AMEGHINIANA (Rev. Asoc. Paleontol. Argent.) - 46 (3): 523-535. Buenos Aires, 30-09-2009 ISSN 0002-7014

Fossil woods from the Oligocene of southwestern Patagonia (Río Leona Formation). Atherospermataceae, Myrtaceae, Leguminosae and Anacardiaceae

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Abstract. Fossil woods from Oligocene Río Leona Formation were studied and described. A new morphospecies of *Myrceugenellites* with affinity to Myrtaceae was described and a new morphogenus, similar to *Schinus* (Anacardiaceae), was erected and documents the first fossil wood with this affinity from Patagonia. The diagnosis of *Laurelites doroteaensis* with affinity to Atherospermataceae and *Doroteoxylon vicente-perezii* with affinity to Leguminosae were amended. All the described woods resemble the wood of extant species that today inhabit Patagonia with the exception of *D. vicente-perezii* - the generic affinity of which remains uncertain.

Resumen. Maderas fósiles del Oligoceno del sudoeste de la Patagonia (Formación Río Leona). Atherospermataceae, Myrtaceae, Leguminosae y Anacardiaceae. Se estudian maderas fósiles provenientes de sedimentos oligocenos de la Formación Río Leona. Se describen una nueva morfoespecie de *Myrceugenellites* con afinidad a Myrtaceae y un nuevo morfogénero, semejante a *Schinus* (Anacardiaceae) que documenta la primera madera fósil de la Patagonia con esta afinidad. Las diagnosis de *Laurelites doroteaensis* de afinidad a Atherospermataceae y de *Doroteoxylon vicente-perezii* de afinidad a Leguminosae son enmendadas. Todas las maderas descriptas semejan la madera de especies actuales que habitan actualmente la Patagonia, a excepción de *D. vicente-perezii* cuya afinidad genérica permanece incierta.

Key words. Wood anatomy. Patagonia. Oligocene. Secondary xylem. Atherospermataceae. Myrtaceae. Leguminosae. Anacardiaceae.

Palabras clave. Anatomía de madera. Patagonia. Oligoceno. Xilema secundario. Atherospermataceae. Myrtaceae. Leguminosae. Anacardiaceae.

Introduction

Fossil woods from Patagonia provide an important evidence for reconstructing past vegetation and palaeoenvironment of this region. Since Darwin (1876) first mentioned fossil trees from Patagonia, few works have undertaken systematic descriptions of fossil wood specimens despite their abundance. Conwentz (1885) described some fossil morphospecies from north Patagonia and later Kräusel (1924), Cozzo (1950), Boureau and Salard (1960), Salard (1961) and Petriella (1972) examined fossil woods from Patagonia. More recently, however Nishida and colleagues have found and described a number of fossils from Chilean Patagonia (*i.e.* Nishida, 1984a; Nishida *et al*., 1988; Terada *et al*., 2006 and references cited therein).

Río Leona Formation outcrops in southwestern Patagonia and represents continental deposition during the Oligocene. The age of the formation is constrained by absolute radiometric dating of bivalves from the overlying Centinela Formation (Late Oligocene to Early Miocene) (Parras *et al*., 2008) and the unconformably underlying Man Aike Formation which has been referred to the Middle to Late Eocene based on marine invertebrates (Camacho *et al*., 2000). Marenssi *et al*. (2005) have interpreted the palaeoenvironment of the Río Leona Formation as representing a number of fluvial systems. The sediments of this formation yield abundant, excellently preserved wood, leaves and pollen. The fossil wood assemblage is dominated by Nothofagaceae along with frequently encounters Proteaceae, Atherospermataceae, Myrtaceae, Anacardiaceae, Leguminosae, Rosaceae, Araucariaceae and Podocarpaceae (Pujana, 2007; 2008). Although the fossil leaves are not abundant, Nothofagaceae also dominates these assemblages along with leaves belonging to the Myrtaceae and possibly Grossulariaceae (Césari *et al*., 2006). Pollen from shrub and tree taxa identified from this formation have been assigned to the No-

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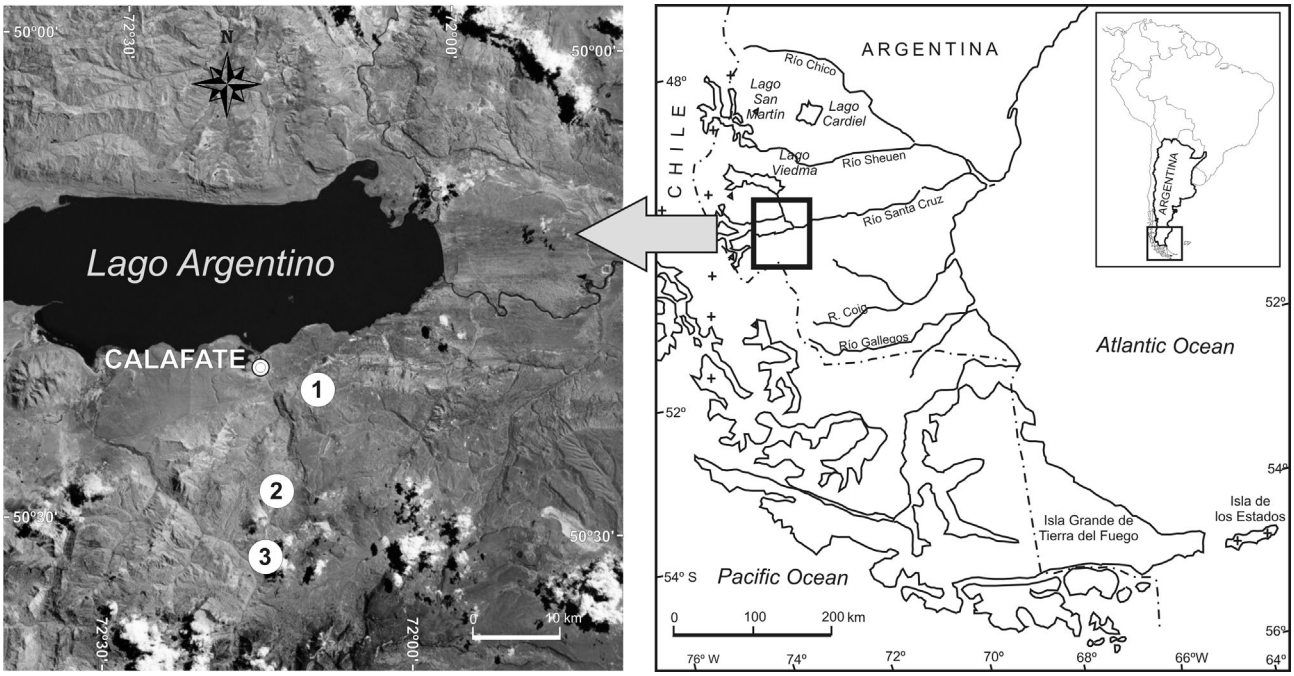


Figure 1. Map and satellite image showing the fossiliferous localities / *mapa e imagen satelital con las localidades fosilíferas*. **1,** Cerro Calafate. **2,** Arroyo de los Guanaquitos. **3,** Arroyo de las Bandurrias.

thofagaceae, Onagraceae, Rosaceae, Proteaceae, Leguminosae, Chlorantaceae, Compositae, Myrtaceae, Euphorbiaceae, Symplocaceae, Anacardiaceae, Araucariaceae and Podocarpacaeae (Barreda *et al*., 2009). Together these records indicate a similar taxa composition of the past forest to the extant Patagonian forests dominated by Nothofagaceae (Roig, 1998).

