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A preliminary investigation of fossil wood from Lower Mekong Basin of Southeast Asia

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Abstract: Nine fossil wood samples from the Mesozoic bedrock and the Quaternary terrace deposits of the Lower Mekong Basin in Southeast Asia including Thailand, Laos and Cambodia were investigated in order to assist in developing a hypothesis about the Mekong River palaeocourses. Six of the samples were conifers assigned to *Aga-thoxylon* sp., and three were dicots of cf. *Pahudioxylon* sp. and two unknown taxa (*Dicotyloxylon* sp.). The preservation of two dicotyledonous wood samples is insufficient for precise identification to family level, such that the samples are not suitable with respect to investigation of the river palaeocourse. However, these findings increase the systematic data of the fossil wood from the Mekong Basin. Further investigations of fossil wood from the Mekong Basin are in progress to gain a regional perspective on the plant communities and to form better reconstruction of the palaeoenvironment.

Key words: fossil wood; *Pahudioxylon*; *Agathoxylon*; Southeast Asia; Mekong Basin

1 Introduction

The Lower Mekong Basin watershed encompasses large territories of northeast Thailand, Laos, much of Cambodia and parts of Vietnam. In geological terms, the Southeast Asia major landscape forming processes relate to the Indosinian orogenic cycle, which was completed by the end of the Mesozoic (Dickin, 1997). Massive sedimentary series of Jurassic-Cretaceous shallow marine (Thailand, Laos) and Triassic-Jurassic continental sandstones (Cambodia), formed during the depositional phase of the orogeny, represent bedrocks of the modern Mekong River. The Neogene and Quaternary deposits of the basin are mainly products of fluvial and weathering processes; basalt volcanic intrusions originating from that period can be observed locally in the Khonburi district of Nakhon Ratchasima, but are widespread in southern parts of the Khorat Plateau, in the Bolovens Plateau of Laos and the northern areas of Cambodia. It has been suggested that the prominent Quaternary basalts of the Bolovens Plateau blocked the palaeocourse of the ancient Mekong (Workman, 1997), which previously may have flowed east of the Bolovens Plateau by the 'Saravan loop', thus occupying the modern Se Kong River course, rejoining the current Mekong route near

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Stung Treng, Cambodia (Fig. 1). To verify this hypothesis, a preliminary investigation on systematic study of petrified wood was conducted along with geomorphological assessment of Mekong Quaternary terraces, where the latter is the subject of a separate upcoming publication.

Fossil wood is abundant in Southeast Asia, especially within the ancient river deposits as well as in Mekong fluvial terraces; however, little research has addressed its taxonomy. There are a few publications about fossil wood from Mekong river deposits in Cambodia (Vozenin-Serra & Privé-Gill, 1991a, b) and Thailand (Vozenin-Serra & Privé-Gill, 1989; Benyasuta, 2003, Wang, 2006; Philippe, 2004), but very rarely for Laos (Sanematsu, 2009), although *in situ* wood is reported widely from the Mesozoic formations of the region. These previous studies suggested that whereas petrified wood supposedly related to Araucariaceae taxa are widespread in Thailand, the fossil tree *Xenoxylon* is absent from Thai outcrops but is recorded in Cambodia (within fluvial terraces; Vozenin-Serra & Privé-Gill, 1991b) and in Quảng Nam, southern Central Vietnam (within Mesozoic rocks) (Philippe, 2004). Thus, the common occurrence of *Xenoxylon* taxa in Mekong terraces in Cambodia (Vozenin-Serra & Privé-Gill, 1991a) is an indication that corresponding material might originate from Vietnam, either from tributary flow to the Mekong or, given the quantity of reworked specimens, from a palaeocourse of the Mekong to the east of the Bolovens Plateau.

Despite large sampling, because of preservation bias and limited funding we were able to identify only nine samples. This article describes the preliminary investigation and provides the taxonomic information of these fossil woods from the Mekong River deposits of Thailand, Laos, and Cambodia.

