Review of Palaeobotany and Palynology 204 (2014) 18–26

Contents lists available at ScienceDirect

Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

Research paper

Shimakuroxylon a new homoxylous Mesozoic wood genus from Asia, with palaeogeographical and palaeoecological implications

Marc Philippe [a,b,*], Anaïs Boura [c,d], Changhwan Oh [e], Denise Pons [c,d]

[a] UMR5276, Campus de la Doua, F69622 Villeurbanne cedex, France
[b] Université Lyon-1, Campus de la Doua, F69622 Villeurbanne cedex, France
[c] UMR 7207 CR2P, MNHN-CP 57, Rue Cuvier, F75231 Paris cedex 5, France
[d] Université Pierre et Marie Curie, MNHN-CP 57, Rue Cuvier, F75231 Paris cedex 5, France
[e] Division of Polar Earth-System Sciences, Korea Polar Research Institute, Incheon 406-840, Republic of Korea

ARTICLE INFO

Article history:
Received 18 November 2013
Received in revised form 29 January 2014
Accepted 13 February 2014
Available online 20 February 2014

Keywords:
fossil wood
Shimakuroxylon gen. nov.
Outer Zone of Southwest Japan
Asia
Mesozoic
paleoclimate

ABSTRACT

Revision of the Mesozoic fossil wood record for Eastern Asia led to the recognition of a new type of homoxylous wood radial pitting, called here "the *japonicum* type". This anatomical feature has a limited distribution in both time and space. On this basis a new genus, *Shimakuroxylon* gen. nov., is recognized. It has limited biostratigraphical interest, ranging from the Jurassic to the Cretaceous. Paleogeographically, however, it is bound to these terranes which lined southernmost Eastern Asia during the Jurassic (Lhasa, Indochina, Semitau, etc.). Being also found in the Outer Zone of Southwest Japan, the origin of which is still a matter of debate, *Shimakuroxylon* points out a southern cradle for this tectonic unit. The genus distribution also suggests it is an indicator for warm and wet climates.

1. Introduction

Permineralized wood is a common type of fossil which records both terrestrial ecosystem floristic composition and paleoecology. This important source of data about past biota is, however, often obscured by taxonomical problems, especially for times predating the Tertiary. This is particularly true for homoxylous woods, the taxonomy of which is still partly unclear. Among these, the woods with araucarioid cross-fields and mixed type of radial pitting, which are common and widely distributed from the Late Triassic to the Late Cretaceous, were assigned with little consistency to various genera like *Dadoxylon* Unger, *Brachyoxylon* Hollick *et* Jeffrey, *Protopodocarpoxylon* Eckhold, etc. This group needs a complete reappraisal.

While reviewing the Mesozoic fossil wood record from eastern Asia (Vozenin-Serra and Pons, 1990; Philippe et al., 2004; Oh et al., 2011) we noted that a peculiar radial pitting type is encountered only in woods from the Jurassic–Early Cretaceous interval and only in eastern Asia. This distribution being well circumscribed in time and space, it is worth segregating a new genus from the plethoric groups of the homoxylous woods with mixed type of radial pitting and araucarioid cross-fields, *Shimakuroxylon* gen. nov.

A bibliographical survey and a reappraisal of specimens in several collections were conducted. Significant anatomical variability was observed among specimens, however with no discontinuity, and a single species is recognized here within *Shimakuroxylon* Philippe, Boura, Oh *et* Pons gen. nov., *Shimakuroxylon japonicum* (Shimakura) Philippe, Boura, Oh *et* Pons comb. nov. This species is discussed and illustrated. Finally the distribution of the new genus is analyzed with paleogeographical and paleoecological perspective.

2. Material and methods

2.1. Xylological terminology and pit counting method

The terminology used here follows the IAWA list of microscopic features for softwood identification (IAWA Committee, 2004). Taxonomy and nomenclature are from Philippe and Bamford (2008).

In most paleoxylological papers radial pitting is assigned to a type (araucarian, abietinean or mixed type) without clear explanations. When percentages are given, the counting method is usually not explained. Some researchers assign each tracheid to a single type of radial pitting, according to its predominant pitting. Others count the number of types (uniseriate contiguous, uniseriate spaced, biseriate contiguous alternate, etc.) of radial pitting represented within each tracheid in order to calculate percentages. Others eventually assign each single pit to a type for their calculation.

* Corresponding author. Tel.: +33 472 44 58 66.
E-mail address: philippe@univ-lyon1.fr (M. Philippe).

http://dx.doi.org/10.1016/j.revpalbo.2014.02.002
0034-6667/

We choose the third method. Each pit observed is assigned to either one of the six types (see Fig. 1): UD (uniseriate distant); UC (uniseriate contiguous and usually flattened); BA (biseriate alternate); BOR (biseriate opposite round); BOS (biseriate opposite square).

2.2. The japonicum type of radial pitting

In 1936, Shimakura reported on a fossil wood from Southwestern Japan. He named it *Dadoxylon* (*Araucarioxylon*) *japonicum* Shimakura, on the basis of what he considered as an anatomy typical for the Araucariaceae, i.e. crowded flattened radial pitting. This was in accordance with the then concept, well expressed by Jeffrey (1906): "The mutual flattening of the bordered pits of the tracheids is a sufficient diagnostic of Araucarian affinities".

Nowadays, fossil woods similar to that of the extant Araucariaceae are assigned to the genus *Agathoxylon* Hartig on the basis of their secondary xylem anatomical features, viz. 1) contiguous radial tracheid pits, 2) alternate bi- to multiseriate radial tracheid pitting, 3) araucarioid cross-field pitting, 4) normal resin canals lacking, 5) axial parenchyma rare or absent, 6) smooth and thin ray cell walls (no *Abietineentüpfelung*), and 7) usually uni- or partly biseriate rays (Rößler et al., 2014).