This paper describes the wood anatomy of material with anatomical affinity to the families Atherospermataceae, Myrtaceae, Leguminosae and Anacardiaceae collected from sediments of the Río Leona Formation.

Materials and methods

Woods were collected from three localities close to Calafate town in southwestern Patagonia, where the Río Leona Formation outcrops. The localities are: Cerro Calafate (50º 21' 18'' S 72º 10' 12'' W), Arroyo de los Guanaquitos (50º 27' 15'' S 72º 14' 12'' W) and Arroyo de las Bandurrias (50º 31' 24'' S 72º 15' 33'' W) (figure 1). The relative stratigraphic position of these localities is given in figure 2.

The specimens are silicified and were thin sectioned in transverse, tangential longitudinal and radial longitudinal sections following standard techniques for petrified woods (*i.e.* Hass and Rowe, 1999) and studied using light microscopy. To complement the thin-sectioned material acetate peels were also made following the recommendations of Galtier and Phillips (1999), but those never show better anatomy detail than thin cuts. Terminology follows the IAWA recommendations for hardwood identification (IAWA Committee, 1989), measurements are given as the mean followed by the range in parentheses and descriptions are based on the best preserved specimens (holotypes and paratypes in new taxa). Minimum estimated diameter is calculated based on growth ring curvature or direct measurements depending on the specimen. Systematic placement at the familial and suprafamilial level follows the APG II (2003) classification.

Specimens and thin slides are housed in the Palaeobotanical Collection of the Museo Regional Provincial Padre Manuel Jesús Molina (MPMPB) located in Río Gallegos, Santa Cruz Province, Argentina. Slides bear the specimen numbers followed by a lower case letter usually indicating the sections: a, transverse section, b, radial longitudinal section, and c, tangential longitudinal section.

Systematic palaeontology

Genus ***Myrceugenellites*** Nishida, H. Nishida and Nasa, 1988

Type species. *Myrceugenellites maytenoides* Nishida, H. Nishida and Nasa, 1988.

Synonyms. 2001. *Myrceugenelloxylon maytenoides* (Nishida, H. Nishida and Nasa) Poole, Hunt and Cantrill: 44; figs. 39-46.

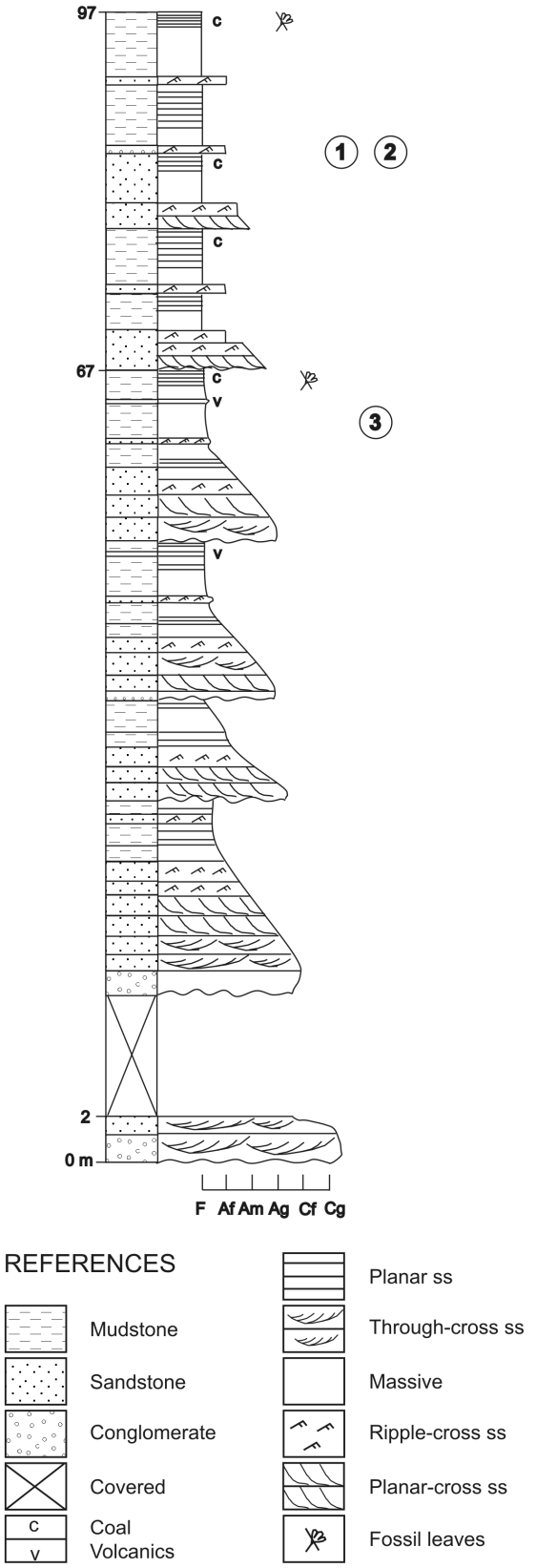


Figure 2. Stratigraphic column with the fossil-bearing strata from the "Estancia 25 de Mayo" section of Río Leona Formation from Marenssi *et al*. (2005) / *perfil esquemático con los estratos fosilíferos de la sección "Estancia 25 de Mayo" de Marenssi* et al. (2005). **1,** Cerro Calafate. **2,** Arroyo de los Guanaquitos. **3,** Arroyo de las Bandurrias.

Other species. *Myrceugenellites antarcticus* (Poole, Hunt and Cantrill) nov. comb.

Myrceugenellites oligocenum sp. nov.
Figure 3

Holotype. MPMPB 2169.
Paratypes. MPMPB 1965, 1972, 2166, 2185 and 2187.
Other specimens. MPMPB 1971, 1975 and 2165.
Type locality. Arroyo de los Guanaquitos.
Derivatio nominis. *oligocenum*, for Oligocene, the age of the sediments.
Affinity. Angiospermae, Myrtales, Myrtaceae, *Luma*.

Diagnosis. Secondary xylem with distinct growth rings. Diffuse porosity. Vessels small, solitary or in tangential pairs. Perforation plates scalariform with numerous bars. Intervessel pits circular with opposite arrangement. Vessel-ray pits circular. Fibres septate and pitted. Rays uniseriate, sometimes with biseriate portions.

Description. The specimens do not reach more than 20 cm in diameter. Growth ring boundaries are marked by the reduction of the radial diameter of the last two or three rows of latewood fibres. Wood is diffuse-porous (figure 3.1). Vessels with angular to oval outline, solitary or in tangential pairs with a mean tangential diameter of 29 (15-52) μm and radially elongated (figure 3.1-2). Vessel density is 250 (102-380) vessels per mm^2. Vessel elements are 590 (425-725) μm in length with steeply inclined end walls (figure 3.6). Perforation plates are scalariform with 25 to 45 bars (figure 3.3-4). Intervessel pits are circular to horizontally elongate, 2-3 μm in height and have an opposite arrangement (figure 3.4). Vessel-ray pits are circular and have a diameter of 2-3 μm (figure 3.8). Tyloses are present. Fibres are sometimes septate, thin walled and have bordered pits (fibretracheids) with a diameter of 3-4 μm (figure 3.7). Rays are uniseriate (69 %), or uniseriate with biseriate portions (31 %) (figure 3.6) and composed of parenchymatic procumbent cells with pitted walls (figure 3.5). The cells comprising the biseriate portions are smaller than the ones in the uniseriate zones. Ray cells have usually one or two dark, circular contents (figure 3.5). Rays can reach up to 30 cells in height, and number 10-16 per mm.