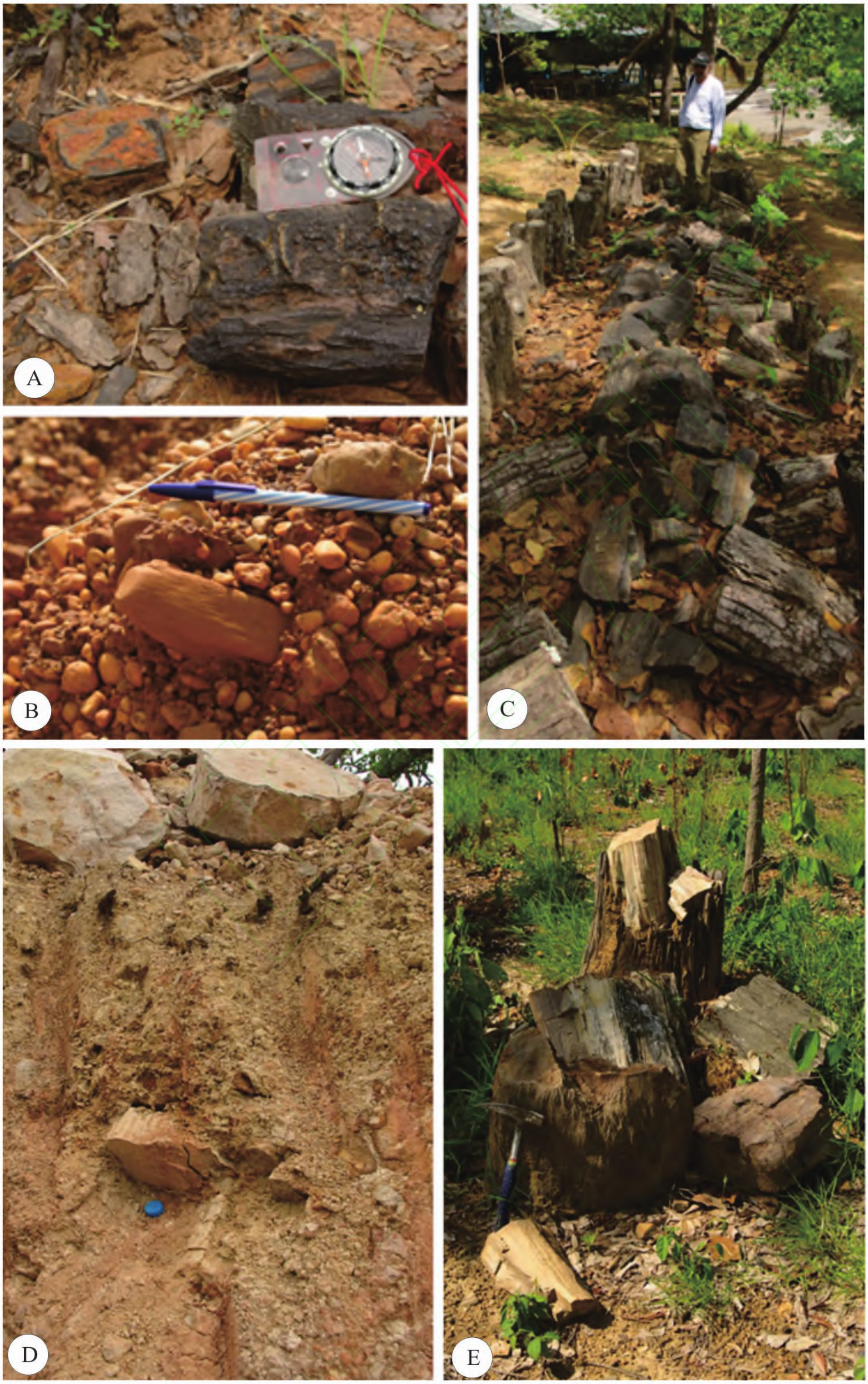
2 Materials and methods

2.1 Field sampling

A hundred and sixty six samples of petrified wood were collected from the Mesozoic bedrock and the Quaternary terrace deposits of the Lower Mekong Basin in Southeast Asia. Due to time restrictions, limited previous research data and the large area of interest, only a few sites in each country were sampled (Fig. 2A-E). The idea of collecting *in situ* wood from the Mekong watershed areas upstream of Stung-Treng and in "Saravan loop" faced an inevitable difficulty of finding genuine *in situ* fossil wood pieces buried in loose river sediment (Quaternary) or consolidated rocks (Mesozoic). This challenge can be illustrated by the surveys conducted in Laos, where roughly ten heavily-forested locations were examined without success before the two sites, included in this study, were found. The majority of samples collected from Thailand and Laos were from the open ground forest floor. Petrified wood pieces were abundant, varying in size between a few centimeters and a few meters, and at many locations (excluding on Thai and Cambodian Quaternary Mekong River terraces) were occasionally found as scattered pieces of large tree trunks in apparently autochthonous positions on the weathered surface. Thus, it is conclusive that nearly all fossil wood samples, apart from the Mekong gravel pit samples (at Khemarat, Thailand and at Stung Treng, Cambodia; see below) belong to the indigenous *in situ* petrified trees (Fig. 2C). In addition, wood near Hatsan village, Laos, has surface crystallization ranging from a few millimeters to a few centimeters and possible signs of chemical weathering expressed by an iron oxide indurated crust (Fig. 2A).

The wood in Cambodia was predominantly collected from minor stream bank exposures but in quantity from commercial gravel pits on the river terraces (Fig. 2B); hence it has been transported by water and found *ex situ*. The distinctive quality of the ancient Mekong terrace wood samples is a high degree of roundness and surface smoothness produced by fluvial rounding during its transportation. A single *in situ* fossil wood sample was extracted from a Cambodian Mesozoic bedrock quarry where an exposed tree trunk was located one meter below ground level (Fig. 2E).

Fig. 1 Map showing the location of the collected fossil samples in Mekong Quaternary terraces, Southeast Asia



(A) Iron oxide on fossil wood surface from Hatsan, Laos; (B) an exposed fragment of fossil wood in commercial gravel pit on the river terraces, Cambodia; (C) A large in *situ* fossil trunk found in Dat Wok Han, Laos; (D) An exposed *in situ* fossil wood trunk found in a Cambodian bedrock quarry, one meter below ground level; (E) Some petrified wood fragments from Phu Por, Thailand.

Fig. 2 Photos of fossil woods in different areas

For future collecting expeditions, it is worth noting that petrified wood locally is (i) considered sacred by local communities (and can be viewed in village shrines) so sampling may need approval; (ii) commonly collected by monks and used to adorn Buddhist temples (Wat); (iii) found in gravel pits, where large quantities are separated into piles away from commercial gravel.

