

On the Permian permineralized woods of the "Fossil Flora of the Coal Measures of Brazil" (D. White, 1908): taxonomic re-evaluation

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ABSTRACT

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D. White published, in 1908, the "Report on the Fossil Flora of the Coal Measures of Brazil", an important work that became a reference for the study of fossil plants collected mainly from Early Permian sediments of the Paraná Basin. In this work, the author described for the first time a large number of plant fossils collected in the states of Santa Catarina and Rio Grande do Sul, including a few pieces of permineralized wood. This paper presents the first taxonomic re-evaluation of the permineralized woods described by D. White, using the samples on which he based his descriptions. *Sigillaria (?) muralis* White is transferred to the genus *Scalaroxylon*, due to presence of scalariform pitting on the radial walls of the tracheids, thus forming a new combination *Scalaroxylon muralis* (White); *Araucarioxylon nummularium* (White) Maheshwari is transferred to the genus *Brachyoxylon*, because of the araucarioid character of its radial- wall pits and cross- fields, thus forming a new combination *Brachyoxylon nummularium* (White); *Araucarioxylon meridionale* (White) Maheshwari is considered as an dubious taxon due to non- preservation of its cross- field pits. The re-evaluation of the fossils described by White enabled a better understanding of the botanical affinities of the *Glossopteris* flora from southern Brazil. For the first time, the genus *Scalaroxylon* is recorded in the Permian; until now it had only been found in the Triassic and Cretaceous of Gondwana.

Key-words—D. White's Report, Permineralized woods, Taxonomy, Paraná Basin, Permian.

“ब्राज़ील में कोयला युक्त संस्तर के जीवाश्म पेड़-पौधे” (डी.व्हाइट, 1908) के पर्मियन पर्मियनीकृत काष्ठ: वर्गिकीय पुनर्मूल्यांकन

फ्रान्सीने कुर्ज़वे, राबर्टो इआन्नुज़्ज़ी एवं शीला मर्लोटी

सारांश

डी. व्हाइट ने 1908 में “ब्राज़ील में कोयला युक्त संस्तर के जीवाश्म पेड़-पौधों पर रिपोर्ट” प्रकाशित की, एक महत्वपूर्ण कार्य जो, मुख्यतः पराना द्रोणी के प्रारंभिक पर्मियन अवसदों से संगृहीत जीवाश्म पादपों के अध्ययन हेतु एक संदर्भ बन गया। उस शोध कर्म में पर्मियनकृत काष्ठ के कुछ खंडों को सन्निहित करते हुए लेखक ने पहली मरतबा सेंट कैटरिना एवं रियो ग्रांन्द दो सुल के राज्यों में संगृहीत पादप जीवमों की बहुत बड़ी संख्या वर्णित की। यह शोध-पत्र डी. व्हाइट द्वारा वर्णित पर्मियनीकृत काष्ठों का पहली बार वर्गिकीय पुनर्मूल्यांकन प्रस्तुत करता है। वाहिनिकॉअफ़्री अरीय दीवारों पर सीढ़ीनुमा गर्तन की विद्यमानता की वजह से *सिजिल्लेरिया(?) मुरैलिस* व्हाइट, *स्कैलरॉक्सिलॉन* वंश को स्थानांतरित हो गया है, इस प्रकार एक नवीन संयोजन *स्कैलरॉक्सिलॉन मुरैलिस* व्हाइट गठित

कर रहा है; अपने अरीय-दीवार गर्त एवं क्रॉसित क्षेत्रों के एरौकेरिऑइड अभिलक्षण के कारण एरौकेरिऑक्सीलॉन नुमुलेरियम (व्हाइट) माहेश्वरी ब्रैकीऑक्सीलान वंश को स्थानांतरित हो गया है; अपने क्रॉसित-क्षेत्र गर्तों के गैर-परिरक्षण की वजह से एक अस्पष्ट टैक्सान के रूप में एरौकेरिऑक्सीलॉन मेरिडायोनेल (व्हाइट) माहेश्वरी पर गौर किया गया है। व्हाइट के वर्णित जीवाश्मों के पुनर्भूल्यांकन से दक्षिणी ब्राज़ील से प्राप्त ग्लोसोप्टेरिस वनस्पति-जात की वानस्पतिक बंधुताओं को बेहतर समझने में मदद मिली। पर्मियन में पहली बार स्कैलरॉक्सिलॉन अभिलिखित किया गया है; अब तक यह गोंडवाना के ट्राइऐसिक व क्रिटेशियस में पाई गई थी।

सकित-शब्द—डी. व्हाइट की रिपोर्ट, पर्मियनीकृत काष्ठ, वर्गिकी, पराना द्रोणी, पर्मियन

Sobre os lenhos permineralizados Permianos da "Flora Fóssil das Coal Measures Brasil" (D. White, 1908): reavaliação taxonômica