Discussion. The specimens do not exhibit any significant variation from the description given above other than a slight variation in the proportion of biseriate rays, mean vessel tangential diameter and other quantitative characters. All specimens are probably derived from mature material, only one specimen, MPMPB 1965, has a partially preserved pith, but parenchyma cells are collapsed.

Many extant species have scalariform perforation plates similar to the fossils. *Weinmannia* L. and *Caldcluvia* D. Don, of the Cunoniaceae (see Dickison, 1977; Rancusi *et al*., 1987), and the woody families

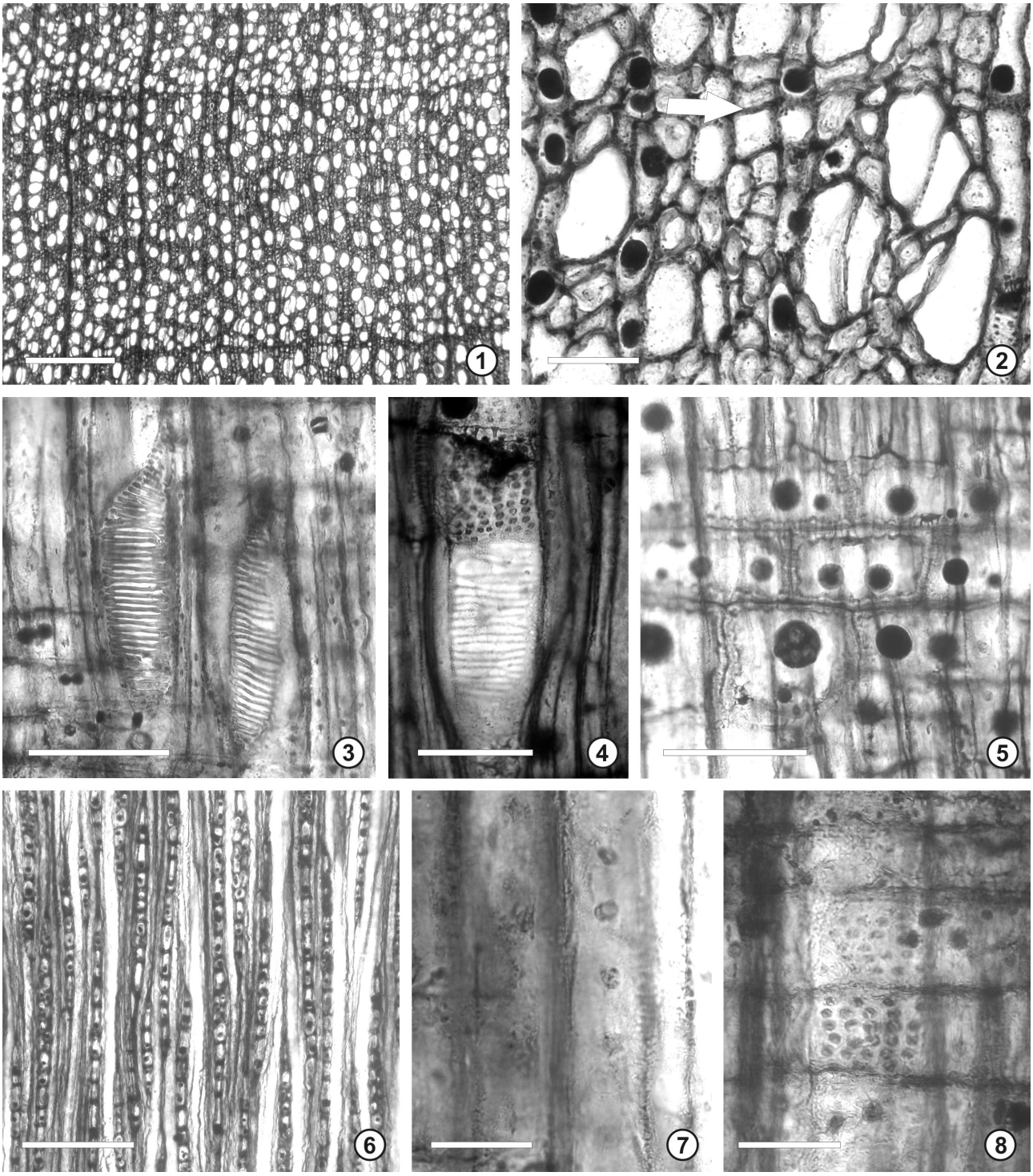


Figure 3. ***Myrceugenellites oligocenum*** sp. nov. **1,** general view of a transverse section (TS) showing vessel arrangement / *aspecto general de una sección transversal (ST) mostrando la disposición de los vasos*. Scale bar / *escala gráfica*: 500 µm. (MPMPB 2169, holotype). **2,** detail of TS showing growth ring boundary (arrow) / *detalle de ST con límite de anillo (flecha)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1965, *paratype*). **3,** scalariform perforation plates in radial longitudinal section (RLS) / *placas de perforación escalariformes en sección longitudinal radial (SLR)*. Scale bar / *escala gráfica*: 100 µm. (MPMPB 1972, *paratype*). **4,** intervessel pitting and scalariform perforation plate (RLS) / *puntuaciones intervasculares y placa de perforación escalariforme (SLR)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1965, *paratype*). **5,** parenchymatic ray cells (RLS) / *células parenquimáticas radiales (SLR)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1965, *paratype*). **6,** rays in tangential longitudinal section (TLS) / *radios en sección longitudinal tangencial (SLT)*. Scale bar / *escala gráfica*: 200 µm. (MPMPB 2169, *holotype*). **7,** pitted fibres (TLS) / *fibras con puntuaciones (SLT)*. Scale bar / *escala gráfica*: 20 µm. (MPMPB 1972, *paratype*). **8,** vessel-ray pitting (RLS) / *puntuaciones radio vasculares (SLR)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1972, *paratype*).

