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COMPARISON OF THE PETRIFIED WOODS FROM THE CRETACEOUS AND TERTIARY OF ANTARCTICA AND PATAGONIA*

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Abstract: Mentioned is a brief history of the studies on the petrified woods from the Cretaceous and Tertiary of Antarctica and Patagonia.

Among nine fossil species described from Antarctica so far, seven were recognized to occur also in Patagonia. It is suggested that the species from Patagonia are expected to be found from Antarctica in the near future. Four species of petrified woods including two new species were described from the Tertiary of Chilean Patagonia.

1. Introduction

The petrified plants from the Cretaceous and Tertiary of Antarctica were first investigated by GOTHAN (1908) who examined the material from Seymour Island collected by the Swedish Antarctic Expedition in 1901–03. After a long interval without any particular work for about 70 years, some Chilean workers started to examine fossil woods there again. The studies of Tertiary petrified woods of Patagonia, on the other hand, were started by CONWENTZ (1885) who described several species of coniferous and angiospermous woods. Then, KRÄUSEL (1925) reported five species of silicified woods from Patagonia, pointing out that four species were common to the Antarctic species, that is, *Dadoxylon pseudoparenchymatosum* GOTHAN, *Phyllocladoxylon antarcticum* GOTHAN, *Laurinoxylon uniseriatum* GOTHAN and *Nothofagoxylon scalariforme* GOTHAN.

Since KRÄUSEL's work, studies dealing with the Patagonian fossil woods had been ceased for 25 years, mainly because of the lack of anatomical studies of the living woods comparable to the fossils. Due to the extensive works by WAGEMANN (1949) and TORTORELLI (1940, 1956) having described the anatomy of the major species of Chilean and Argentinean living woods, the later works more critically accounting the fossil woods of Antarctica and Patagonia came to appear (TORTORELLI, 1941; COZZO, 1950; BOUREAU and SALARD, 1960; SALARD, 1961; MENÉNDEZ, 1962; ROMERO, 1968, 1970; NISHIDA, 1970; PETRIELLA, 1969, 1972; RAGONESE, 1977, 1980). Recently many species of petrified woods have been described from South Chile and Antarctica by

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Table 1. Petrified woods from the Cretaceous–Tertiary of Antarctica and their distribution in Patagonia.

Species	Locality	
	Patagonia	Central Chile
Araucarioxylon doeringii CONWENTZ (1885)	+	+
(=*Dadoxylon pseudoparenchymatosum* GOTHAN, 1908)		
(=*Araucarioxylon resinosum* TORRES and BIRO-BAG., 1986)		
(=*Araucarioxylon pluriresinosum* TOR. and BIRO-BAG., 1986)		
(=*Araucarioxylon chilense* NISHIDA, 1970)		
Araucarioxylon pichasquense TORRES and RALLO (1981)	+	+
(=*Araucarioxylon arayai* TORRES *et al.*, 1982)		
Cupressinoxylon parenchymatosum TORRES (1984)	–	–
Phyllocladoxylon antarcticum GOTHAN (1908)	+	–
Podocarpoxylon aparenchymatosum GOTHAN (1908)	–	–
Laurinoxylon uniseriatum GOTHAN (1908)	+	–
(=*Nothofagoxylon boureaui* SALARD, 1961)		
(=*Salicinoxylon serrae* TORRES *et al.*, 1981)		
Nothofagoxylon scalariforme GOTHAN (1908)	+	–
Nothofagoxylon antarcticum TORRES (1984)	+	–
Nothofagoxylon ohzuanum NISHIDA *et al.* (1987)	+	–
(=*Laurinoxylon* sp. GOTHAN's species, 1908)		

Chilean workers (TORRES, 1981, 1984a, b; TORRES and RALLO, 1981; TORRES and GODY, 1982; TORRES and BIRO-BAGOCZKY, 1986; TORRES *et al.*, 1981, 1982, 1984). These fossil woods appear to have been compared with the living species mainly based on WAGEMANN's work, leaving some problems concerning their identification.

Recently a large amount of fossil woods have been accumulated at the senior author's laboratory by several Botanical Expeditions to Chile financed by a Grant-in-Aid for Overseas Scientific Survey from the Ministry of Education, Science and Culture of Japan. In those expeditions, wood specimens of major species of living Chilean trees have also been collected for the comparison with the fossils. The anatomy of these living woods has already been published (RANCUSI *et al.*, 1987), allowing us to more correctly identify Tertiary woods of Chile (NISHIDA, 1984a, b, c, d; NISHIDA and NISHIDA, 1987; NISHIDA *et al.*, 1987, 1988a, b, 1990). More than fifteen fossil species have been described by these works. In this paper we try to compare the fossil woods hitherto known from Patagonia and Antarctica (Table 1).

2. Comparison of the Petrified Woods from Antarctica and Patagonia

As far as we know, nine species of the petrified woods are known from the Cretaceous and Tertiary of Antarctica. Of these, seven species are comparable to the Patagonian species (Table 1).

Araucarioxylon (*Dadoxylon*) *pseudoparenchymatosum* GOTHAN (1908) from the Upper Cretaceous of Seymour Island is a synonym of *A. doeringii* CONWENTZ (1885) from both Patagonia and Central Chile (NISHIDA *et al.*, 1990).

Araucarioxylon arayai TORRES *et al.* (1982) from the Lower Cretaceous of Livingstone Island is also reported from the Tertiary of Quiriquina Island near Concepción, Central Chile and from the Upper Cretaceous of Chile Chico, Patagonia and is a synonym of *A. pichasquense* TORRES and RALLO (1981) from the Upper Cretaceous of Pichasca, near Ovalle, Central Chile (NISHIDA *et al.*, 1990).