All collected wood samples were assigned the known age of underlying strata as indicated on the geological maps of each particular location. The geological maps of a scale from 1 to 250 000 by the Department of Mineral Resources of Thailand were used for Thailand; limited published geology maps (Sanematsu, 2011) were utilized for locations in Laos and the JICA digital dataset of a scale from 1 to 500 000 was applied in Cambodia.

2.2 Laboratory works

Initially around 30 samples were scanned in the μ-VIS CT Imaging Centre (University of Southampton, UK). The average X-ray technical settings for each sample were 160 kV X-ray with 185 μA, 1mm Cu filter, 500 ms exposure, 3 142 projections with eight frames per projection and approximately 3.5 hours time spent per each sample scan. Nevertheless, none of the obtained scans were helpful in taxonomic identification due to inability to reveal an internal cell shape and structure as well as the overall cell tissue pattern. Hence, CT scanning technique can be used for the description of mechanical deformation of structures and zones of different mineralization in heavily chemically-transformed samples; however, none of the aforementioned is essential to the remainder of this article.

Nine samples from the following localities: Wat Pha Sai Chon (n = 2), Phu Noi (n = 1), Phu Por (n = 1), and Khemarat, West Bank of Mekong gravel pit (n = 1) in Thailand; Hatsan (n = 2) and Dat Wok Hun (n = 1) in Laos; and Sre Kantang (n = 1) in Cambodia were selected for anatomical investigation.

Slides of petrified wood thin sections preparation was performed at the National Oceanography Laboratory, University of Southampton, UK, by the ground thin-section method. The samples were marked and cut in transverse, tangential and radial sections with a diamond saw into slices. The slices were dried in an oven, then put in a tray containing freshly mixed epoxy resin and placed in an impregnating chamber for approximately 30 minutes. Afterwards, the petrified wood slices were removed from the tray and placed on foil in the oven overnight at 50°C to allow the resin to harden. One surface of each sample was ground on a fixed diamond lap and polished with silicon carbide (#600) by Logitech LP30 Polishing/Lapping machine for approximately 30 minutes until the surface was evenly smooth. The sections were rinsed, dried, and fixed onto the frosted glass slides with Epoxy, Epo-tek 301, and placed on a spring loaded mounting jig overnight. The other side of the petrified wood slice was then cut down to 500 microns thickness and polished to 120 microns thickness using a Buehler thin-sectioning machine. Afterwards, the surface was hand ground on a glass plate using silicon carbide #400 and #600, respectively, until the thin section was about 30 microns thick. The slides were cleaned, dried, and mounted with the coverslips using Canada balsam on a slide warmer and were left to cool. The excess balsam outside the cover glass was removed by using Methylated Spirit and a toothbrush. After rinsing the slides with soapy water and drying, the slides were ready for microscopic study.

Microscopic examination of dicots was conducted at Suranaree University of Technology, and the specimens were photographed using a Carl Zeiss compound microscope, Axio Lab. A1, at the Northeastern Research Institute of Mineral Resources, Nakhon Ratchasima, Thailand. Identifications were made with reference to the InsideWood Database (InsideWood 2004-onwards; Wheeler 2011) and the Anatomy of the dicotyledons (Metcalfe & Chalk 1950); descriptions, and illustrations of other fossil and extant wood from other literature. Dicot anatomical descriptions and cell measurement were completed following theterminology and definitions of IAWA List of Microscopic Features for Hardwood Identification (IAWA Committee, 1989), except where we have indicated a smaller number of measurements due to poor preservation. The mean and standard deviation (SD) for each sample with the lowest and highest means of SD were provided. Microscopic examination of conifer wood samples was conducted with a Leitz microscope, at Laboratoire de Paléobotanique of the University Lyon-1, France. Conifer anatomical descriptions following the terminology and definitions of IAWA List of Microscopic Features for Softwood Identification (IAWA Committee, 2004), taxonomical and nomenclatural frameworks are described in Philippe and Bamford (2008).

3 Results

Three different dicot taxa and one genus of conifer were described respectively for each specimen as follows:

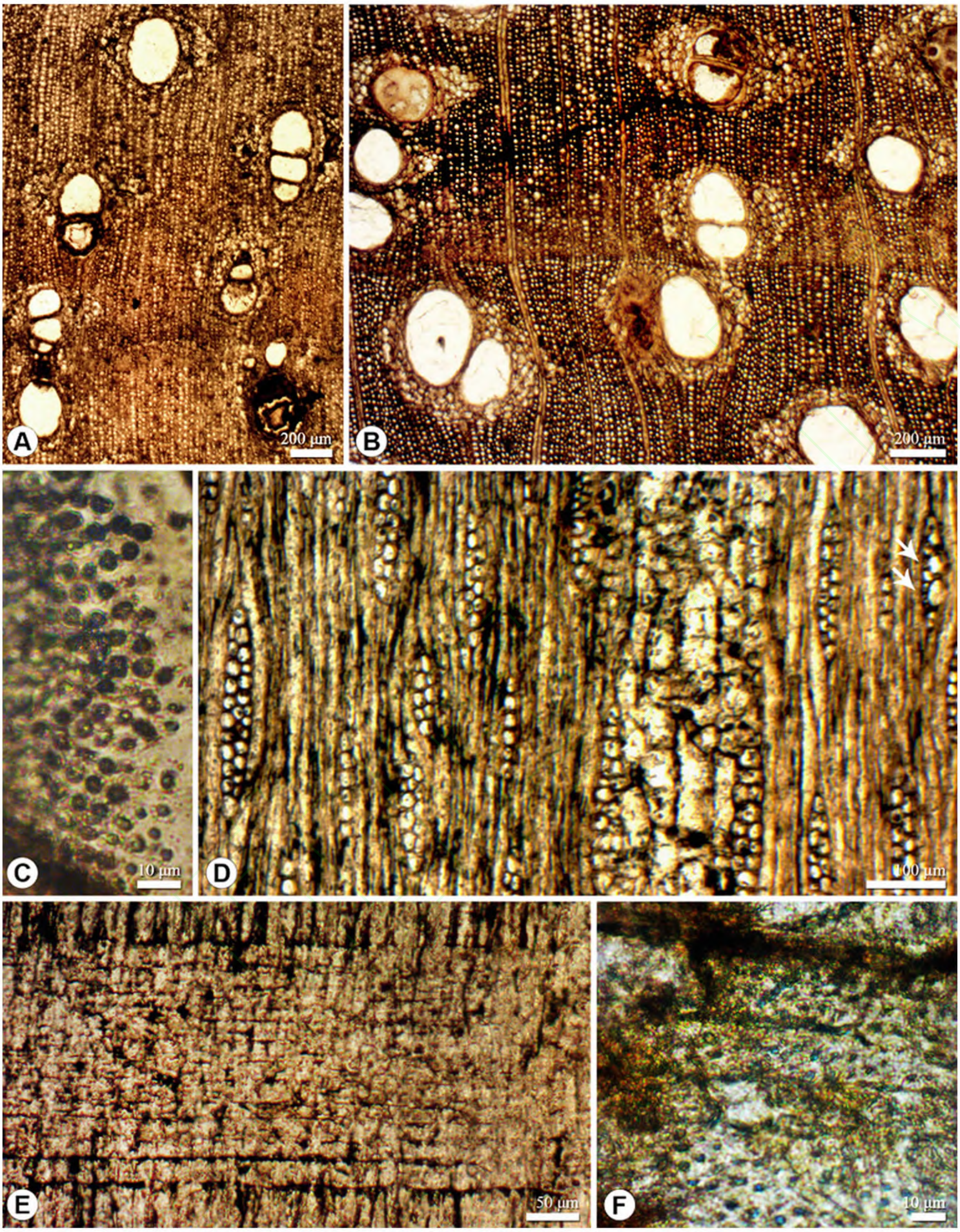
cf. *Pahudioxylon* sp. (Fig. 3)

Specimen no. MEK- FW 1 Locality: Wat Pha Sai Chon, Thailand

Description: Growth ring boundaries intermediate between distinct and indistinct, marked by radially narrower fibers. Wood diffuse-porous (Fig. 3A, B). Vessel frequency 2–8/mm^2. Vessels solitary (37%–55%) and in radial multiples of 2- 3(-4), round and oval in outline, mean tangential diameters 189 μm (SD = 41), with a total range of 100–250 μm; mean vessel element length 336 μm (SD = 80, n = 25), with a total range of 200–600 μm; perforation plates exclusively simple. Intervessel pitting alternate (Fig. 3C), small ~ 5–7 μm. Vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell (Fig. 3F). Black deposits partially blocking the vessel lumina or occasionally collected at the end of some vessel elements. Axial parenchyma paratracheal, vasicentric, aliform to confluent, and occasionally in marginal or seemingly marginal bands; commonly 2–4 cells/strand. Fibers non-septate, thin to-thick walls. Rays non-storied, 1-2-(3)-seriate, biseriate predomimant, uniseriate common, triseriate very rarely present in the middle of biseriate ray (Fig. 3D); mean ray height 240 (SD = 52, n = 40) μm with a total range of 100–300 μm. Rays 6–9/mm; rays consisting of procumbent body cells with a row of upright and/or square marginal cells (Fig. 3E) and possibly all procumbent cells (?) in some rays.

Comments: Transverse section and tangential section are well-preserved; however, the radial section is not well preserved, it is difficult to tell the composition of some rays. Intercellular canals absent. The majority of rays observed were composed of procumbent body cells with a row of upright and/or square marginal cells, although in some rays it wasn't clear whether or not the ray cells were all procumbent. A few enlarged ray cells, possibly idioblasts, were observed (Fig. 3D). Many hexagonal crystals are observed in vessel lumina. This sample was collected by Carling *et al.* on May 9, 2012.