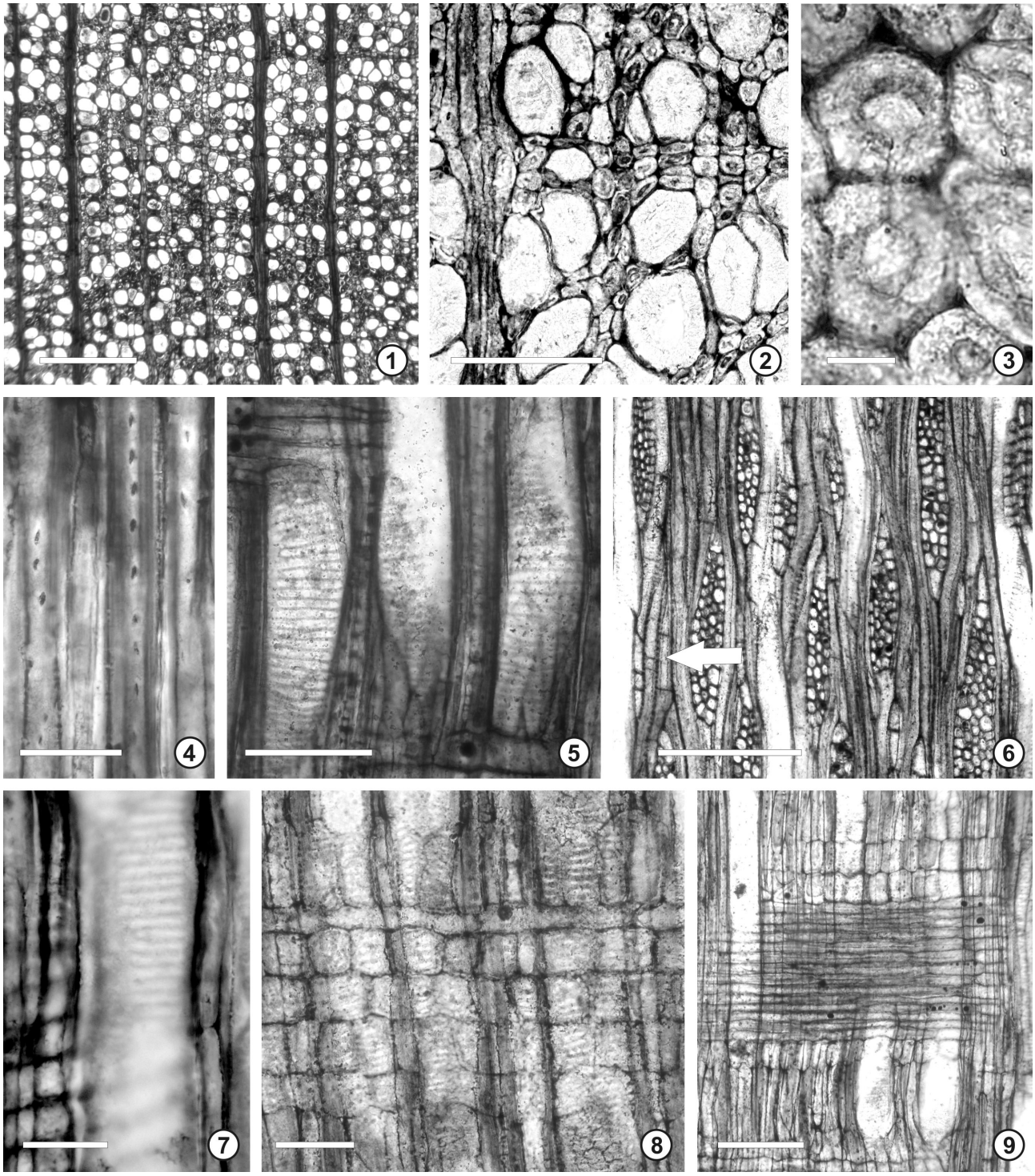


Figure 4. ***Laurelites doroteaensis*** Nishida, H. Nishida and Nasa, 1988. **1,** general view of a transverse section (TS) showing vessel arrangement / *aspecto general de una sección transversal (ST) mostrando la disposición de los vasos*. Scale bar / *escala gráfica*: 500 µm. (MPMPB 1973). **2,** detail of TS showing growth ring boundary (arrow) / *detalle de ST con límite de anillo (flecha)*. Scale bar / *escala gráfica*: 100 µm. (MPMPB 2184). **3,** pitted fibres in TS / *fibras con puntuaciones en ST*. Scale bar / *escala gráfica*: 10 µm. (MPMPB 2184). **4,** pitted fibres in TLS / *fibras con puntuaciones en SLT*. Scale bar / *escala gráfic*a: 50 µm. (MPMPB 1973). **5,** scalariform perforation plates (RLS) / p*lacas de perforación escalariformes (SLR)*. Scale bar / *escala gráfica*: 100 µm. (MPMPB 1973). **6,** multiseriate rays and axial parenchyma (arrow) (TLS) / *radios multiseriados y parénquima axial (flecha) (SLT)*. Scale bar / e*scala gráfica*: 200 µm. (MPMPB 1973). **7,** intervessel pits (RLS) / *puntuaciones intervasculares (SLR)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1973). **8,** vessel-ray pitting (RLS) / *puntuaciones radio vasculares (SLR)*. Scale bar / *escala gráfica*: 50 µm. (MPMPB 1973). **9,** procumbent ray cells and square-upright marginals (RLS) / *células radiales procumbentes y cuadradas a verticales marginales (SLR)*. Scale bar / *escala gráfica*: 100 µm. (MPMPB 1973).

Monimiaceae, Atherospermataceae and Lauraceae of the Laurales (see Patel, 1973; 1987; Rancusi *et al*., 1987) show similar anatomy but they have horizontally elongated vessel-ray pits with opposite to scalariform arrangement. Within the Myrtaceae, many genera have circular vessel-ray pits, for example *Luma* A. Gray (=*Myrceugenella* Kausel), *Amomyrtus* (Burret) D. Legrand and Kausel, *Myrceugenia* O. Berg, *Lepstospermum* J. R. Forst. and G. Forst. or *Neomyrtus* Burret (see Ingle and Dadswell, 1953; Rancusi *et al*., 1987; Patel, 1994; 1995). In the Myrtaceae many species have both simple and scalariform perforation plates with few bars (Schmid and Baas, 1984). *Luma* however has exclusively scalariform perforation plates (with generally more than 20 bars per plate), therefore this genus is considered to show the greatest anatomical similarity to these fossils.

Patagonian fossil *Myrceugenellites maytenoides* Nishida *et al*. (1988) is very similar to the fossils described above. The main difference is the uniseriate, sometimes biseriate and never triseriate rays in the material from the Río Leona Formation and bi-triseriate, and shorter rays in *M. maytenoides*. In addition, tangential pairs of vessels are relatively frequent in the Río Leona Formation fossils and are very rare in *M. maytenoides*. *Myrceugenelloxylon antarcticus* Poole *et al*. (2001) from Western Antarctica also shares good anatomical similarity. However, *M. antarcticus* has significantly fewer vessels per mm^2, unpitted fibres and normally biseriate rays. Moreover they are also different both in geological age and in the continent of origin.

Poole *et al*. (2001) considered *Myrceugenellites maytenoides* to be a junior synonym of *Myrceugenelloxylon*, and made a new combination: *Myrceugenelloxylon maytenoides*. They reject *Myrceugenellites* morphogenus and this criterion was later followed by Terada *et al*. (2006). Nevertheless, this criterion is not shared here, so *Myrceugenelloxylon* and *Myrceugenellites* are considered as two separate morphogenera following Nishida (1984a) and Nishida *et al*. (1988). The type species of *Myrceugenelloxylon* morphogenus, *M. pseudoapiculatum* Nishida (1984a) from Central Chile, has indistinct growth rings, large vessels with a tangential diameter of 100-150 µm, low density of vessels (*ca.* 19 vessels per mm^2), sometimes scalariform intervessel pitting and scalariform perforation plates with few bars (5-8). These characters are not shared with *Myrceugenellites maytenoides* and with the fossils from Río Leona Formation, so the differences are considered to be great enough to separate the Río Leona Formation fossils and to place them into *Myrceugenellites*. Consequently, the specimens are assigned to a new morphospecies of *Myrceugenellites*, re-erecting the morphogenus and keeping *Myrceugenelloxylon* as a separate morphogenus for fossil woods with indistinct growth rings, larger vessels, lower vessel density, and perforation plates with few bars. In addition, it is proposed that *Myrceugenelloxylon antarcticus* should be placed in *Myrceugenellites* (see Systematic Addenda).