Cupressinoxylon parenchymatosum TORRES (1984a) from Rey Jorge Island somewhat resembles *Taxodioxylon pseudocompressum* NISHIDA and NISHIDA (1987) from the Upper Cretaceous of Quiriquina Island in general structure, especially in having abundant wood parenchyma which are arranged in more or less tangential rows, but differs from the latter in having 2–4 pits in the cross field instead of single in the latter.

Nothofagoxylon boureaui SALARD (1961) from Cerro Dorotea, Ultima Esperanza, Chile and *Salicinoxylon serrae* TORRES *et al.* (1981) from Chiloe Island are synonyms of *Laurinoxylon uniseriatum* GOTHAN (1908) from Seymour Island and from Santa Cruz, Argentina (NISHIDA *et al.*, 1988a, b).

Laurinoxylon sp. (GOTHAN, 1908) from Seymour Island seems to be a synonym of *Nothofagoxylon ohzuanum* NISHIDA *et al.* (1987) from the Tertiary of Cerro Dorotea, Ultima Esperanza.

Nothofagoxylon antarcticum TORRES (1984b) and *Nothofagoxylon scalariforme* GOTHAN (1908) were newly found by us from Cerro Dorotea as described below.

Of ten species of petrified woods from the Cretaceous and Tertiary of Antarctica, seven species are common to those from Patagonia and Central Chile. DUSÉN (1908) described 15 genera of seed plant leaves from the Tertiary of Seymour Island and 7 of them are extant in Patagonia; *i.e.*, *Caldcluvia*, *Laurelia*, *Drimys*, *Lomatia*, *Nothofagus*, *Myrica* and *Araucaria*. This suggests a possible discovery of Patagonian fossil species in Antarctica in the future.

Two new species from the Tertiary of Cerro Dorotea, Ultima Esperanza, described below are also expected to occur in Antarctica.

3. Taxonomic Treatment

Gomortegoxylon patagonicum gen. et sp. nov.
(Fig. 1, Plates 1, 2A, B)

Material: Specimen no. 797741 (holotype) is a small fragment of secondary wood, 6×4×4.5 cm in dimensions. The specimen is rather good in preservation.

Description: Growth rings discernible by 1–8 layers of radially compressed wood fibers and decreasing pore sizes, 1580–2220 μm, average 2112 μm in width. Wood diffuse porous; pores scattered evenly throughout the increment, 76–163, average 118, pores per square mm, usually solitary (88.0%), 2–3 in multiple (3.0%), in couple (7.7%) or rarely in cluster (1.2%), circular to elliptical in outline in cross section, 20–52 μm, average 32 μm, in tangential and 20–74 μm, average 42 μm, in radial diameters. Vessel segment length unmeasurable; end walls steeply inclined and elliptical in outline; perforation plates scalariform bearing 10–30, rarely up to 68, cross bars, and sometimes more or less inclined to make reticulate perforation. Intervessel pits usually scalariform, sometimes elongate-elliptical and oppositely arranged, 4–26 μm and 2–4 μm in horizontal and vertical dimensions respectively; pits apertures elliptical or slit-like; tyloses not abundant; lacking spiral thickenings.

Wood fibers filled among vessels and rays, comprising ground tissues, 12–34 μm × 8–22 μm in radial and tangential diameters in the early wood, 4–10 μm × 8–20 μm in the late wood, and sometimes regularly arranged in radial rows; walls 2–8 μm in thickness; not septate.

Wood parenchyma not clearly discernible in cross section, but probably apotracheal and diffuse.

Rays 4–11, average 7, in number per 1 mm, heterogeneous, types I A and II B of Kribs, uni- (30.8%), bi- (15.7%), tri- (35.1%) and quadriseriate (18.5%). Uniseriate rays usually 1–9 cells or 67–380 μm, rarely up to 12 cells or 618 μm in height. Multiseriate rays 5–34 cells or 160–820 μm in height, often bearing uniseriate wings, usually less than 4 cells (79.8%), sometimes 4–6 cells (16.2%), rarely up to 13 cells (4.1%) in height. Rarely two rays are fused to make a fused ray which is up to 38 cells or 1007 μm in height. Uniseriate portions of rays consist usually of upright and square cells, 40–100 μm in height, 8–20 μm in width and 12–24 μm in length. Multiseriate portions of rays consist of procumbent cells only, 12–24 μm in height, 4–10 μm in width and 34–206 μm in length. Ray-vessel pits scalariform or sometimes oppositely arranged elliptical or oval, 4–26 μm in horizontal and 2–8 μm in vertical dimensions. Ray cells of uniseriate portion sometimes contain yellowish globular contents.

Affinity: The specimen is characteristic in having diffuse porous wood, scalariform performation plates with numerous cross bars, scalariform intervessel pittings, scalariform ray-vessel pits and multiseriate rays usually bearing low uniseriate wings which are usually less than 4, but rarely up to 13, cells high.

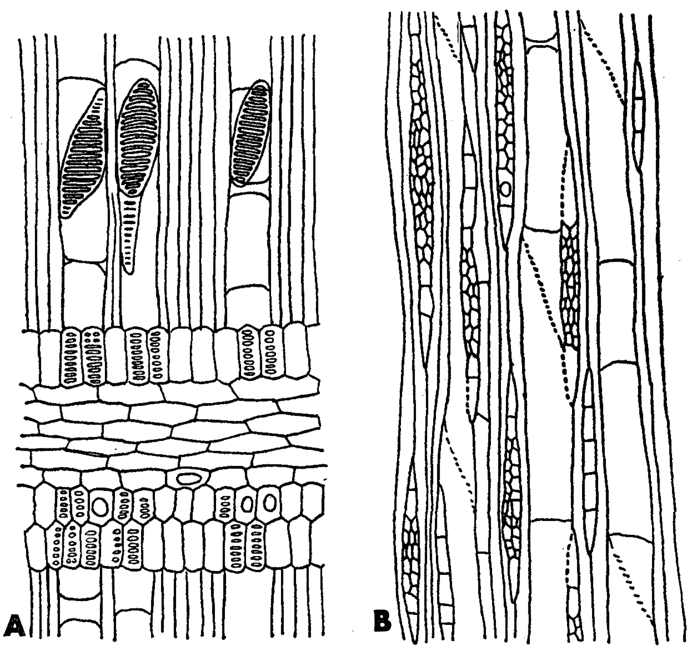

Fig. 1. Semi-diagrammatic figure of Gomortegoxylon patagonicum *sp. nov. A: Radial section showing scalariform perforation plates and scalariform and elliptical ray-vessel pits. B: Tangential section exhibiting uniseriate and multiseriate rays with low margins, and profile of scalariform perforation plates.*