Affinities: The combination of anatomical features, including diffuse porous wood with vessel solitary and in short radial multiples, simple perforation plates, alternate intervessel pits, vessel-ray pits with distinct borders similar to intervessel pits in size and shape; vasicentric, aliform to confluent axial parenchyma, and in marginal or seemingly marginal bands; 1–2–(3)-seriate rays; non-septate fibers with thin-to thick-walled; non-storied rays, is widespread among dicotyledonous wood of Combretaceae (especially *Terminalia*) and Fabaceae (more common in Caesalpinioideae, especially *Afzelia*, *Intsia*, and *Pahudia*) (InsideWood, 2004-onwards; Wheeler, 2011; Metcalfe & Chalk, 1950; Prakash, 1965). Most *Terminalia* spp. and its related fossils of *Terminalioxylon* spp. consist of exclusively uniseriate rays and medium (7–10 μm) to large (>10 μm) intervessel pits (InsideWood, 2004-onwards; Vozenin-Serra & Privé-Gill, 1989; Prakash, 1965; Prakash & Navale 1962), this fossil shows 1–2-seriate rays, commonly biseriate, and small intervessel pits. Although some rays in *Terminalia catappa* are 1–3 cells wide and small



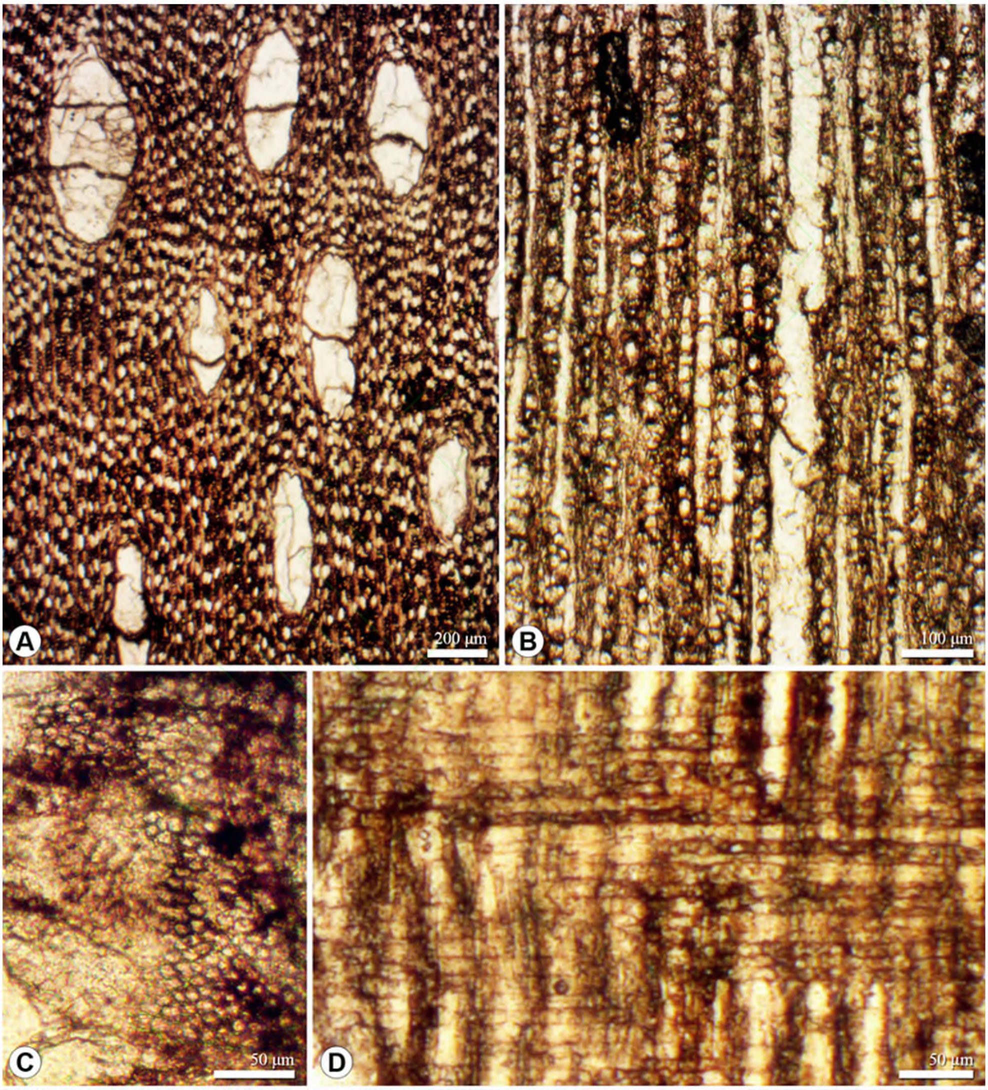
A & B. Wood diffuse porous, vessel solitary and in short radial multiples, aliform to confluent axial parenchyma and occasionally in marginal or seemingly marginal bands. C. Alternate intervessel pits. D. Non-storied, 1-2 (-3)-seriate rays. E. Rays consisting of procumbent body cells with a row of upright and/or square marginal cells. F. Vessel-ray pits with distinct borders similar to intervessel pits in size and shape. A-B = XS; C-D = TLS, E- F = RLS.