Other myrtaceous fossil woods already documented are *Myrceugenia chubutense* Ragonese (1980) from the Paleocene of Argentinean Patagonia and two specimens assigned to *Myrceugenelloxylon apiculatum* (Nishida, 1984b) from Quiriquina Island in Chilean Patagonia. In sediments of the Río Leona Formation fossil pollen (Barreda *et al*., 2009) and fossil leaves (Césari *et al*., 2006) with affinity to Myrtaceae were found.

Genus ***Laurelites*** Nishida, H. Nishida and Nasa, 1988

Type species. *Laurelites doroteaensis* Nishida, H. Nishida and Nasa, 1988.
Amended diagnosis. Poole and Francis, 1999.

Laurelites doroteaensis Nishida, H. Nishida and Nasa, 1988
Figure 4

Holotype. Specimen nº 797875, Faculty of Science, Chiba University, Japan.
Other specimens. Specimens nº 797822 and nº 797876, Faculty of Science, Chiba University, Japan.
New specimens. MPMPB 1973, 2174, 2184, 2272, 2273 and 2277.
Type locality. Cerro Dorotea.
New locality. Arroyo de los Guanaquitos.
Affinity. Angiospermae, Laurales, Atherospermataceae.

Amended diagnosis. Secondary xylem with distinct growth rings. Diffuse porous. Vessels small, solitary or in tangential pairs, rarely in short radial series. Perforation plates scalariform with numerous bars. Intervessel pits horizontally elongated, opposite to scalariform in arrangement. Vessel-ray pits, in ray marginal cells only, horizontally elongated. Axial parenchyma apotracheal diffuse. Fibres pitted and thick walled. Rays usually 3-4 seriate, composed of procumbent cells with square to upright marginal cells.

Description. Minimum estimated diameter of the widest specimen 30 cm (MPMPB 2273). Growth rings are demarcated by the reduction of the radial diameter of the last one or two rows of latewood fibres (figure 4.2). Wood is diffuse porous with predominantly solitary vessels but also sometimes tangentially paired (figure 4.1-2). Vessels with angular to oval outline (figure 4.2). Perforation plates are scalariform with 20 to 45 bars (figure 4.5). Vessels in longitudinal section are slightly sinuous (figure 4.6), tangential diameter 47 (25-75) µm, and 560 (425-735) vessels per

mm². Intervessel pits are circular to horizontally elongated, *ca.* 7 μm in vertical diameter and opposite to scalariform in arrangement (figure 4.7). Vessel-ray pits are horizontally elongated, scalariform in arrangement and are present only in the square to upright marginal ray cells (figure 4.8). Diffuse apotracheal axial parenchyma is common and present in strands of 3 to 5 cells (figure 4.6). Fibres are apparently non-septate, thick walled with pits present on both tangential and radial walls (figure 4.3-4). Rays are multiseriate usually 3 or 4 cells wide but can reach up to 6 cells wide (figure 4.6). Rays are composed of procumbent cells forming the body of the ray and one to three files of square to upright marginal cells (figure 4.9). Ray frequency is 3 to 6 per mm.

Discussion. Six specimens were assigned to this morphospecies based on their anatomy. They do not show significant anatomical variations among them, except for a slight variation in quantitative characters such as proportion of different multiseriate ray width and frequency of vessel tangential pairs, which can all vary either ontogenetically and/or through differences in the local environment. The diagnosis was amended to include some characters: marked growth rings, perforation plates with numerous bars and fibres pitted and thick walled. Some characters were removed: vessel density value and abundant tyloses.

Among extant plants, wood of Patagonian *Laureliopsis philippiana* (Looser) Schodde (=*Laurelia philippiana* Looser) (Rancusi *et al*., 1987; Diaz Vaz, 1988a) and *Laurelia sempervirens* Tul. (Diaz Vaz, 1988b) are very similar in many characters as is *Laurelia* novae-zelandiae A. Cunn. from New Zealand (Patel, 1973). Therefore an atherospermataceous affinity (or monimiaceous *sensu lato*) is highly likely. All these species have multiseriate rays, scalariform perforation plates and small, generally solitary, vessels.

Several fossil woods of atherospermataceous affinity have been described from South America and Antarctica. *Laurelites jamesrossi* Poole and Francis (1999) was described from the Cretaceous of Antarctica and shares anatomical similarity alike.

However *L. jamesrossi* differs from the Río Leona Formation fossils by the abundance of axial parenchyma in the Patagonian fossils whereas this character is rare in *L. jamesrossi*. Moreover there is a great difference between *L. jamesrossii* and the fossils described here both geographically and temporally. Another atherospermataceous fossil wood from Antarctica is *Hedycaryoxylon tambourissoides* Poole and Gottwald (2001), which has much wider rays than *L. doroteaensis*. *Laurelioxylon* Nishida (1984b) from the Tertiary of Quiriquina Island is also similar, but its vessels are larger, present in lower density, generally present in radial multiples and with scalariform perforation plates with fewer bars (8-15). *Laurelites doroteaensis* Nishida *et al*. (1988) has been described from the Cerro Dorotea locality of South America but its Middle Tertiary age remains uncertain (see discussion of *Doroteoxylon vicente-perezii* below). *Laurelites doroteaensis* is characterised by small vessels, scalariform perforation plates with numerous bars, intervessel pits opposite to scalariform in arrangement and rays usually 3-4 seriate, which are shared by the fossils described here. However slight differences do exist between the fossils and *Laurelites doroteaensis* such as the relatively larger vessel density and slightly smaller tangential diameter exhibited by *Laurelites doroteaensis*, but these characters can be the result of ontogenetical or local environmental differences and do not justify the erection of a new morphospecies. Therefore greatest anatomical similarity is shared with *L. doroteaensis* and given the close geographical location and geological age the specimens are placed in *Laurelites doroteaensis* Nishida *et al*. (1988).

The Atherospermataceae now occupies a disjunctive distribution across the southern hemisphere in South America and Oceania. Renner *et al*. (2000) suggested a South American origin for the family in the Cretaceous, followed by its later dispersal into Oceania. The presence and relative abundance of this family in the fossil record, suggests a more extensive distribution during the past. *Laureliopsis* Schodde and *Laurelia* Juss. are now restricted to northern Patagonia. Yet the presence of these woods in Río Leona Formation helps confirm a wider geographical (from Antarctica to South America) and temporal distribution (Nishida, 1984b; Nishida *et al*., 1988, Poole and Francis, 1999). Moreover fossil leaves of atherospermataceous affinity have also been found in Patagonia (Berry, 1928; 1935) and Antarctica (Dusén, 1908). Surprising, however, is the absence of fossil atherospermataceous pollen in the sediments of the Río Leona Formation since the pollen of *Laurelia* Juss. and *Laureliopsis* are easily identifiable (Sampson, 1996).

Genus ***Doroteoxylon*** Nishida, H. Nishida and Ohsawa, 1989

Type species. *Doroteoxylon vicente-perezii* Nishida, H. Nishida and Ohsawa, 1989

Doroteoxylon vicente-perezii Nishida, H. Nishida and Ohsawa, 1989

Figure 5

Holotype. Specimen n* 797848, Faculty of Science, Chiba University, Japan.
Type locality. Cerro Dorotea, Patagonia.
New material. MPMPB 1955.
New locality. Arroyo de las Bandurrias.