RESUMO

D. White publicou em 1908 "Relatório sobre a flora fóssil das coal measures do Brasil", um importante trabalho que se tornou uma referência para o estudo de plantas fósseis coletados principalmente de sedimentos eopermianos da bacia do Paraná. Naquele trabalho o autor descreveu pela primeira vez um grande número de plantas fósseis coletados nos estados de Santa Catarina e Rio Grande do Sul, incluindo poucas peças de lenhos permineralizados. Este trabalho apresenta a primeira reavaliação taxonômica dos lenhos permineralizados descritas por D. White usando as amostras sobre as quais ele baseou suas descrições. *Sigillaria (?) muralis* White foi transferida para o genero *Scalaroxylon*, devido a presença de pontuações escalariformis sobre as paredes radiais das traqueides constituindo uma nova combinação *Scalaroxylon muralis* (White); *Araucarioxylon nummularium* (White) Maheshwari é transferida para o gênero *Brachyoxylon*, devido ao caráter araucarióide de suas perfurações de parede radial e campos cruzados, daí formando uma nova combinação *Brachyoxylon nummularium* (White); *Araucarioxylon meridionale* (White) Maheshwari foi considerado como um táxon duvidoso devido a não preservação de suas pontuações de campo cruzado. A reavaliação dos fósseis descritos por White possibilitaram um melhor entendimento das afinidades botânicas da flora de glossopteris do sul do Brasil. Pela primeira vez o gênero *Scalaroxylon* é documentado no permiano; até o momento tinha sido somente encontrado no Triássico e Cretáceo do gondwana.

Palavras-chave—Relatório de D. White; Lenhos Permineralizados, Taxonomia, Bacia do Paraná, Permiano.

INTRODUCTION

In 1908, I.C. White published the "Final Report" to the *Comissão de Estudos das Minas de Carvão de Pedra do Brasil*, which was created by the Brazilian Government in 1904, to assess the coal potential of southern Brazil (I.C. White, 1908). This Report is divided into three parts. The first part covers geological aspects of the coal deposits and associated rocks of the Paraná Basin, and was written by I.C. White himself, at that time chief of the commission. The second part is the description and characterization of the fossil reptile *Mesosaurus braziliensis*, and was written by J.H. McGregor. The third part, the "Report on the Fossil Flora of the Coal Measures of Brazil", was written by D. White and dealt with the fossil plants collected during the field excursions carried out by the Commission in the states of Santa Catarina and Rio Grande do Sul, in 1904- 1905. Sixty- three fossils were collected, eight of which are fossil woods. Among these, only three were formally described as new species: *Sigillaria muralis*, *Dadoxylon meridionale*, and *D. nummularium*. The other samples were only listed, not studied, due to poor preservation or because they were considered identical to samples previously described by other authors. All the paleobotanical samples collected by the Commission were donated and deposited at the United States Geological Survey (USGS). At the end of the last century, the USGS collections were

transferred to other institutions, and all the paleobotanical samples were donated to the National Museum of Natural History (NMNH) of the Smithsonian Institution, where they remain. However, the samples studied by D. White in 1908 were lost to Brazilian researchers. Nevertheless, in 2004, one of the authors (RI) found White's samples in the Department of Paleobiology of the NMNH.

In 2008, as a part of the 100th anniversary of the "Final Report", a project to re-evaluate the paleobotanical samples published by D. White was begun, coordinated by one of us (RI). The present contribution describes the results of the re-evaluation of the fossil woods described by D. White (1908).

MATERIAL AND METHODS

Unfortunately, over the years, the slides of the samples collected by D. White became unviable for study. However, there remained some fragmentary wood samples, originally sectioned for study by White. These fragments were kindly lent by the NMNH, and new slides were made of cross, radial longitudinal and tangential longitudinal sections. The remaining wood fragments and the new slides are temporarily deposited in the Departamento de Paleontologia e Estratigrafia, Instituto de Geociências, Universidade Federal do Rio Grande do Sul (DPE-IG-UFRGS). They will be returned to the USNM (Smithsonian Institution) for permanent deposit.

The anatomy of the sections was studied based on Richter *et al.* (2004) and Philippe (1995). At least 100 measurements were made of the tracheids, pits and ray cells.

SYSTEMATICS

Division—CONIFEROPHYTA

Order—CONIFERALES

Genus—BRACHYOXYLON Hollick & Jeffrey, 1909

Type species—*Brachyoxylon notabile* Hollick & Jeffrey, 1909

Type Age and Locality—Cretaceous; Kreicherville, New York, United States.

Diagnosis—Homoxyllic and pycnoxyllic secondary wood. Radial bordered pits of mixed type, often circular and sparse. Xylem rays short and with smooth walls. Araucarioid cross-fields. Tangential pits present. Traumatic resin canals occasional (*in* Hollick & Jeffrey, 1909, p. 54-57; Bamford & Philippe, 2001, tab. 1).

Brachyoxylon nummularium (White) comb. nov.

(Pl. 1.1.3, 2-5)

Synonymy:

Dadoxylon nummularium White, 1908: 578-583; pl. 13, figs 1-4.