The *japonicum* type displays all these features except the second one; its biseriate pits (77% of the total number of pits, n = 150) are peculiar as they are mostly (82%) opposite to slightly sub-opposite and mutually flattened, which gives them a square outline (Shimakura, 1936, text-fig. 1D, pl. XII, fig. 4; type BOS in Figs. 1, 2). By the modern Araucariaceae, as well as in most fossil softwoods, this type of biseriate radial tracheid pitting is exceedingly rare and local (Greguss, 1955, pl. 13), and usually concerns only one to some pairs of pits, while in *Dadoxylon japonicum* long chains of biseriate opposite pits are present.

The percentage of typical biseriate opposite square pits varies greatly between the different specimens we considered (see Appendix A). It is often variable even within a specimen. We observed, however, a gap at a 10% threshold (Fig. 3), which we consider as diagnostic. A specimen which displays at least 10% of its radial tracheid pit total number being biseriate-opposite, at least in some of the slides, when more than 100 pits are counted, will be considered as having the *japonicum* type of radial pitting. By this type of pitting almost all pits are contiguous and flattened at contact, biseriate pits are commonly building long chains of square pits, usually completely covering the tracheid wall, and the alternate biseriate pits are usually a quarter of the number of the opposite pits (Fig. 2c).

By the araucarian radial pitting biseriate pits are basically alternate, rarely opposite to sub-opposite, and then never building such long chains of square pits (Fig. 2B). In woods with abietinean radial pitting biseriate pits are usually opposite, round and distant, rarely somewhat flattened when contiguous, and separated wholly or partly by crassulae (Fig. 2a). The *japonicum* type of radial pitting can be recognized only if a number of tracheid with biseriate pitting are observed. As biseriate pitting is usually common in the *japonicum* type, it is seldom a problem to observe sufficient tracheids with biseriate pits.

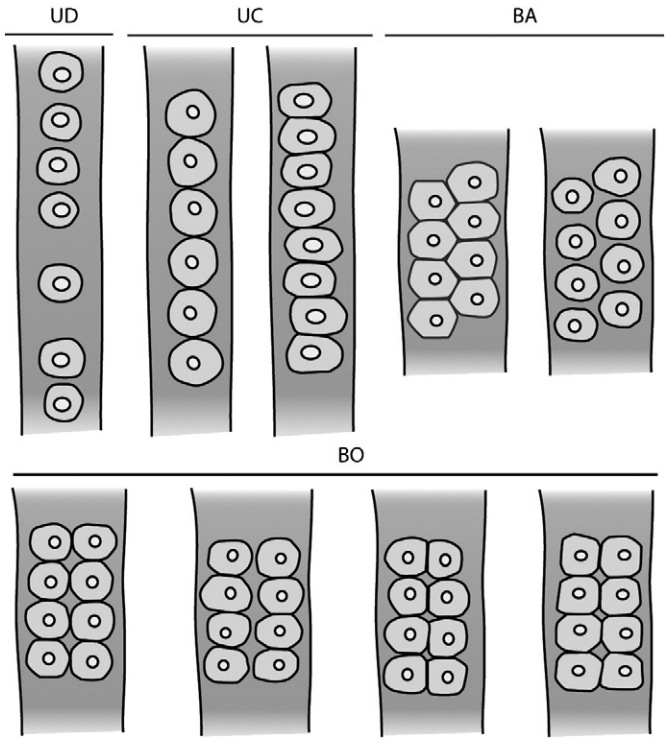

Fig. 1. The different types of radial pits considered — UC (uniseriate contiguous and usually flattened); UD (uniseriate distant); BA (biseriate alternate); BOR (biseriate opposite round); BOS (biseriate opposite square).

2.3. Material

We reviewed all the species mentioned in the literature for the Mesozoic of Asia (see partial reviews in Philippe et al., 2004; Terada, 2008; Zheng et al., 2008 and Oh et al., 2011). We also studied several tens of unpublished specimens from Asia (mainly Thailand, Cambodia, China and Japan). All woods with some chains of biseriate opposite pits and araucarioid cross-fields were compiled in a data base (Appendix A/Supplementary material).

Abbreviations: UPMC, Université Pierre et Marie Curie, Palaeobotanical collection, Paris; LPUL, Laboratoire de Paléobotanique de l'Université de Lyon; SWTU, Shimakura's fossil wood collection at the Tohoku University; NWCU, Nishida's fossil wood collection at the Chuo University, Tokyo.

3. Results

3.1. Reexamination of types

The results of the investigations of types are given in Table 1. The type for *Brachyoxylon boureaui* Serra displays an unusually high number of pits per cross-fields. The same was observed for some material from Thailand (Philippe et al., 2004). While investigating the material, we noticed that cross-field pit number was subject to strong variations on a continuous gradient, within a sample as well as among specimens which are otherwise similar. We currently consider that one species only should be recognized within *Shimakuroxylon* Philippe, Boura, Oh & Pons.

3.2. Taxonomical and nomenclatural treatment

Fossil-Gymnospermae
Pinophyta?

Shimakuroxylon Philippe, Boura, Oh *et* Pons, gen. nov.

Typus: *Shimakuroxylon japonicum* (Shimakura) comb. nov., =*Dadoxylon japonicum* Shimakura, Science Reports Tohoku Imperial University, 18: 268, text-fig 1, pl. 12 figs 1–6. 1936.

Note: despite published as a trinomial [*Dadoxylon* (*Araucarioxylon*) *japonicum*], the name *Dadoxylon japonicum* Shimakura is considered as validly published.

Diagnosis: fossil wood closely resembling *Brachyoxylon* but differing in having the *japonicum* type of radial pitting; pycnoxylic secondary