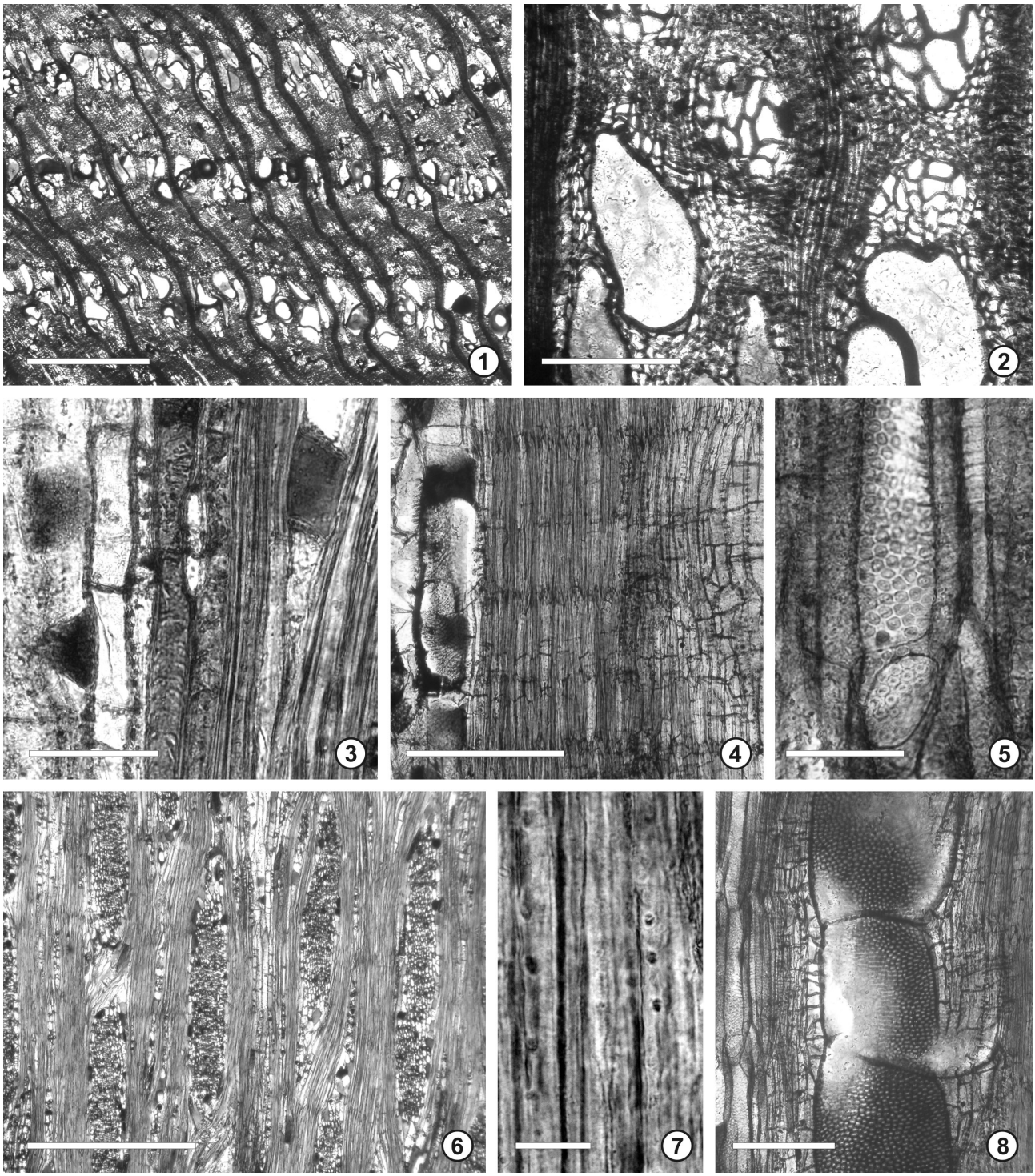


Figure 5. ***Doroteoxylon vicente-perezii*** Nishida, H. Nishida and Ohsawa, 1989. (MPMPB 1955). **1,** general view of a transverse section (TS) showing vessel arrangement / *aspecto general de una sección transversal (ST) mostrando la disposición de los vasos*. Scale bar / *escala gráfica*: 1 mm. **2,** detail of TS showing growth ring boundary (arrow) / *detalle de ST con límite de anillo (flecha)*. Scale bar / *escala gráfica*: 100 µm. **3,** vasicentric axial parenchyma (TLS) (arrow) / *parénquima axial vasicéntrico (SLT) (flecha)*. Scale bar / *escala gráfica*: 50 µm. **4,** storied fibres (RLS) / *fibras estratificadas (SLR)*. Scale bar / *escala gráfica*: 500 µm. **5,** small vessel with helical thickenings and simple perforation plate (RLS) / *vaso pequeño con engrosamientos helicoidales y placa de perforación simple (SLR)*. Scale bar / *escala gráfica*: 50 µm. **6,** multiseriate rays (TLS) / *radios multiseriados (SLT)*. Scale bar / *escala gráfica*: 500 µm. **7,** fibres with bordered pits (TLS) / *fibras con puntuaciones areoladas (SLT)*. Scale bar / *escala gráfica*: 10 µm. **8,** large vessel with alternate pitting (RLS) / *vaso grande con puntuaciones alternas (SLR)*. Scale bar / *escala gráfica*: 200 µm.