Fig. 3 cf. *Pahudioxylon* sp.

to medium intervessel pit size, the ray composition and the presence of septate fibers are different from this fossil (InsideWood, 2004-onwards; Wheeler, 2011; Metcalfe & Chalk, 1950). Fossil wood samples resemble modern wood of *Pahudia* were assigned to *Pahudioxylon* (Chowdhury *et al*., 1960; Prakash, 1965), however, based on the wood anatomy alone, *Afzelia*, *Intsia*, and *Pahudia* cannot always be distinguished from each other (Prakash, 1965). Although this studied fossil wood shares numerous characters with *Pahudioxylon* and its nearest living relatives, the number of seriate ray are still different. Many publications show that *Pahudioxylon* spp. commonly have 2–3- seriate or more in many species, uniseriate occasionally present or rare to absent in some reports (Feng *et al.*, 2015, Damblon *et al.*, 1998, Vozenin-Serra & Privé-Gill, 1989, Chowdhury *et al.*, 1960; Prakash, 1965). In our fossil, uniseriate rays present about one-third of the biseriate, triseriate are rarely. As it cannot be considered as exclusively matching, therefore, this sample is assigned to cf. *Pahudioxylon* sp.

Dicotyloxylon sp. 1 (Fig. 4)

Specimen no. MEK-FW2 Locality: Wat Pha Sai Chon, Thailand.



1. A. Vessels solitary and in radial multiples, apotracheal axial parenchyma diffuse-in-aggregates. B. Exclusively uniseriate rays. C. Alternate intervessel pits. D. Procumbent ray cells. A = XS; B = TLS, C- D = RLS.

Fig. 4 *Dicotyloxylon* sp. 1

Description: Growth ring boundaries indistinct, marked by a change in fiber radial diameter. Wood diffuse-porous (Fig. 4A). Vessel frequency 2–10/mm^2. Vessels solitary (~35%–40%) and in radial multiples of 2(-3), oval in outline, tangential diameters of vessel lumina range from 150–200 μm (n = 15); mean vessel element length 448 μm (SD = 88, n = 12), with a total range of 330- 620 μm; perforation plates exclusively simple. Intervessel pitting alternate (Fig. 4C), medium ~ 8–10 μm. Vessel-ray pits with much-reduced borders to apparently simple, pit outline rounded and angular and pits horizontally elongate. Tyloses abundant; Black deposits fill the lumina of some vessel elements. Axial parenchyma apotracheal, diffuse-in-aggregates (Fig. 4A); commonly 3 (?) - 6 (?) cells/strand Fibers nonseptate, probably with thin to medium-thick walls. Rays non-storied, 1 (- 2)-seriate (Fig. 4B). Rays very crowded in transverse and tangential section, 10–14/mm (n = 2); Rays consisting of all procumbent cells (Fig. 4D).

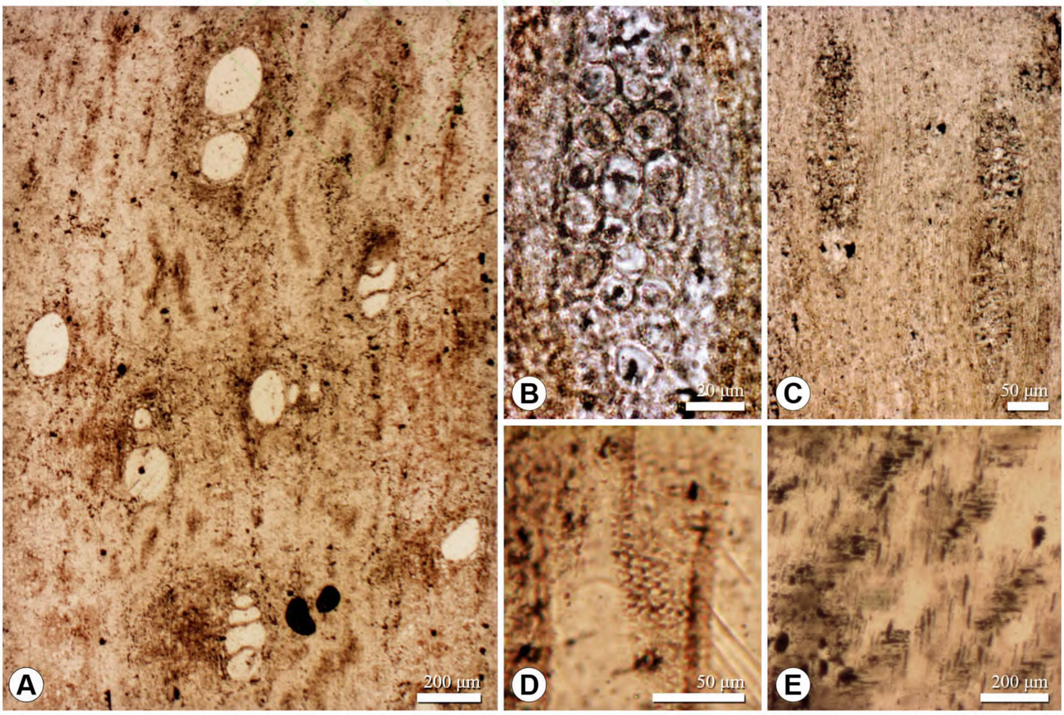
Comments: In transverse section, most cells were horizontally compressed. There are small areas in which some vessels can be measured for tangential diameter, these vessels contain black deposits filling in vessel lumina. Fiber wall thickness is not clear because of the preservation and compression. Longitudinal sections are poorly preserved. In the tangential section, it is not clear where the marginal cell of each ray is; therefore, the height of the ray cannot be measured. The wall thickness of intervessel pits is not observed because of the poor preservation. This sample was collected by Carling *et al.* (2012).