Araucarioxylon nummularium (White) Maheshwari, 1972: 8.

Holotype—USNM 32045A, slides 32045A-R, 32045A-TA and 32045A-TR (2 slides).

Type Locality—São Rafael, Rio Grande do Sul State, southern Brazil.

Type Horizon and Age—Red shales, 100-200 m above the coal beds; (probably Mid to Late) Permian.

Emended Diagnosis—Tracheids in fairly regular radial rows, extremely long, narrow, sinuate, acute, relatively large though varying greatly in diameter in the same section, with a tangential diameter averaging 44.5 µm, usually greater than the radial diameter, especially in the larger cells. Radial bordered pits of mixed type, predominantly uniseriate, seldom biseriate. Medullary rays numerous, close, usually not more than one or two tracheids distant, 1-39 cells, averaging 2 to 7 in height, mostly uniseriate, though frequently biseriate for the height of two or three cells; ray cells somewhat irregular in form where biseriate, generally higher than broad, averaging 30 µm in height, usually rectangular in radial section, and ordinarily subtending about 6 tracheids; ray cells narrowly elliptical when the ray is just one cell in height; cross-field pits round or

nearly so, 10 µm in diameter, 1 to 6 disordered oculipores in each cross-field.

Description—Homoxyllic and pycnoxyllic secondary wood with indistinct or absent growth rings; circular to oval tracheids (radial diameter = 25-65 µm, mean = 41.5 µm; tangential diameter = 17.5-70 µm, mean = 44.5 µm) in cross-sections. Radial bordered pits of mixed type, predominantly uniseriate, seldom biseriate; uniseriate sparse or contiguous, circular to slightly flattened; biseriate alternate. Xylem rays homogeneous with smooth walls, uni- to partly biseriate (mean = 1s), with 1-39 (mean = 2-7) cells high. Cross-field of araucarioid type with 1-6 (mean = 2) small and disordered pits.

Discussion—Endlicher (1847) created the genus *Dadoxylon* for wood with pith, showing alternate and contiguous, uni- to pluri-seriate pits on the radial walls of tracheids, and uni- to multi-seriate rays. Yet Kraus (*in* Schimper, 1870) created the genus *Araucarioxylon* for wood with alternate to contiguous, uni- to pluri-seriate pits, and rays uni- to pluriseriate, but did not mention the presence or absence of the pith. He transferred several species of *Dadoxylon* to his new genus. Thereafter, as the diagnoses of both genera were too similar and overlapping, in the course of time, this gave rise to a "taxonomic complex" of similar forms classified in one or another genus. Several authors formulated proposals for more than 100 years to clarify this complex (Knowlton, 1890; Kräusel, 1956; Kräusel & Dolianiti, 1958; Grambast, 1960a, b; Vogellehner, 1964; Lepekhina & Yatsenko-Khemelevsky, 1966; Lepekhina, 1972; Maheshwari, 1972; Marguerier, 1973a, b; Pant & Singh, 1987; Giraud, 1991; Philippe, 1993; Bamford & Philippe, 2001). Of these, Philippe (1993) and Bamford and Philippe (2001) considered both genera illegitimate.

Therefore, the removal of this species from the genera *Dadoxylon* Endlicher, 1847 and *Araucarioxylon* Kraus (*in* Schimper, 1870), and its transfer to the genus *Brachyoxylon* are proposed herein. According to Philippe and Bamford (2008), the main characteristics of the genus *Brachyoxylon* are mixed pitting on the radial walls of the tracheids, and araucarioid cross-fields. These characteristics were also observed in White's sample, as in the description given above.

Among the species of this genus, *Brachyoxylon saurinii* Boureau and Serra, 1961 (Early Cretaceous) and *B. voisinii* Thevenard *et al.*, 1995 (Early Jurassic), as well as the form classified just as *Brachyoxylon* sp. by Machhour and Pons (1992) (Early Cretaceous), resemble most the specimen under study, especially regarding the uniseriate pattern of the pits on the radial walls. *B. saurinii* also resembles our specimen with regard to the rays (1-31 cells high and mean = 2-4), but differs in the presence of tangential pitting and traumatic secretory canals, and it has more cross-field pits (2-12). Similar to the specimen under study, *Brachyoxylon* sp. of Machhour and Pons (1992) has uniseriate to partly biseriate rays, 3-7 pits in the cross-fields, and no tangential pitting; on the other hand, it differs in the presence of traumatic secretory canals

and shorter rays (3-20 cells high). Finally, *B. voisinii* is the species that most resembles the sample studied here. It also has 3-8 pits per cross-field and no secretory canals or tangential pitting, but differs because of the exclusively uniseriate pits on the radial walls and rays and shorter (6 cells) rays.

Taking into account the above discussion, a new combination *Brachyoxylon nummularium* (White) comb. nov. is proposed here. Since White's diagnosis did not present all diagnostic features described above, an emended diagnosis is also proposed here.

