the best anatomical descriptions were obtained observing small fragments under MEB rather than acetate peels and thin cuts under light microscopes. Almost 70 % of the observed samples were identified as gymnosperms. Among them, *Phyllocladoxylon* of the Podocarpaceae is the most common, followed by Araucariaceae and Cupressaceae. *Phyllocladoxylon* fossil woods have an affinity to the Prumnopityoid clade plus *Microcachrys* and *Microstrobos* of the Podocarpaceae, characterized by one or rarely two large pits in the cross-fields. Some variation on the fossils assigned to *Phyllocladoxylon* was observed, indicating that least two taxa may be represented. Araucariaceae have the typical alternate pitting and Cupressaceae are characterized by the small cross-field pits and axial parenchyma. On the other hand, angiosperms are dominated by the Nothofagaceae. The results of our palaeoxylological data indicate that the Early-Middle Eocene forest canopy in the Marambio (Seymour) Island area was dominated by gymnosperms, mainly Podocarpaceae, in contrast with the Nothofagaceae dominance observed in slightly younger (close to the Eocene-Oligocene boundary) units of West Antarctica. Growth ring analysis indicates seasonality based on the well marked growth ring boundaries and stable annual conditions based on the mean sensitivity values. Both, the growth rings and the present taxa suggest temperate climates.

Keywords: palaeoxylology, wood anatomy, Antarctica, taxonomy, secondary xylem.

SS30-P06 (434)

A new Malvaceae wood from the Middle Miocene Cucaracha Formation in the Panama Canal

Oris Rodríguez-Reyes[1], Howard Falcon-Lang[1], Margaret Collinson[1], Peter Gasson[2]

[1] *Department of Earth Sciences, Royal Holloway, University of London, Egham, TW20 0EX, U.K., o.rodriguez@es.rhul.ac.uk*
[2] *Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3DS, U.K.*

The Middle Miocene Cucaracha Formation is the volcaniclastic continental part of the Gaillard Group in the Panama Canal Basin. It is characterized by mudstones interbedded with lithic arenites, pebble conglomerate beds, with a tuff layer towards the top. Its age is inferred to be 17 - 18 Ma based on mammalian biostratigraphy. Near the base of the formation, fluvial deposits contain an allochthonous permineralized wood assemblage. These well-preserved permineralized woods can be determined to generic level. Here we described a Malvaceae wood from the Hodges Hill locality. Its characters include vessels in multiples of 2 – 4, simple perforation plates, alternate intervessel pits, 2 – 5-seriate rays, tile and sheath cells, and regular tangential bands of axial parenchyma > 3 cells wide. This character combination suggests placement in the Malvaceae family *sensu* Angiosperm Phylogeny Group (APG). However, the combination of parenchyma bands > 3 cells wide, rays less than 10 seriate, and tile cells are not observed in any known genus from the family, justifying the proposition of a new form genus. This is the first Malvaceae wood described from Panama and one of the few known in the Neotropics.

Keywords: Miocene, Cucaracha Formation, permineralized woods, tile cells, Malvaceae.