In Patagonia and the region nearby, there are six extant genera comparable to the specimen; they are, *Gomortega* of the Gomortegaceae, *Laurelia* of the Monimiaceae, *Caldcluvia* and *Weinmannia* of the Cunoniaceae, *Myrceugenella* of the Myrtaceae and *Aextoxicon* of the Aextoxicaceae (RANCUSI *et al.*, 1987). The latter two genera, however, resemble our specimen to a lesser extent than the others in having usually high wings, up to 9–24 cells high in multiseriate rays and higher fused rays, up to 2000–5000 μm in height. The former four genera are more or less similar to our specimen in gross morphology. *Laurelia*, however, is distinguished from our specimen in lacking high wings of multiseriate rays, less than 5 cells high. Two genera of the Cunoniaceae differ from the specimen in having higher percentages of uniseriate rays, more than 75% instead of 30%. The species with diagnostic characters most closely comparable to our specimen is *Gomortega keule* JOHN (RANCUSI *et al.*, 1987). The specimen differs from *G. keule* in the number of cross bars of the perforation plate and the width and height of rays. The cross bars of the specimen are counted up to 60, while those of *G. keule* are less than 17. The rays of the specimen are usually tri- or quadriseriate attaining to 34 cells high, but *G. keule* often has biseriate rays less than 20 cells high. *G. keule* is also characteristic in having oil bodies in some ray cells. Instead, our specimen has yellowish globular content in some ray cells. The specimen lacks oil bodies, though some ray cells have yellowish globular bodies.

Laurelites doroteaensis NISHIDA *et al.* (1988a) from the same locality and horizon as of the specimen resembles our specimen in having dominantly solitary pores, scalariform perforation plates bearing numerous cross bars, scalariform intervessel pittings, scalariform ray-vessel pits and multiseriate rays bearing low wings. Its pore density, however, is 495–676 per square mm which is higher than that of our specimen. The height of ray wings of *L. doroteaensis* is less than 6 cells and is lower than that of the specimen which is 13 cells high. Our specimen is also distinguishable from *L. doroteaensis* in having globular content in some ray cells. *Aextoxicoxylon harambouri* NISHIDA *et al.* (1988a) and *Myrceugenellites maytenoides* NISHIDA *et al.* (1988a) both from Cerro Dorotea also resemble our specimen in general structure, especially in having high pore density and the fused rays consisting of two or more rays vertically fused with uniseriate wings. Our specimen, however, differs from *Aextoxicoxylon harambouri* in having lower fused rays, less than 1500 μm in height instead of up to 5000 μm in the latter. The specimen also differs from *Myrceugenellites maytenoides* in having scalariform ray-vessel pits instead of circular pits of the latter. Our specimen seems to belong to *Gomortega* or related genera.

Diagnosis of the genus Gomortegoxylon: Wood diffuse porous. Pores 76–163 per square mm, mostly solitary or 2–3 in multiple arranged in radial series. Intervessel pittings scalariform or oppositely arranged elliptical. Perforation plates scalariform bearing 10–68 cross bars. Tyloses not so abundant. Wood parenchyma apotracheal and diffuse. Ray heterogeneous, types I and II A of Kribs, usually bi- to quadriseriate, sometimes uniseriate. Multiseriate rays bearing uniseriate wings, usually 2–3, and rarely up to 13 cells high. Ray-vessel pits scalariform or oppositely arranged elliptical. Globular content in ray cells of uniseriate portions.

Locality: Cerro Dorotea, Ultima Esperanza, Chile.

Horizon: Tertiary; Mina Chilena Formation (Late Oligocene–Early Miocene).

Doroteoxylon vicente-perezii gen. et sp. nov.
(Fig. 2, Plates 2C, D, 3)

Material: Specimen no. 797848 (holotype) is a piece of secondary wood, 12×9 ×4 cm in dimensions. The specimen could be examined its histology, though it is not so well in preservation.

Description: Growth rings visible, 840–4440 μm, average 2371 μm, in width, delineated by their ring porosity. Three or four tangential rows of pores form a porous zone in the early wood. Pores sometimes inclined to be arranged in more or less tangential rows in the late wood, 67–210 μm, average 133 μm, in tangential and 95–285 μm, average 190 μm, in radial diameters, and scattered in low density, 16–21, average 18.8, per square mm in the early wood, 38–133 μm, average 95 μm, in tangential and 57–209 μm, average 133 μm, in radial diameters and 8–17, average 11.1, per square mm in the late wood. Much smaller pores arranged in cluster in the outer marginal portions of growth rings. Pores mostly solitary (78%), sometimes 2–3 in multiple (15%) and coupled (7%) in porous zones and usually solitary (51%), in cluster (40%), rarely 2–3 in multiple (7%) and coupled (1%) in the late wood; circular or elliptical in outline in cross section. Vessel segments short, 143–285 μm, average 223 μm, in length, bearing almost horizontal or slightly oblique end walls. Perforation plates simple; intervessel pits circular or hexagonal in outline and alternately arranged, generally 5–7 μm in diameter; pits apertures narrow elliptical or horizontally elongated slit. Tyloses abundant. Spiral thickenings present.