Incertae Sedis

Genus—*SCALAROXYLON* Vogellehner, 1967

Type species—*Scalaroxylon multiradiatum* Vogellehner, 1967

Type Age and Locality—Triassic; Franconia, Germany.

Diagnosis—Homoxyl secondary wood. Radial walls of tracheids only with scalariform pitting, with no tendency to reticulation. Only radial walls of tracheids pitted. Rays of heterogeneous type, composed of "erect ray cells" and "procumbent ray cells", multiseriate. Wood parenchyma and resin canals absent (*in* Vogellehner, 1967, p. 216).

Scalaroxylon muralis (White) comb. nov.

(Pl. 1.1-1, 6; Pl. 2.1-3)

Synonymy:

Sigillaria muralis White, 1908: 466-471; pl. 12, figs 1-4.

Holotype—USNM 32044B (3 pieces), slides 32044B-R, 32044B-TA and 32044B-TR.

Type Locality—Near São Sepé, Rio Grande do Sul State, southern Brazil.

Type Horizon and Age—Weathered red beds, 100-200 m above São Jerônimo Coal; (probably Mid to Late) Permian.

Emended Diagnosis—Manoxylic secondary wood composed of thin-walled scalariform tracheids separated by

numerous, large-celled rays; tracheids distinctly radial in arrangement, very long, sinuate, sometimes meandering, acute in contact with the medullary cells; in cross section, tracheids unequal in width, varying much in diameter and in relative proportions, though averaging 75 μm in tangential diameter and 78 μm in radial diameter; medullary rays large and profuse, ranging from 1 to 50 cells in height and from 1 to 4 cells in width, generally fusiform, sometimes attenuate and sinuate, rarely more than two tracheids distant from one another, ray cells varying greatly in size; distinctly rectangular and muriform in radial section, the radial diameter considerably exceeding the tangential, frequently by over one and a half times the latter. There are 3 to 9 oval cross-field pits present in the cross-field.

Description—Manoxylic secondary wood with indistinct or absent growth rings; oval cells (radial diameter = 47.5-115 μm , mean = 78 μm ; tangential diameter = 22.5-112.5 μm , mean = 75 μm) in cross-section; the tracheids are twisted in some places on the slide. Radial walls of tracheids with scalariform pitting. Xylem ray heterogeneous with smooth walls, uni- to tetra-seriate (mean = 1-2s), and 1-50 (mean = 4-8) cells high. Cross-fields with 3-9 (mean = 6) wide oval radially elongated pits.

Discussion—White (1908) called this wood *Sigillaria* based "merely on the evidently great development of the secondary xylem in the type" (p. 469). He considered it as a representative of one of the specimens of lycophyte stems preserved as compressions / impressions that he had earlier described in the "Final Report". However, Brongniart (1821, p. 392) created the genus *Sigillaria* based only on the external characters of the stem. In the sample described by White (1908), the fossilization as permineralization had not preserved the external characteristics of the stem, only its anatomy. Therefore, it is not possible to classify this sample as *Sigillaria*.

Considering the above-mentioned new description of the material, one of the diagnostic features that arise is the presence of scalariform pitting on the radial walls of the tracheids. Among the permineralized woods of the Palaeozoic-Mesozoic flora, only few genera show scalariform pitting on the radial walls of the tracheids, viz. *Ecpagloxyton* Philippe *et al.*, 2010, *Phoroxyton* Sze, 1954, *Sahnioxyton* Bose and Sah,

PLATE 1



1. General view of wood samples. Black bars = 1 cm. 1-1. *Scalaroxylon muralis* (White) comb. nov. Sample No. USNM 32044B. 1-2. Undetermined Coniferales. Sample No. USNM 32043C. 1-3. *Brachyoxylon nummularium* (White) comb. nov. Sample No. USNM 32045A.
2. *Brachyoxylon nummularium* (White) comb. nov. Cross-section showing tracheids and rays. Black bar = 100 μm . Sample No. USNM 32045A.
3. *Brachyoxylon nummularium* (White) comb. nov. Radial longitudinal section showing uniseriate pits on the tracheid walls. Black bar = 100 μm . Sample No. USNM 32045A.
4. *Brachyoxylon nummularium* (White) comb. nov. Radial longitudinal section showing small disordered pits in araucarioid cross-fields. Black bar = 100 μm . Sample No. USNM 32045A.
5. *Brachyoxylon nummularium* (White) comb. nov. Tangential longitudinal section showing predominantly uniseriate rays. Black bar = 100 μm . Sample No. USNM 32045A.
6. *Scalaroxylon muralis* (White) comb. nov. Cross-section showing tracheids and rays. Black bar = 100 μm . Sample No. USNM 32044B.