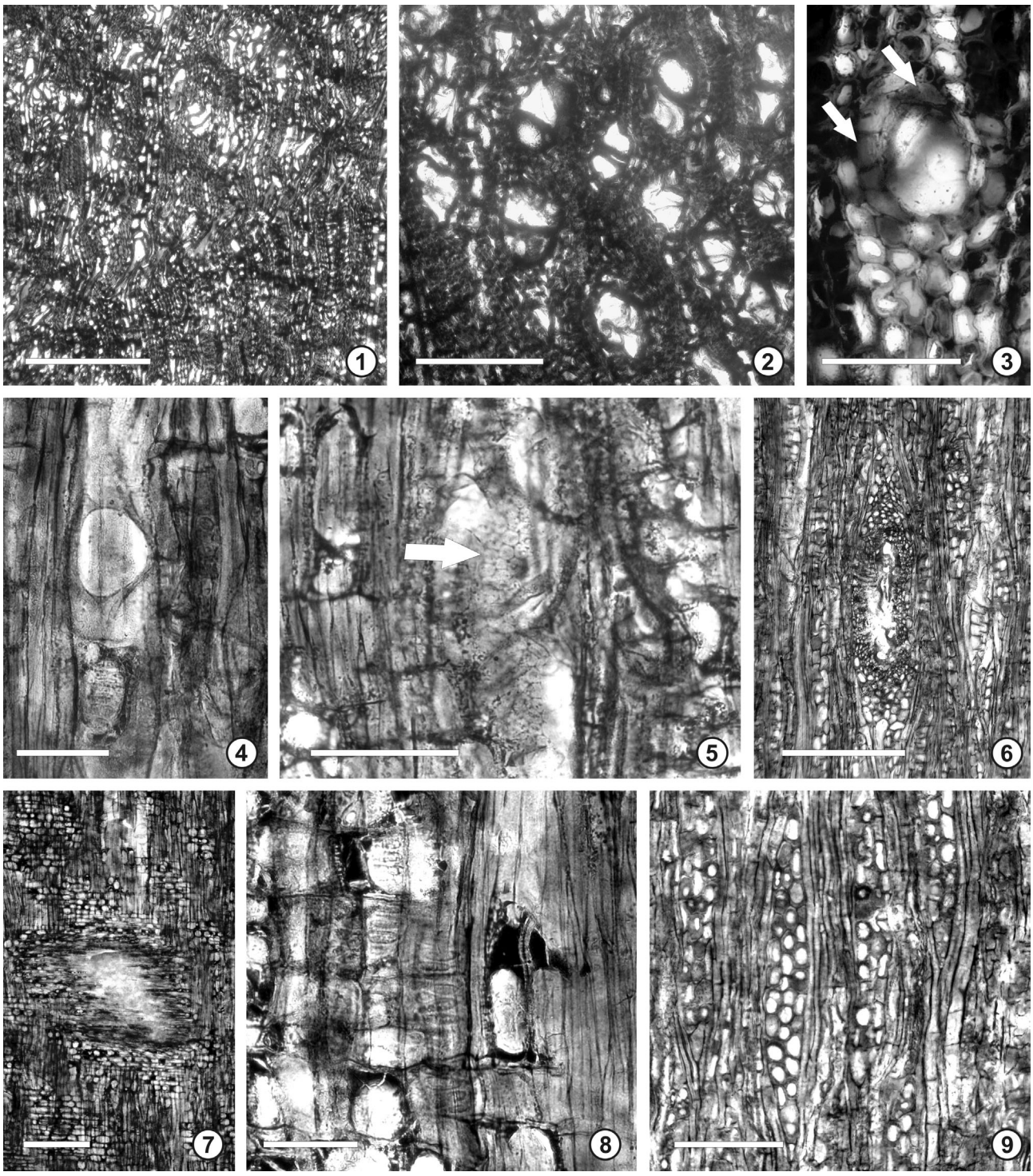


Figure 6. ***Resinaxylon schinusoides*** nov. gen. et sp. (MPMPB 2170, holotype) **1,** general view of a compressed transverse section (TS) showing vessel arrangement / *aspecto general de una sección transversal (ST) comprimida mostrando la disposición de los vasos*. Scale bar / *escala gráfica*: 200 µm. **2,** detail of TS / *detalle de ST*. Scale bar / *escala gráfica*: 100 µm. **3,** detail of TS showing paratracheal axial parenchyma (arrows) / *detalle de ST mostrando parénquima axial paratraqueal (flechas)*. Scale bar / *escala gráfica*: 50 µm. **4**, simple perforation plate (RLS) / *placa de perforación simple (SLR)*. Scale bar / *escala gráfica*: 50 µm. **5,** alternate intervessel pits (arrow) (RLS) / *puntuaciones intervasculares alternas (flecha) (SLR)*. Scale bar / *escala gráfica*: 50 µm. **6,** resin canal (TLS) / *canal resinífero (SLT)*. Scale bar / *escala gráfica*: 20 µm. **7,** resin canal (RLS) / *canal resinífero (SLR)*. Scale bar / *escala gráfica*: 50 µm. **8,** vessel-ray pitting (RLS) / *puntuaciones radio-vasculares (SLR)*. Scale bar / *escala gráfica*: 50 µm. **9,** bi and triseriate rays (TLS) / *radios bi y triseriados (SLT)*. Scale bar / *escala gráfica*: 100 µm.

Affinity. Fabales, Leguminosae, Caesalpinoideae.

Amended diagnosis. Secondary xylem with distinct growth rings. Ring porous. Vessels large and solitary in earlywood, small and clustered in the latewood. Perforation plates simple. Intervessel pits circular to hexagonal with alternate arrangement. Ray-vessel pits circular to elliptical similar to intervessel pits. Tyloses abundant. Helical thickenings present. Fibres pitted and storied. Axial parenchyma paratracheal vasicentric. Rays up to 17 cells in width with sheath cells.

Description. The specimen is a fragment of secondary xylem of 1x3x2 cm, with a minimum estimated diameter of 12 cm. Growth rings are *ca.* 1.1 mm wide, distinct and demarcated by the reduction in radial diameter of the last two to four rows of latewood fibres, the reduction in vessel size and the presence of vessel clusters in the latewood (figure 5.1-2). Wood is ring porous with vessels being of two distinct sizes. Larger vessels are solitary or tangentially paired in the earlywood with a tangential diameter of 192 (70-330) μm (figure 5.1-2). Smaller vessels form clusters of 6 to 18 in the latewood and have a tangential diameter of 24 (10-40) μm (figure 5.2). Perforation plates are simple and, in the larger vessels, horizontal whereas in the smaller vessels they are oblique (figure 5.5). Intervessel pits are hexagonal, with an alternate arrangement and diameters of 5-7 μm in both small and large vessels (figure 5.5, 8). Vessel-ray pitting is similar to the intervessel pitting. Small vessels have helical thickenings (figure 5.5). Large vessels frequently have tyloses. Fibres are septate, with bordered pits (fibretracheids), thin walled (figure 5.7) and storied (figure 5.4). Axial parenchyma is vasicentric and forms strands of 3-4 cells (figure 5.3). Rays are multiseriate, 12 to 16 cells wide and can reach more than 1 mm high (figure 5.6). Radial cells are procumbent with two to four rows of upright marginal cells. Rays have one or two sheath cells (figure 5.6), and a frequency of up to 4 per mm.

Discussion. This fossil wood sample is exceptionally well preserved and allowed a complete character assessment. This specimen is characterised by vessels of two sizes (solitary vessels of large size in the earlywood, narrow vessels in clusters in the latewood) helical thickenings in the narrow latewood vessels and multiseriate rays of up to 16 cells wide and 1 mm or more in height. The diagnosis was amended to include fibres pitted and storied and to remove vessel density and vessel element length values.

The fossil share a greater affinity with members of the subfamily Caesalpinoideae of the Leguminosae, in particular *Gleditsia* L. (*i.e. Gleditsia triacanthos* L., *Gleditsia aquatica* Marshall) and *Robinia* L. (*i.e. Robinia pseudoacacia* L.) both genera native to the northern hemisphere. Unfortunately due to the rare status of many of the Leguminosae shrubs native to Patagonia their wood anatomy has not yet been studied and thus prevents any further comparison with the fossil described here.

Some characters exhibited by *D. vicente-perezii* do vary within the holotype and the fossil from Río Leona. The most significant difference between the specimen described here and the holotype is that the specimen from Río Leona Formation has storied structure in fibres not observed in the holotype. The holotype for *D. vicente-perezii* from the Cerro Dorotea locality (Nishida *et al*., 1989) was of uncertain affinity but considered to be most similar to the Proteaceae due to the multiseriate rays and the tendency to form tangential bands of earlywood vessels. However, the Proteaceae have well-defined tangential bands throughout the growth ring, and the Patagonian Proteaceae have smaller vessels than *D. vicente-perezii*.

The presence of this morphospecies represented by one specimen from Cerro Dorotea and another from Río Leona Formation suggests that this taxon formed a minor component of the vegetation. Pollen of Leguminosae affinity is present in the strata of Río Leona Formation (Barreda *et al*., 2009).

Genus ***Resinaxylon*** gen. nov.

Type species. *Resinaxylon schinusoides*.
Diagnosis. Same as species by monotypy.

Resinaxylon schinusoides gen. et sp. nov.
Figure 6

Holotype. MPMPB 2107.
Type locality. Cerro Calafate.
Derivatio nominis. *Resina*, Latin, resin for the resin canals. *Xylon*, Greek, wood. *Schinus*, after the genus *Schinus*. *Oides*, Latin, resemble.
Affinity. Angiospermae, Sapindales, Anacardiaceae, *Schinus*.