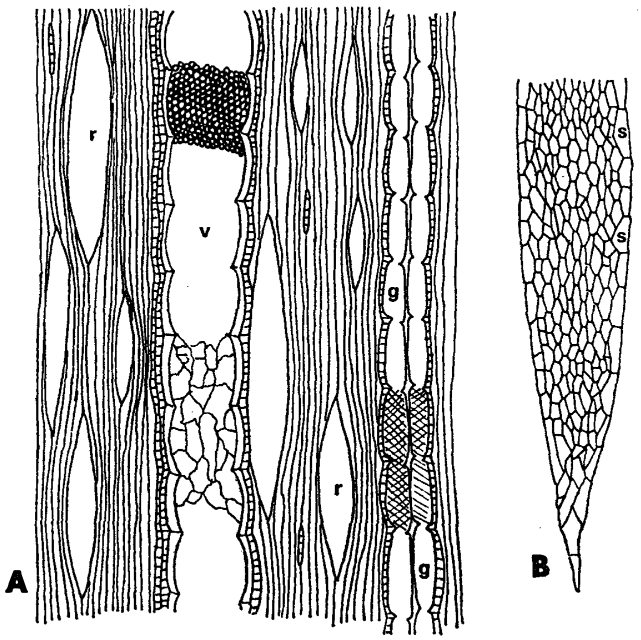

Fig. 2. Semi-diagrammatic figures of Doroteoxylon vicente-perezii *sp. nov. A: Tangential section showing fusiform rays (r), short vessel segments (v) and grouped vessels (g). Vessels with alternately arranged circular pits and tyloses are seen in the center. B: A part of a broad ray (magnified); showing seath cells (s) along the periphery of the ray.*

Wood fibers abundant, comprising the ground tissue of the wood, 10–19 μm in tangential and 10–24 μm in radial dimensions. Wood parenchyma vasicentric and surround vessels, 10–31 μm in diameter.

Rays heterogeneous or homogeneous, mostly multiseriate, 2–3 (26%), 4–10 (47.3%), and 10–17 (11.7%) cells wide, and sometimes uniseriate (15%). Rays of 4–17 cells wide often have sheath cells on their peripheries. Uniseriate rays 8–22 cells or 29–770 μm in height, bi- or triseriate rays 95–219 μm in height and 10–38 μm in width; 4–17 cells wide rays 143–1321 μm in height and 19–96 μm in width, bearing low uniseriate wings up to 2–3 cells high. Uni-, bi- and triseriate rays consist of square, upright and sometimes procumbent cells. Inner part of 4–17 cells wide rays consists of procumbent cells and sheath cells of square and upright cells. Upright and square cells are 22–53 μm in height, 7–22 μm in width and 14–55 μm in length. Procumbent cells 10–26 μm in height, 5–14 μm in width and unmeasurable in length. Ray-vessel pits circular to elliptical, 4–10 μm in horizontal and 2–6 μm in vertical dimensions and alternately arranged.

Affinity: Our specimen exhibits following diagnostic characters: Ring porous wood; inclined pores arranged in tangential rows; short vessel segments, 140–190 μm long, with horizontal or slightly oblique end walls bearing simple perforation plates and with spiral thickenings; high percentage of multiseriate rays, attaining to 17 cells wide, with sheath cells; vasicentric wood parenchyma; spiral thickenings. Some of these characteristics, such as ring porous wood, multiseriate rays with sheath cells and spiral thickenings of vessels occur in *Gevuina*, *Embothrium* and *Lomatia* in the Proteaceae. Three genera of the Proteaceae are distributed in Patagonia.

These have higher rays exceeding 3000 μm in height and thin vessels arranged in several tangential bands along the increments.

The specimen exhibits the characteristics that occur in some of both temperate and tropical species of the Proteaceae; namely, it exhibits pores arranged in more or less tangentially in the late wood and large solitary pores scattered in the early wood. Of other species of the Proteaceae, one of the tropical species, *Grevillea papuana* DIELS, more closely resembles the specimen in having large solitary pores in low density, spiral thickenings of vessels and sheath cells in broader rays. The former, however, differs from the latter in having diffuse porous wood and higher rays.

Proteoxylon chargeense KRÄUSEL (1939) from the Cretaceous of Egypt also resembles our specimen in having tangentially arranged pores aggregated in bow-shape between broad rays, but differs from the specimen in having diffuse porous wood and tangentially arranged large secretory canals.

Celtis sinensis PERS. of the Ulmaceae somewhat resembles our specimen in having ring porous wood, thin pores in cluster in the outer margins of the growth rings, sheath cells in broad rays and vasicentric parenchyma. *Celtis sinensis*, however, differs from the specimen in having thinner vessels arranged in tangential of obliquely inclined bands, that is, so-called ulmiform arrangement and abundant crystals in the ray cells and wood parenchyma. Some species of *Morus* of the Moraceae also resemble the specimen in pore arrangement and in the presence of short vessel segments, vessels with spiral thickenings, alternate intervessel pittings and abundant tyloses, broad rays, and vasicentric parenchyma. The sheath cells that occur in the broad rays of the specimen are absent in *Morus*. *Gleditschia* of the Leguminosae also resembles the specimen in general structure, especially in having sheath cells, but differs from the specimen in having aliform wood parenchyma and septum-like tyloses.

The true affinity of the specimen remains uncertain until making more precise comparison with extant species possible. The generic name is based on the fossil locality and the specific epithet is dedicated to Mr. Vicente Perez D'ANGELLO, ENAP in Punta Arenas, who helped us in the field survey in Magallanes, Ultima Esperanza and Fuego Island.