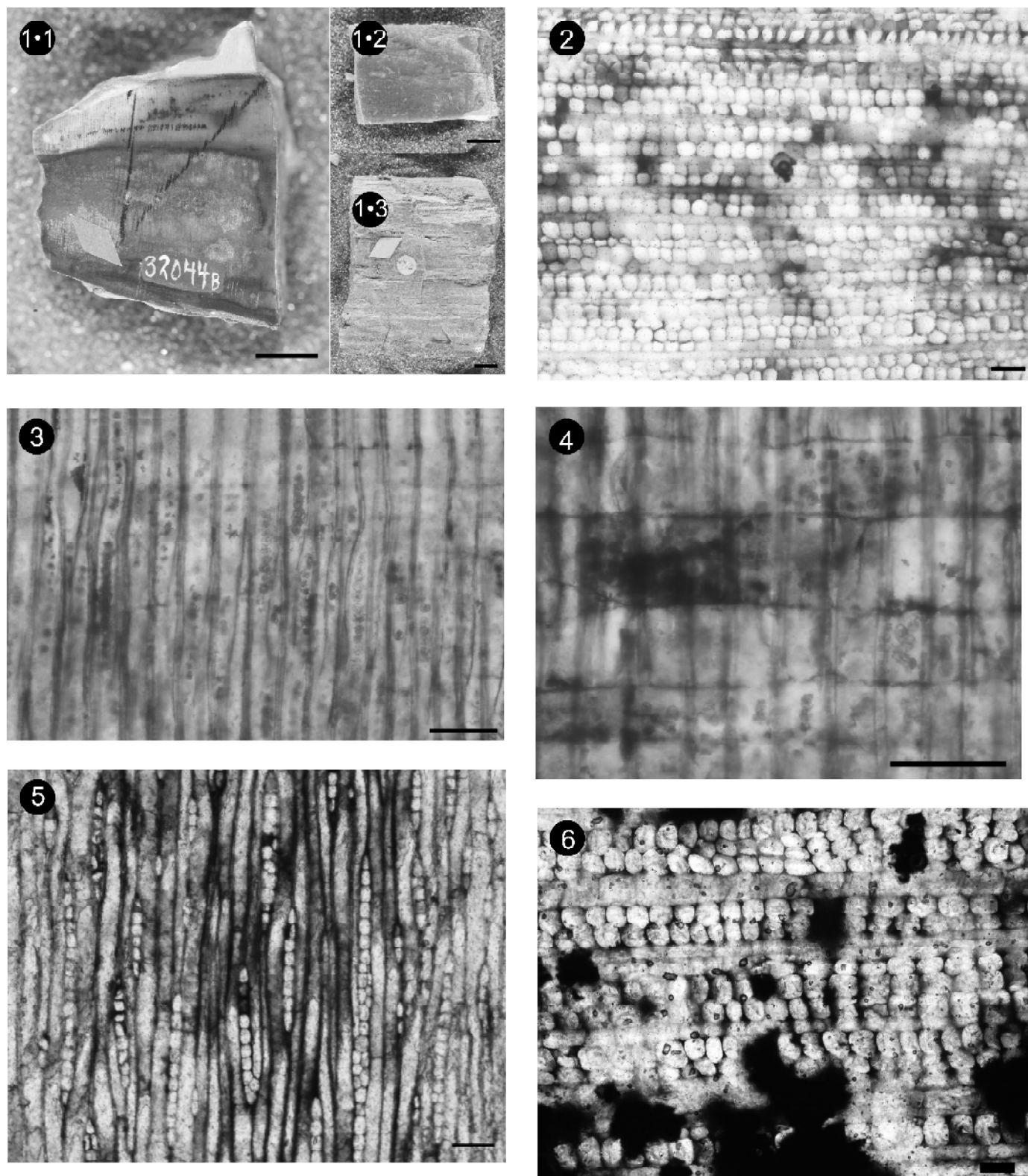


PLATE 1

1954 and *Scalaroxylon* Vogellehner, 1967. However, *Ecpagloxyton* has araucarioid and mixed type of pitting in addition to scalariform pitting on radial walls of tracheids; *Phoroxylon* has scalariform pitting on tangential walls of tracheids with only uniseriate rays and *Sahnioxylon* has the longitudinal and tangential walls of the ray cells pitted, which are not the case with the wood under study. Therefore, this wood was assigned herein, to genus *Scalaroxylon* due to presence of scalariform pitting exclusively on their radial walls and multiseriate rays.

Among the species of this genus, *Scalaroxylon multiradiatum* Vogellehner, 1967 and *S. menendezii* Artabe *et al.*, 2009 are closest to the specimen studied. The former has up to 50 cells high rays, as in the present sample, but shows penta- to hexa-seriate rays, and there are no more than three pits in its cross-fields. The latter species has cross-fields similar to the species studied here, but each cross-field has up to six pits, and furthermore, *S. menendezii* has higher rays (up to 70 cells high) and with more series (5s). Therefore, the species described by White (1908) is valid and endemic to the Paraná Basin. It is now transferred to *Scalaroxylon*, as *Scalaroxylon muralis* (White) comb. nov. White (1908) gave the diagnosis of this wood without the characterization of the wood cross-fields. Therefore, an emended diagnosis in addition to the original diagnosis is also proposed here.