Diagnosis. Secondary xylem with indistinct growth rings. Diffuse porous. Vessels small solitary and in radial groups of 2 to 4 or clusters. Vessels have a tendency to diagonal arrangement. Perforation plates simple. Intervessel pitting alternate. Vessel-ray pitting opposite to scalariform. Fibres thick walled. Axial parenchyma paratracheal scarce. Rays normally triseriate with one or two marginal upright cells. Resin canals present in wide multiseriate rays.

Description. Minimum estimated diameter of the sample is 16 cm based on the curvature of the growth rings. Growth rings boundaries indistinct, ring delimitation is vague. Wood is diffuse porous with vessels arranged solitary and in radial groups of 2 to 4 pores, rarely clustered (figure 6.1), compressed, with a mean tangential diameter of 20 (5-30) μm and 199 (102-242) vessels per mm^2. Vessels have a tendency

to diagonal arrangement (figure 6.2). Perforation plates are simple (figure 6.4). Intervessel pits are small (diameter *ca.* 6 μm), hexagonal, alternately arranged and bordered, (figure 6.5). Vessel-ray pits are horizontally elongate with opposite to scalariform arrangement (figure 6.8). Fibres are thick walled, septate and non-septate and pitted on radial walls. Scarce paratracheal vasicentric axial parenchyma is present (figure 6.3). Rays are usually triseriate, sometimes biseriate, and composed of procumbent, sometimes upright, cells with one, rarely two, rows of marginal upright cells (figure 6.8-9) with pitted cell walls (figure 6.8). Ray frequency is 10 to 12 per mm. Radial resin canals are present in the body of wide multiseriate rays, one per ray, 86-190 μm in height and 18-30 μm in width (figure 6.6).

Discussion. This fossil is characterised by the combination of radial resin canals, triseriate rays and very small vessels, characters also found in the wood of many extant species of the Anacardiaceae (Metcalfe and Chalk, 1950; Terrazas, 1999). Today representatives of the Anacardiaceae in Patagonia include several species of the genus *Schinus* L. and their woods are anatomically very similar to the fossil (Fernández, 2007). However helicoidal thickenings, a unique important character found in woods of Patagonian *Schinus*, were not observed in the fossil. The presence of this character would enable an unquestionable assignment to *Schinus*, but this discrepancy could be accounted for by a possible change in ecological conditions over the last *ca.* 30 million years. Anatomical variation among Patagonian species of *Schinus* is scarce, the most important anatomical characters of them are: mean vessel tangential diameter 22 to 33 μm, diagonal arrangement of vessels, resin canals, rays usually uniseriate to triseriate and scarce paratracheal axial parenchyma (Fernández, 2007). *Lithraeae* spp. show similar wood anatomy to *Resinaxylon schinusoides* in the porosity, intervessel pitting and ray width (Wagemann, 1948; Martijena, 1987), however *Lithraea* spp. lack radial resin canals.

Table 1 compares *Resinaxylon schinusoides* with its closest anatomical morphospecies. *Schinopsixylon herbstii* Lutz (1979) and *Schinopsixylon heckii* Lutz (1979) fossil woods with affinity to Anacardiaceae were described for specimens with large vessels, resin canals and scarce axial parenchyma. Brea (1999) added one specimen to *S. heckii*. These two morphospecies are similar to extant genus *Schinopsis* Engl. on the main characters: vessel diameter, axial parenchyma, perforation plates, resin canals and type of rays. The vessels and rays of these morphospecies are wider and vessels are in less density than the specimen from Río Leona Formation. *Schinoxylon actinoporosum* Kruse (1954), unique in the morphogenus, has vessels of 15-70 μm in tangential diameter, vessels of two distinct types and uniseriate rays with biseriate portions, while in the fossil from the Río Leona Formation rays are normally triseriate, vessels smaller and of one type. *Resinaxylon schinusoides* has also vessels with a tendency to diagonal arrangement, character absent in *S. actinoporosum*. In addition, even though he named *Schinoxylon* after *Schinus*, he hesitated about the certain affinity of *S. actinoporosum* to that extant genus. For those reasons, the fossil is placed in a new morphogenus with close affinity to Patagonian *Schinus*.

Although, several authors have described Paleocene to Miocene fossil pollen (see Palazzesi and Barreda, 2007) and leaves (*i.e.* Berry, 1932; 1938; Troncoso, 1992), from Patagonia as belonging to the Anacardiaceae, this record constitutes the first fossil wood for the Patagonia with affinity to Anacardiaceae. In addition, pollen grains from sediments of the Río Leona Formation with affinity to Anacardiaceae were reported (Barreda *et al*., 2009).

Conclusions

A new morphospecies *Myrceugenellites oligocenum* with affinity to Myrtaceae was described. A new morphogenus with a morphospecies, *Resinaxylon schinusoides*, with affinity to *Schinus* (Anacardiaceae)

Table 1. Comparison of ***Resinaxylon schinusoides*** with its closest anatomical morphospecies / *comparación de* **Resinaxylon schinusoides** *con las morfoespecies más cercanas anatómicamente.*

	vessels per mm²	Vessel tg. diam. [μm]	Ray width	Rays per mm	Axial parenchyma	Comments
Resinaxylon schinusoides	102-242	20 (5-30)	1-3 seriate	10-12	paratracheal scarce	tendency to diagonal arrangement of vessels
Schinoxylon actinoporosum Kruse, 1954	*ca.* 100	15-70	1-2 seriate	*ca.* 15	apparently absent	vessels of two distinct types
Schinopsixylon heckii Lutz, 1979	10-18	104 (79-125)	1-5 seriate	4-9	paratracheal scarce	see also Brea (1999)
Schinopsixylon herbstii Lutz, 1979	10-16	108 (66-165)	1-5 seriate	4-8	paratracheal scarce	up to 3 resin canals per ray

was also erected. Additional descriptions on *Laurelites doroteaensis* (affinity to Atherospermtaceae) and *Doroteoxylon vicente-perezii* (affinity to Leguminosae) with their amended diagnoses were made.

A fossil wood with affinity to Anacardiaceae was described for the first time from Patagonia.

Botanical families represented in the fossil woods from Río Leona Formation here described are also present in the fossil leaf and pollen records from Patagonia, except for the Atherospermataceae that has no pollen record for that region yet.

Systematic addenda

Genus ***Myrceugenellites*** Nishida, H. Nishida and Nasa, 1988

Type species. *Myrceugenellites maytenoides* Nishida, H. Nishida and Nasa, 1988

Myrceugenellites antarcticus (Poole, Hunt and Cantrill) Pujana nov. comb.

Basonym. 2001 *Myrceugenelloxylon antarcticus* Poole, Hunt and Cantrill, 43-44, figs. 39, 41-42, 45.

Diagnosis. as in Poole, Hunt and Cantrill, 2001: 44.

Acknowledgments

The author would like to thank Imogen Poole for her invaluable comments and suggestions and also Nishida for reading the manuscript. He is also grateful to S.N. Césari, S.A. Marenssi and J. Francis for their assistance in the field work. The funds were provided by the PICT 10747 and 32320 of the Agencia Nacional de Promoción Científica y Tecnológica.

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Recibido: 9 de octubre de 2008.
Aceptado: 23 de junio de 2009.