Diagnosis of the genus Doroteoxylon: Wood ring porous. Pores moslty solitary, 16–21 per square mm in the early wood, or solitary and in cluster, 8–17 per square mm in the late wood. Vessel segments short less than 300 μm in length, with horizontal or slightly oblique end walls. Perforation plate simple; intervessel pittings alternately arranged circular or hexagonal; tyloses abundant; spiral thickenings present. Wood parenchyma vasicentric and surround vessels. Rays 1–17 cells wide; sheath cells on the peripheries of broad rays. Ray-vessel pits elliptical and arranged alternately.

Locality: Cerro Dorotea, Ultima Esperanza, Chile.

Horizon: Tertiary; Mina Chilena Formation (Late Oligocene–Early Miocene).

Nothofagoxylon antarcticum (originally *antarcticus*) TORRES,
Mem. III Congr. Latino-amer. Paleontol., p. 558 (1984a).
Ser. Cient. INACHI, **31**, 41 (1984b).

Materials: Specimens nos. 797701, 797703, 797709, 797734, 797748, 797750 and 797850 are small, well-preserved fragments of the secondary wood.

Notes: Growth rings invisible. Wood diffuse porous; pores scattered evenly throughout the increment; 16–33, average 23, per square mm, usually solitary (68.2%) or 2 (21.6%), 3 (4.0%), rarely 4 (1.2%) in multiples in radial series and rarely in couple or in cluster (5.0%), elliptical in outline in cross section, 31–170 μm, average 95 μm, in tangential and 41–259 μm, average 128 μm, in radial diameters. Vessel segment length unmeasurable; simple perforation plates; intervessel pits elliptical, oppositely arranged, rarely scalariform in thin vessels, 7–24 μm and 5–7 μm in horizontal and vertical dimensions respectively; pit apertures slit-like; lacking spiral thickenings and crystals; septum-like tyloses abundant.

Wood fibers filled among vessels and rays, comprising ground tissues, polygonal or rectangular in cross section, 12–38 μm $\times$ 10–33 μm in radial and tangential diameters, sometimes regularly arranged in radial rows; walls thin, 2–4 μm thick; non-septate. Wood parenchyma not clearly discernible in cross section but discernible in radial and tangential sections, apotracheal and diffuse.

Rays 3–11, average 7 in number per 1 mm, heterogeneous, type II B of Kribs, usually uniseriate (75.6%) and sometimes partially biseriate (24.4%). Uniseriate rays 1–18 cells or 105–1159 μm in height, partially biseriate rays 3–18 cells or 162–1093 μm in height, 22–62 μm in width. Uniseriate rays consisting of upright, square and sometimes procumbent cells; biseriate portions of rays consisting of only procumbent cells. Upright cells and square cells 57–149 μm in height, 17–41 μm in width and 24–84 μm in length. Procumbent cells 31–79 μm in height, 11–31 μm in width and 70–173 μm in length. Ray-vessel pits simple, scalariform or often oppositely arranged, horizontally elongated elliptical or oval, 6–65 μm in horizontal and 5–10 μm in vertical dimensions. Lacking crystals in ray cells.

Affinity: The specimens belong to *Nothofagoxylon* in having following diagnostic characters: Diffuse porous wood, solitary pores, 2–4 in multiple in radial series; simple perforation plates; heterogeneous, uni- and biseriate rays; abundant tyloses in vessel segments and apotracheal, diffuse wood parenchyma. The specimens are also characterized by oppositely arranged, circular intervessel pittings, scalariform to circular ray-vessel pits, dominant uniseriate rays (75%) and low pore density, 16–33 pores per square mm. Among the species of *Nothofagoxylon* reported from the Cretaceous–Tertiary of Patagonia and Antarctica, *N. kraeuseli* BOUREAU and SALARD, *N. scalariforme* GOTHAN and *N. ruei* SALARD are comparable to our specimens, especially in having either scalariform ray-vessel pits or uni- and biseriate rays. *Nothofagoxylon kraeuseli* differs from the specimens in having a larger amount of biseriate rays (*ca.* 45%) and rarely triseriate rays instead of chiefly uniseriate rays (75%). *Nothofagoxylon scalariforme* GOTHAN (1908) from the Cretaceous of Antarctica and from the Tertiary of Chilean Patagonia (KRÄUSEL, 1925) is distinguished from the specimens in having scalariform intervessel pittings and exclusively scalariform ray-vessel pits instead of circular intervessel pittings and often circular ray-vessel pits. *Nothofagoxylon ruei* SALARD (1961) from the same locality and horizon as of our specimens is more similar to the latter than to the other two species of *Nothofagoxylon* compared above. They are common in having uniseriate and sometimes biseriate rays. *Nothofagoxylon ruei* differs from the specimen in the absence of scalariform ray-vessel pits. This species was, however, transferred to *Laurinoxylon* by NISHIDA *et al.* (1988b). The specimens are also distinguishable from the species mentioned above in the pore density which is 16–33 per square mm in the specimens instead of 60–200. Our specimens exhibit diagnostic characters similar to those of *Nothofagoxylon antarcticum* TORRES (1984) from the Tertiary of Rey Jorge Island, Antarctica. Our specimens, however, have pore density lower than that of the type specimen of *N. antarcticum.* The ray cells and vessel segments of the specimens are larger than those of the type specimen of *N. antarcticum.*

TORRES (1984a, b) compared *Nothofagoxylon antarcticum* with the extant species, *Nothofagus betuloides* OERST. *Nothofagus betuloides*, however, has rays exclusively uniseriate, mostly scalariform ray-vessel pits and scalariform intervessel pittings. In the living *Nothofagus* species, *N. pumilio* KRASS. and *N. nitida* KRASS. closely resemble *Nothofagoxylon antarcticum* in having chiefly circular intervessel pittings and scalariform to circular ray-vessel pits. *Nothofagus pumilio* resembles more *Nothofagoxylon antarcticum* than does *N. nitida* in lacking crystals in the ray cells and in wood parenchyma. *N. nitida* has crystals like *N. betuloides.* Thus we think *Nothofagoxylon antarcticum* most resembles *Nothofagus pumilio* within extant species of *Nothofagus.*

Locality: Cerro Dorotea, Ultima Esperanza, Chile.