Affinities: Possible related families with the combination of vessels solitary and in short radial multiples, simple perforation, medium alternate pitting, apotracheal; axial parenchyma diffuse-in-aggregates, 1 (- 2)-seriate non-storied rays are Euphorbiaceae (e. g. cf. *Hura*) and Lecythidaceae (e. g., cf. *Planchonia*) (InsideWood, 2004-onwards; Wheeler, 2011; Metcalfe & Chalk, 1950). The characters shown by this fossil are overlapping among species of the two families. Due to insufficient information ray height and ray composition, in addition to the poor preservation; identification cannot be made on a more profound level.

Dicotyloxylon sp. 2 (Fig. 5)

Specimen no. MEK-FW3 Locality: Khemarat, Mekong gravel pit, Thailand

Description: Growth ring boundaries indistinct.



A. Wood diffuse porous, vessels solitary and in radial multiples of 2-4, aliform to confluent axial parenchyma. B. Triseriate ray. C. Non-storied, 1-3-seriate rays. D. Alternate intervessel pits. E. Poorly preserved radial section. A = XS; B-C = TLS, D-E = RLS.

Fig. 5 *Dicotyloxylon* sp. 2.

Wood diffuse-porous. Vessel frequency 2 – 9/mm^2. Vessels solitary (~30%–40%) and in radial multiples of 2–3, very rarely 4 (Fig. 5A); oval in outline, mean tangential diameters 131 μm (SD = 25, n = 15), with a total range of 100 - 180 μm; intervessel pitting alternate (Fig. 5D), medium ~ 8 μm. Dark deposits occasionally filled the lumina of some vessel elements. Axial parenchyma paratrachel, vasicentric to aliform; fibers thin-walled. Rays non-storied, commonly 2–3-seriate (Fig. 5B, C).

Comments: This specimen is poorly preserved, especially in longitudinal sections; perforation plate and composition of the rays were unable to be described (Fig. 5E); fungi are clearly visible in vessel lumina. Intercellular canals absent. This sample was collected by Carling *et al*. on May 12, 2012.

Affinities: The combination of anatomical features, including diffuse porosity, vessels solitary and in short radial multiples, simple perforation plates, alternate intervessel pits, vasicentric to aliform axial parenchyma, 2–3-seriate, non-storied rays c, is widespread among dicotyledonous wood of Anarcardiaceae, Bignoniaceae, Combretaceae, Fabaceae, Meliaceae, Moraceae, Rutaceae and Vochysiaceae (InsideWood, 2004-onwards; Wheeler, 2011; Metcalfe & Chalk, 1950). The characters shown by this specimen can be also found among species in different families. Due to its poor preservation and insufficient information of the vessel ray pitting, ray composition, fibers, idioblasts, canals, and other features, identification cannot be made on a more profound level.

Agathoxylon Hartig

Agathoxylon sp.

Specimen no. MEK-FW4 Locality: Phu Por, Thailand

Description: Tracheids are deeply mineralized with zoned crystals (sedimentation in phreatic system with oscillating water level?), which mimic pits and scalariform plates; this is, however, a tracheidoxyl (an isolated piece of homoxylous secondary xylem made of tracheids and rays), with homogenous uniseriate low rays (2–10 cells high), tracheid radial pitting in long chains of araucarian contiguous areolated pits, which are only slightly flattened, occasional biseriate alternate radial pitting, rare biseriate sub-opposite radial pit pairs; few preserved cross-fields, these belong to the araucarioid type (several alternate contiguous oculipores per field).

Comments: Growth rings might have occurred, but are difficult to recognize microscopically because of alteration; the middle lamella was destroyed in most parts, before fossilization, probably by fungal attack, pointing out a rather late silicification; tracheids are deeply mineralized with zoned crystals, suggesting that taphonomical processes took place in a phreatic system with oscillating water level.

Affinities: This specimen can be tentatively assigned to *Agathoxylon* Hartig, as it features araucarian radial pitting and possibly araucarioid cross-fields (Philippe & Bamford, 2008). Due to the poor preservation, the species level cannot be determined. This sample was collected by Carling *et al*. on May 10, 2012.

Agathoxylon sp.

Specimen no. MEK-FW5 Locality: Sre Kantang, Terrains Rouges, Cambodia

Description: Tracheidoxyl; radial pitting either uniseriate in chains of contiguous slightly flattened pits, or rarely biseriate and then alternate (only 1%–2% of subopposite pit pairs); cross-fields with up to 12 alternate contiguous oculipores; weak growth-rings, only locally expressed; in traumatic area thick-walled pitted axial parenchyma.

Comments: Due to its poor preservation and limited material, this wood cannot be identified to the species level. Its fossilization is much departing from that of the Phu Por sample. Similar woods were observed in alluvial deposits of Thailand (Vozenin-Serra & Privé-Gill, 1989). This sample was collected by Carling *et al*. on May 24, 2012.

Affinities: This specimen can be positively assigned to *Agathoxylon* Hartig.

Agathoxylon sp.

Specimen no. MEK-FW6 Locality: Hatsan, Laos

Description: Very poorly preserved tracheidoxyl, probably similar to the previous ones based on the few pit observations; the specimen is filled with rot-pockets, probably from white-rot.

Comments: Due to its poor preservation, this wood cannot be identified to the species level. This sample was collected by Carling *et al.* on May 18, 2012.