Undetermined Coniferales

(Pl. 1.1-2; Pl. 2.4-6)

Synonymy:

Dadoxylon meridionale White, 1908: 582-585; pl. 14, figs 1-4.

Araucarioxylon meridionale (White) Maheshwari, 1972: 5.

Holotype—USNM 32043C (2 pieces), slides 32043C-R, 32043C-TA and 32043C-TR.

Type Locality—Butiá, Rio Grande do Sul State, southern Brazil.

Type Horizon and Age—30-60 m above São Jerônimo Coal; Permian.

Description—Homoxylic and pycnoxylic secondary wood with indistinct or absent growth rings; oval tracheids (radial diameter = 20-62.5 µm, mean = 39 µm; tangential diameter = 15-52.5 µm, mean = 34 µm) in cross-sections. Radial bordered

pits of abietoid type, predominantly uniseriate, seldom biseriate; uniseriate pits sparse or contiguous, circular to flattened; biseriate pits opposite to alternate, circular to flattened. Xylem ray cells homogeneous, with smooth walls, uni- to bi-seriate (mean = 1s), with 1-27 (mean = 4-7) cells high. Cross-field pits not preserved.

Discussion—White (1908) stated that the attribution to the genus *Dadoxylon* was dubious, because the sample did not have pith. Maheshwari (1972) considered that multiseriate rays were a typical characteristic of the genus *Dadoxylon*. Therefore, because the sample had uniseriate rays, he transferred it to the genus *Araucarioxylon* Kraus (In Schimper, 1870).

As stated earlier (see above discussion of *Brachyoxylon*), the genera *Dadoxylon* and *Araucarioxylon* are no longer considered valid, and therefore the sample cannot be included in the genus *Dadoxylon*, as done by White (1908); nor in the genus *Araucarioxylon*, as done by Maheshwari (1972).

The genera that have abietoid pitting on the radial walls of the tracheids, such as the sample under study, are *Circoporoxylon* Kräusel, 1949; *Cupressinoxylon* Göppert, 1850; *Oguraxylon* Nishida, 1974; *Perisemoxylon* He & Zhang, 1993; *Phyllocladoxylon* Gothan, 1905; *Podocarpoxyton* Gothan, 1905; *Semicircoporoxylon* Süb & Schultka, 2006; *Taxaceoxylon* Kräusel & Jain, 1964; *Taxodioxyton* Hartig, 1848; *Tsugoxylon* Vozenin-Serra & Salard-Chebaldoeff, 1992 and *Turkestanioxylon* Khudaiberdyev *et al.*, 1971. Nevertheless, of these, *Oguraxylon*, *Perisemoxylon*, and *Taxaceoxylon* have thickenings on the radial walls of the tracheids, *Tsugoxylon* has heterogeneous xylem rays and axial parenchyma and *Turkestanioxylon* has resin canals, all characteristics missing in the sample under study. All the other genera differ from each other on the basis of the type of the cross-field pits. Considering this last characteristic was not preserved in the sample studied, it is impossible to assign this form to a valid and legitimate genus.

Thus, once an important diagnostic characteristic is not present in the wood fragment, and the genera to which it was assigned are invalid, the invalidity of this taxon is proposed. This wood should be considered simply as an undetermined member of Coniferales.