Horizon: Tertiary; Mina Chilena Formation (Late Oligocene–Early Miocene).

Distribution: Antarctica and Patagonia. New to Patagonia.

Nothofagoxylon scalariforme GOTHAN
O. NORDENSKJÖLD (ed.), Wiss. Ergebn. Schwed.

Südpol. Exped. 1901–1903, **3**, 20 (1908).
KRÄUSEL, R., Arch. Bot. Sven. Vetensk., **19**, 19 (1925).

Material: Specimen no. 797754 is a small fragment of the secondary wood, 4×4 ×3 cm in dimensions and able to examined its histology, though it is comparatively ill-preserved.

Notes: Growth rings invisible. Wood diffuse porous; pores scattered evenly throughout the wood, 73–140, average 107 per square mm, usually solitary (64.7%) or 2 (24.2%), 3 (4.9%) rarely up to 4–5 (1.6%) in multiple in radial series and rarely in couple or in cluster (4.6%), elliptical to circular in outline in cross section, 22–67 μm, average 41 μm in tangential and 24–98 μm, average 58 μm, in radial diameters. Vessel segments unmeasurable, simple perforation plates. Intervessel pittings mostly scalariform, sometimes oppositely arranged elongate-elliptical, 10–70 μm and 3–6 in horizontal and vertical dimensions respectively; pit apertures slit-like; spiral thickening absent; tyloses abundant.

Wood fibers filled among vessels and rays, comprising ground tissues, polygonal or rectangular in cross section, 10–26 μm × 10–30 μm in radial and tangential diameters, sometimes regularly arranged in radial rows; walls 2–6 μm thick; septate. Wood parenchyma apotracheal and diffuse.

Rays 12–20, average 16.5 in number per 1 mm, heterogeneous, type II B of Kribs, usually uni- (55.0%), bi- (42.6%) and unexpectedly triseriate (2.3%). Uniseriate rays 2–29 cells or 86–694 μm in height, multiseriate rays 5–33 cells or 133–884 μm in height. Biseriate rays 12–34 μm and triseriate 26–50 μm in width. Uniseriate rays and uniseriate portions of multiseriate rays consist of upright, square and often procumbent cells. Multiseriate portions consist of only procumbent cells. Upright cells and square cells 24–53 μm in height, 7–22 μm in width and 14–36 μm in length. Procumbent cells 22–26 μm in height, 7–24 μm in width and 36–84 μm in length. Ray-vessel pits simple, scalariform or rarely oppositely arranged, horizontally elongated elliptical or oval, 6–26 μm in horizontal and 2–4 μm in vertical dimensions. Crystals not discernible in both ray cells and wood parenchyma.

Affinity: The diagnostic characters of our specimen are similar to those of *Nothofagoxylon scalariforme* GOTHAN (1908) from the Upper Cretaceous of Seymour Island, Antarctica and from the Tertiary of southern Patagonia (KRÄUSEL, 1925), especially in having silitary pores or 2–5 pores in multiple in radial series, uni- and biseriate rays, scalariform intervessel pittings and scalariform ray-vessel pits. The specimen somewhat differs from the type specimen of *N. scalariforme* in the presence of triseriate rays. *Nothofagoxylon ohzuanum* NISHIDA *et al.* (1987) from the same locality and horizon as of the specimen sometimes exhibits scalariform intervessel pittings and scalariform ray-vessel pits. It differs from the specimen in having high fused rays consisting of two or three vertically fused rays, up to 2200 μm in height. *Nothofagoxylon antarcticum* TORRES (1984a, b) from the Tertiary of Rey Jorge Island, Antarctica and also from the same locality and horizon as of the specimen closely resembles the specimen in general structure, especially in having scalariform ray-vessel pits, but differs from the latter in having larger size of pores and lower pore density, usually elliptical or circular intervessel pittings and often elliptical to circular ray-vessel pits. *Nothofagoxylon kraeuseli* BOUREAU and SALARD (1960) from the same locality and horizon as of the specimen is similar to the specimen in having uni- to triseriate rays, but is distinguishable from the latter in having exclusively elliptical to circular intervessel pitting and higher pore density.

Our specimen can be identified with *N. scalariforme*, though it rarely has triseriate rays which do not occur in the type specimen.

N. scalariforme is reported by KRÄUSEL (1925) from the Tertiary of Cerro Prat, Magallanes, Chile. He described that it had scalariform intervessel pittings and crystals in the ray cells without mentioning the features of ray-vessel pits. There is a little difficulty, therefore, in correctly identifying KRÄUSEL's specimen from Cerro Prat with *N. scalariforme*. This report may be the first reccrd of *N. scalariforme* in South American Continent.

Locality: Cerro Dorotea, Ultima Esperanza, Chile.

Horizon: Tertiary; Mina Chilena Formation (Late Oligocene–Early Miocene).

Distribution: Antarctica and Patagonia. New to Ultima Esperanza.