Affinities: This specimen can be positively assigned to *Agathoxylon* Hartig.

Agathoxylon sp.

Specimen no. MEK-FW7 Locality: Hatsan, Laos

Description: Tracheidoxyl, preservation type similar to that of previous wood (MEK-FW6, Hatsan), but anatomy locally better preserved; radial pitting either uniseriate in chains of contiguous slightly flattened pits or locally biseriate, and then alternate; cross-fields with up to 12 alternate contiguous oculipores; growth-rings weak, only locally expressed, generally symmetrical and/or tangentially discontinuous; in traumatic area thick-walled pitted axial parenchyma.

Comments: Due to the poor preservation, this wood cannot be identified to the species level.

Affinities: This specimen can safely be assigned to *Agathoxylon* Hartig. Due to the poor preservation and limited observation, the species level cannot be determined. This sample was collected by Carling *et al.* on May 18, 2012.

Agathoxylon sp.

Specimen no. MEK-FW8 Locality: Dat Wok Hun, Laos

Description: Tracheidoxyl; cross-section appearing sub-heteroxylous, probably partly as an effect of alteration, but also from an originally variable tracheid radial diameter; radial pitting uniseriate in chains of contiguous slightly flattened pits, very rarely biseriate (only a few isolated opposite pairs observed); cross-fields with up to 10 alternate contiguous oculipores; growth-rings weak, only locally expressed.

Affinities: This specimen can be assigned to *Agathoxylon* Hartig. Due to the poor preservation, this wood cannot be identified to the species level. Similar woods were observed in the Khorat Group of Thailand and identified to *Agathoxylon saravanensis* (Serra) Philippe *et al.* 2004 (Philippe, 2004). This sample was collected by Carling *et al.* on May 18, 2012

Agathoxylon sp.

Specimen no. MEK-FW9 Locality: Phu Noi, Thailand

Description; Tracheidoxyl; radial pitting uniseriate in chains of contiguous slightly flattened pits, locally some rounded uniseriate pits and even distant pits (Fig. 6), very rarely biseriate (only a few isolated opposite pairs observed); cross-fields with up to ten alternate contiguous oculipores; growth-rings weak, only locally expressed.

Comments: Due to the poor preservation, this wood cannot be identified to the species level. This sample was collected by Carling *et al.* on May 10, 2012.

Affinities: This specimen can be positively assigned to *Agathoxylon* Hartig.

4 Discussion and conclusion

Our fossil wood sampling was large (166 specimens), however X-ray failed to give interpretable results and only nine samples could be investigated palaeoxylologically. The results are insufficient to attempt the reconstruction of the palaeoenvironment, palaeoclimate and the former course of the Mekong River considering the low diversity of fossil wood taxa and low quantity of specimens. Both *Pahudioxylon* and *Pahudioxylon*-like woods are found very commonly in India, Thailand, Myanmar, other Southeast Asia countries, Southern China, and Africa (InsideWood, 2004-onwards; Vozenin-Serra & Privé-Gill, 1989; Prakash 1965). Although two other samples of dicotyledonous wood are not identified to specific level, the report here still provides additional information about fossil wood from the Mekong Basin in Southeast Asia. Anatomical features of dicot fossil wood specimens here include features similar to those commonly found in tropical and subtropical regions, which have an essentially worldwide distribution, especially in the tropics and subtropics. The dicotyledonous wood samples in this study conform to the modern taxa distribution pattern in the Mekong Basin. The gymnospermous fossil wood samples which are documented here belong exclusively to *Agathoxylon* Hartig. This genus is common and widespread within the four formations of the Khorat Group (Philippe, 2004), which crops out extensively in the Mekong watershed in Southeast Asia, and in particular in Thailand and adjacent Laos. Reworked Mesozoic silicified wood was reportedly mentioned from the Mekong terraces (Vozenin-Serra & Privé-Gill, 1991a, b) and other Tertiary sediments, e. g., in Thailand (Vozenin-Serra & Privé-Gill, 1991a), including several *Agathoxylon* species.

A recently described wood genus, *Shimakuroxylon* (Philippe, 2014) is also common within the Khorat Group. This genus is particularly abundant within the Phu Kradung Fm in Northeast Thailand (Philippe, 2004). It is, however, not represented in this study sampling. If this absence is confirmed, it could point out that the origin of the studied material is to be searched for within underlying Nam Phong Fm or within the upper formations of the Khorat Group, from which *Shimakuroxylon* has not yet been reported. Or is to be searched in an area where the Phu Kradung Formation does not crop out.

Xenoxylon is similarly not recorded in our sampling, despite that it was reported as commonly occurring in Mekong Terraces[3]. This absence might indicate some temporal heterogeneity for Mekong terraces material sources. Different terraces may be built with material from different sources. The absence of *Shimakuroxylon* in the Cambodian assemblage studied by Vozenin-Serra (Vozenin-Serra & Privé-Gill, 1991a, b), as well as in those we studied suggests that at their deposition time Mekong River might have had an more eastern palaeocourse as today.

Future investigations and additional sample collections should be performed to acquire more information of a regional perspective on the palaeovegetation, including investigations on other plant fossil organs preserved in the sediment, to form a more complete reconstruction of the palaeoenvironment.

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