PLATE 2



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| <p>1. <i>Scalaroxylon muralis</i> (White) comb. nov. Radial longitudinal section showing scalariform pitting. White bar = 100 µm. Sample No. USNM 32044B.</p> <p>2. <i>Scalaroxylon muralis</i> (White) comb. nov. Radial longitudinal section showing oval and elongated pits in cross-fields. White bar = 100 µm. Sample No. USNM 32044B.</p> <p>3. <i>Scalaroxylon muralis</i> (White) comb. nov. Tangential longitudinal section showing multiseriate, long and heterogeneous rays. White bar = 100 µm. Sample No. USNM</p> | <p>32044B.</p> <p>4. Undetermined Coniferales. Cross-section showing tracheids and rays. White bar = 100 µm. Sample No. USNM 32043C.</p> <p>5. Undetermined Coniferales. Tangential longitudinal section showing predominantly uniseriate rays. White bar = 100 µm. Sample No. USNM 32043C.</p> <p>6. Undetermined Coniferales. Radial longitudinal section of Sample No. USNM 32043C. Black bars = 100 µm. 6-1. Uniseriate pitting on tracheids. 6-2. Cross-fields without pits.</p> |
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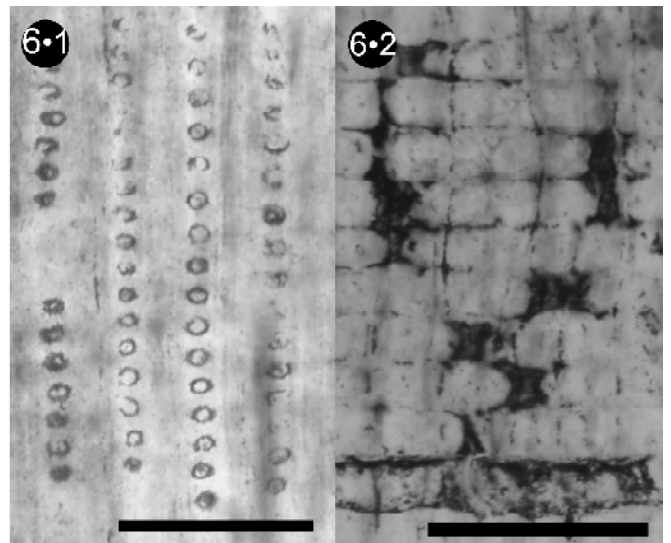
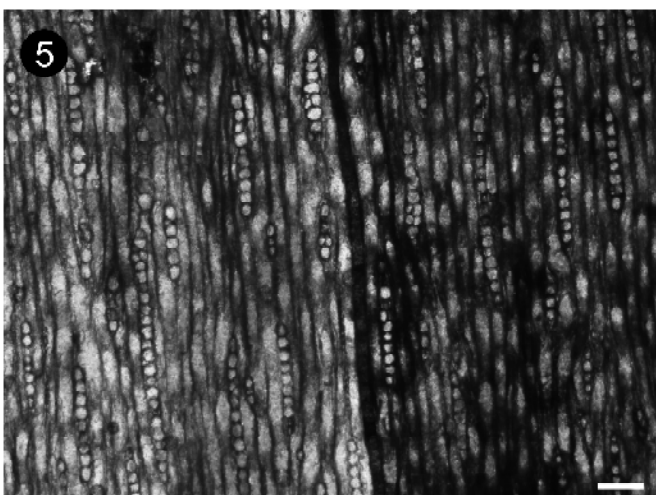
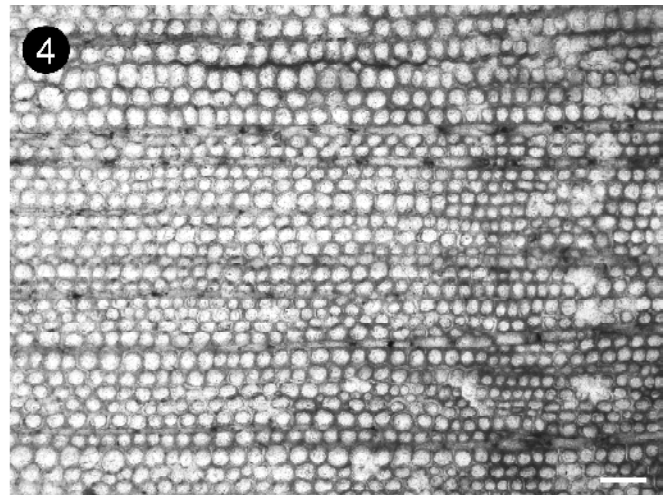
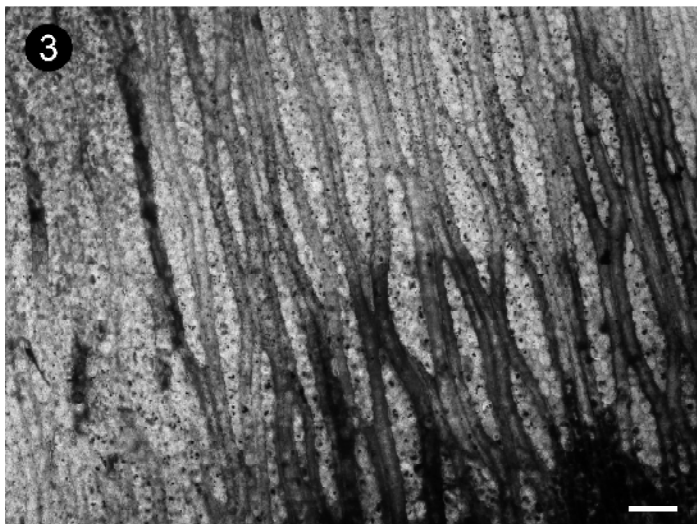
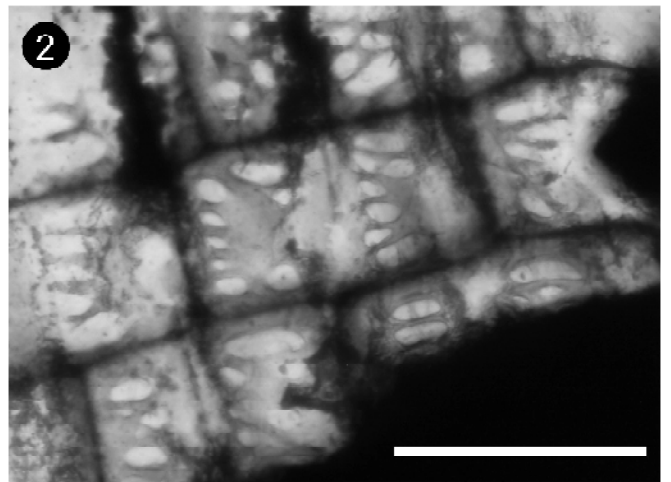
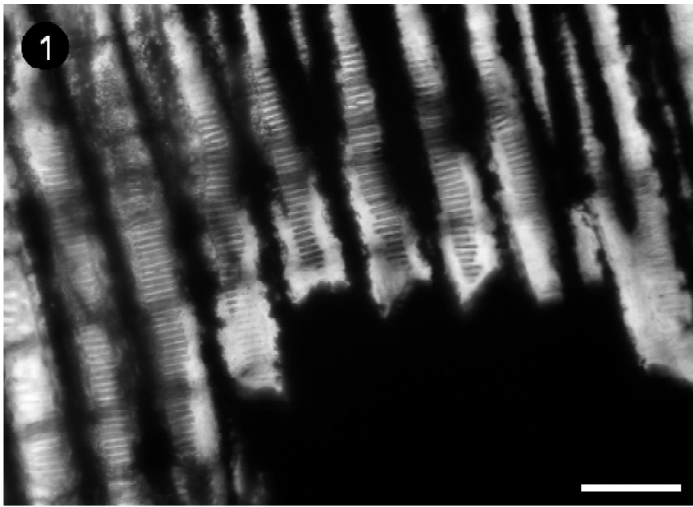