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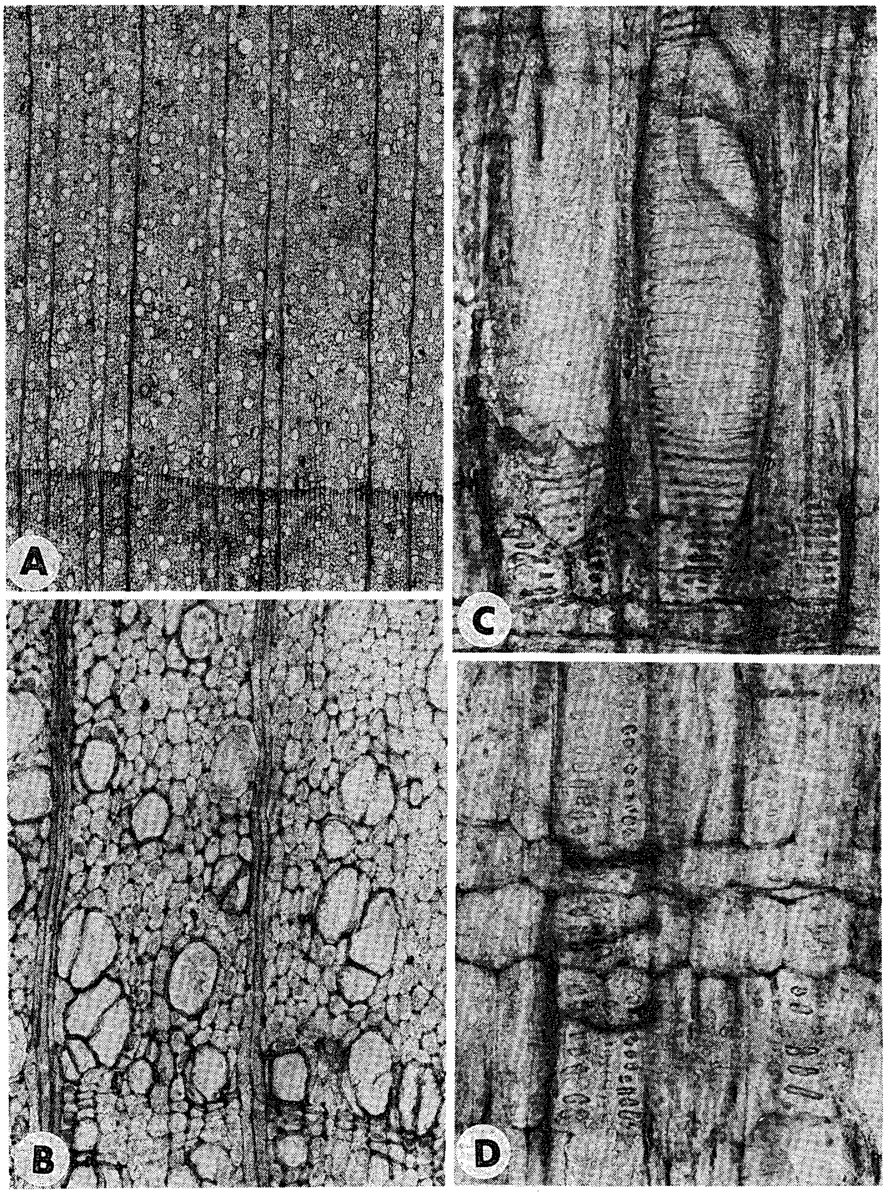

Plate 1. Gomortegoxylon patagonicum *sp. nov.*
A and B: Cross sections showing diffuse porous wood. C and D: Radial sections showing scalariform perforation plate (in C), scalariform and circular intervessel pittings (in D) and scalariform ray-vessel pits (in C and D). A: ×39, B: ×195, C and D: ×390.

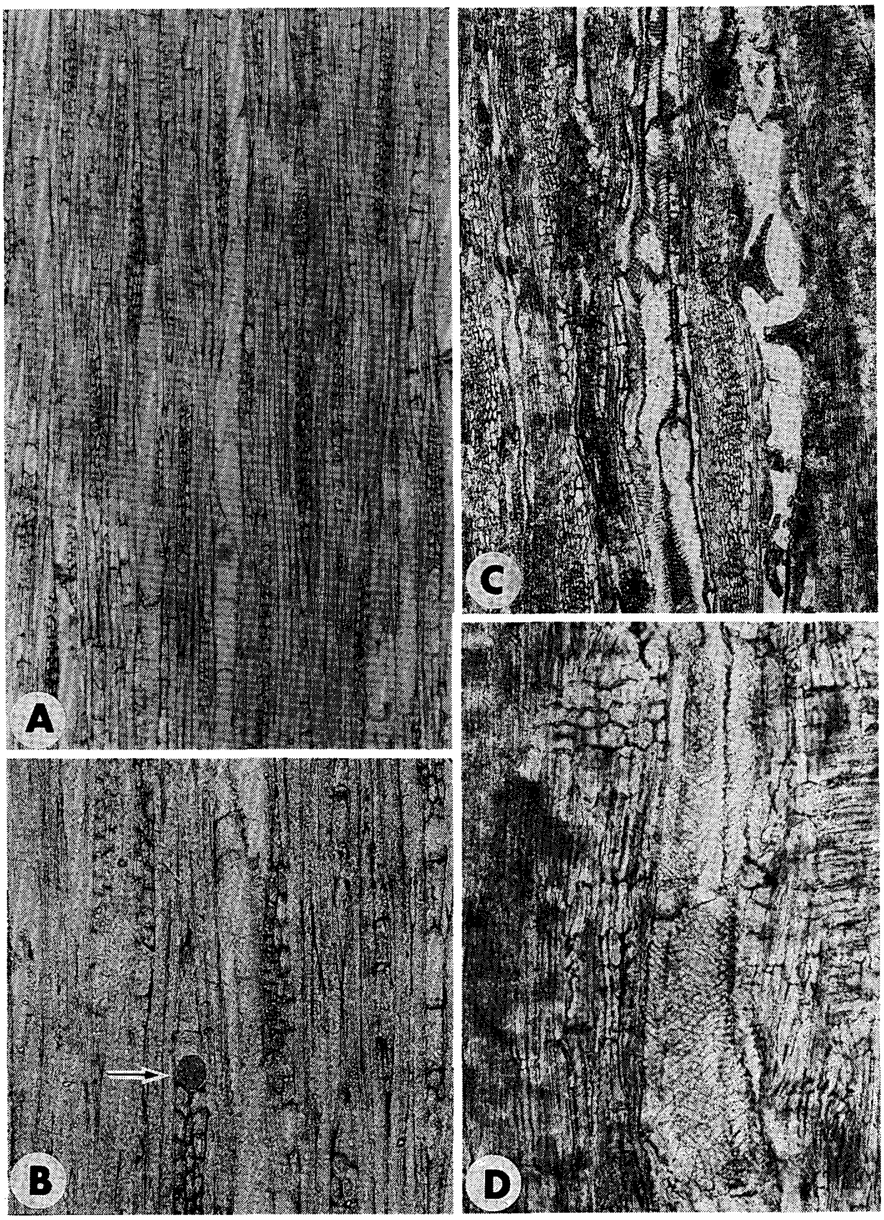

Plate 2. Gomortegoxylon patagonicum *sp. nov.* (*A and B*) *and* Doroteoxylon vicente-perezii *sp. nov.* (*C and D*).
A and B: Tangential sections showing multiseriate rays with low margins. A globose content (arrow) in a ray cell is seen in B. C: Tangential sections showing multiseriate rays bearing sheath cells. Spiral thickenings on vessels are seen in the central part. D: Radial section showing spiral thickenings on a vessel at the middle part. A: ×95, B and C: ×195, D: ×390.

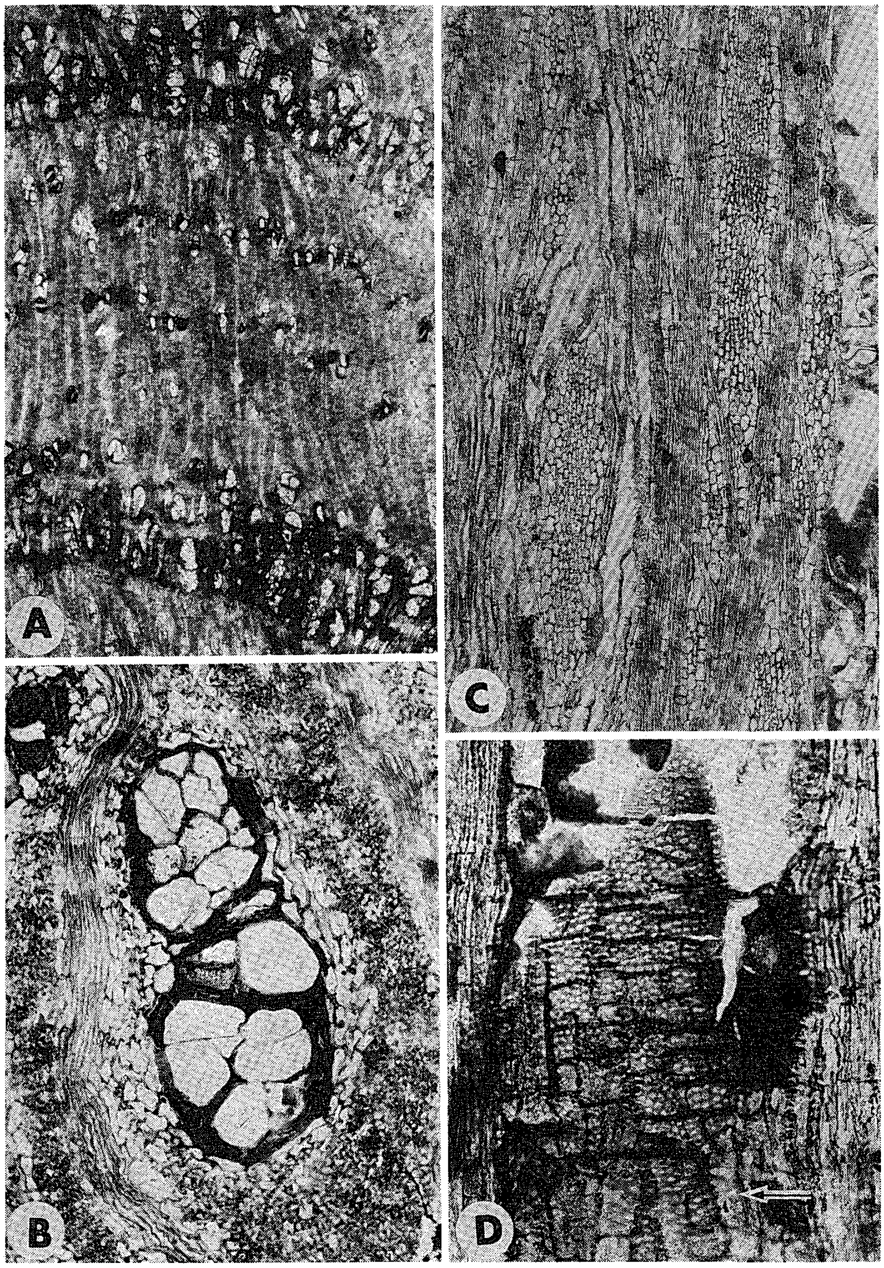

Plate 3. Doroteoxylon vicente-perezii *sp. nov.*
A and B: Cross sections. Ring porous arrangement of vessels are seen in A. B: Pores in multiple, bearing vasicentric wood parenchyma. C: Tangential section showing multitseriate spindle-form rays bearing sheath cells. D: Radial section showing elliptical ray-vessel pits (arrow) and circular inter-ray cells pits. A: ×39, B: ×195, C: ×95, D: ×390.