PLATE 2

CONCLUSIONS

Of the three permineralized wood species described by White, none retains its original combination. Two, *Dadoxylon meridionale* and *D. nummularium*, were earlier included by Maheshwari (1972) in *Araucarioxylon*, a genus that is no longer valid (Philippe, 1993; Bamford & Philippe, 2001). The former is judged to be a dubious taxon in the present work, and the latter was transferred to *Brachyoxylon*. The remaining wood, *Sigillaria muralis*, could not be included in this genus, because the genus is defined only on the morphology of the stem, not its anatomy; and the specimen was therefore transferred to *Scalaroxylon*. This reinforces the need for attention to original descriptions of the genera, to avoid misunderstood taxonomic classifications.

Finally, even with the reduction from three to two taxa, the new combinations have clarified the botanical affinities of these species. The presence of a lycophyte stem (= *Sigillaria muralis* White) was not confirmed; on the other hand, the presence of a *Scalaroxylon* wood was confirmed for the first time for the Permian of the Paraná Basin (Vogellehner, 1967). Consequently, the determination of *Scalaroxylon muralis* (White) comb. nov. expands the occurrence of this genus to this area during the Permian.

Another important aspect of the occurrence of *Scalaroxylon* in the Paraná Basin is that this is probably the first record in the world of this genus from the Palaeozoic rocks. *Scalaroxylon* was previously recorded only in the Triassic of Germany (Vogellehner, 1967), Argentina (Artabe *et al.*, 2009) and China (Zhang *et al.*, 2006), and in the Cretaceous of Belgium (Meijer, 2000). Here, the occurrence of *Scalaroxylon* is extended to the Palaeozoic based on the overall stratigraphic assignment proposed by I.C. White (1908). However, because of the lack of high precision in either the determination of lithostratigraphic unit and/or the stratigraphic position of the deposit where this fossil was obtained, this Palaeozoic occurrence may not be correct. In fact, the collection of the sample of *Scalaroxylon muralis* (White) comb. nov. within “red bed” facies, as described by I.C. White (1908), is a clear indicative that this fossil wood was situated in a higher lithostratigraphic unit. Red beds are a facies predominating in the Rio do Rasto Formation, dated as Middle to Late Permian (Wordian to Wuchiapingian; Holz *et al.*, 2010), but also in the Sanga do Cabral and Santa Maria formations of the Early to Late Triassic ages (Scythian to Carnian; Zeffass *et al.*, 2003), all units outcropping at the São Sepé, in Rio Grande do Sul State. Bearing in mind the impossibility to elucidate this stratigraphic question here, it is assumed for while, a Permian age in this case.

Conifers are known from the Paraná Basin since the Late Carboniferous times, as compressions and/or impressions (Iannuzzi, 2010), so the presence of *Brachyoxylon nummularium* (White) comb. nov. is expected. Furthermore, the genus *Brachyoxylon* is rare in the Permian deposits: only

one other species is known from the Permian of Gondwana, *B. semibisseriatum* (Pant & Singh) Kurzawe and Merlotti, 2010, found in the Raniganj Formation, India.

As seen here, the re-evaluation of the samples of White (1908) enabled a better taxonomic determination, which improved our understanding of the botanical affinities of the “*Glossopteris* Flora” in the Paraná Basin. These results are indispensable for better knowledge of the evolution of the flora in this part of Gondwana.

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