AMEGHINIANA
A GONDWANAN PALEONTOLOGICAL JOURNAL

Submitted: August 28th, 2019 – **Accepted**: January 8th, 2020 – **Published online**: February 13th, 2020

To link and cite this article:

doi: 10.5710/AMGH.08.01.2020.3287

REVISION OF FRENGUELLI'S (1941) PATAGONIAN ANGIOSPERM FOSSIL LEAF COLLECTION WITH COMMENTS ON THE ORIGINAL LOCALITIES (EOCENE–MIOCENE)

NICOLÁS A. CAVIGLIA and ROBERTO R. PUJANA

Nicolás A. Caviglia [*nicocavi09@gmail.com*], Museo Argentino de Ciencias Naturales.- CONICET; Av. Ángel Gallardo 470 - C1405DJR - Buenos Aires – Argentina

Roberto R. Pujana [*rpujana@gmail.com*], Museo Argentino de Ciencias Naturales.- CONICET; Av. Ángel Gallardo 470 - C1405DJR - Buenos Aires – Argentina.

55 pages, 8 figures, 1 table y 1 appendix

Propuesta para el cabezal: ANGIOSPERM FOSSIL LEAVES FROM PATAGONIA

Abstract. Frenguelli (1941) described a fossil leaf assemblage of 36 taxonomic units (9 gymnosperms and 27 angiosperms) collected from ten localities in southwestern Patagonia. Frenguelli's article has two limitations according to present day standards: 1) most of the material was neither described nor illustrated; 2) the fossiliferous localities were not associated to any formal stratigraphic unit. A revision of the fossiliferous outcrops and of the descriptions and systematics of the angiosperm taxa of this collection was made. The original fossiliferous localities were explored and included into three formal stratigraphic units: Río Turbio, Río Guillermo and Río Leona formations. We recognized 27 taxa: 7 were assigned to known fossil-species, 18 were kept in open nomenclature and the other two were synonymized to another genus. In addition, new paleofloristic information of each unit was reported: in the Río Turbio Formation the first record of the Salicaceae (*Thouinia philippii*?) was recorded; in the Río Guillermo Formation it was reported the first record of the Grossulariaceae, Lauraceae and Salicaceae; and in the Río Leona Formation *Nothofagus variabilis* and *Escalloniiyphyllum* sp. were described for the first time.

Keywords. Patagonia, Paleogene, Paleoflora, Río Turbio Formation, Río Guillermo Formation, Río Leona Formation.

Resumen. REVISIÓN DE LA COLECCIÓN DE HOJAS DE ANGIOSPERMAS FÓSILES DE PATAGONIA DE FRENGUELLI (1941) CON COMENTARIOS SOBRE LAS LOCALIDADES ORIGINALES (EOCENO–MIOCENO). Frenguelli (1941) describió un conjunto de hojas fósiles, recolectadas en diez localidades en el suroeste de la Patagonia, donde identificó 36 unidades taxonómicas (9 gimnospermas y 27 angiospermas). Sin embargo, el artículo de Frenguelli presenta principalmente dos problemas: 1) la mayor parte del material no se describió ni se ilustró; 2) las localidades fosilíferas no estaban asociadas a ninguna unidad estratigráfica formal. Por lo tanto, se realizó una revisión de los afloramientos fosilíferos y de las descripciones y sistemática de los taxones de angiospermas de esta

colección. Las localidades fosilíferas originales fueron exploradas e incluidas en tres unidades estratigráficas formales: las formaciones de Río Turbio, Río Guillermo y Río Leona. Se reconocieron 27 taxones: 7 fueron asignados a especies fósiles conocidas, 18 se mantuvieron en nomenclatura abierta y los otros dos fueron sinonimizados a otro género. Este estudio proporcionó nueva información paleoflorística a las tres unidades nombradas: en las formaciones Río Turbio y Río Guillermo se reportó el primer registro de Salicaceae (*Thouinia philippii*?) y Grossulariaceae, Lauraceae y Salicaceae, respectivamente; y en la Formación Río Leona *Nothofagus variabilis* y *Escalloniiyphyllum* sp. fueron descritos por primera vez.

Palabras clave. Patagonia, Paleógeno, Paleoflora, Formación Río Turbio Formation, Formación Río Guillermo, Formación Río Leona.

CENOZOIC Patagonian leaf floras experienced several taxonomic turnovers and they were particularly influenced by the climate changes, marine transgressions and Andean uplift (Barreda and Palazzesi, 2007). Many fossil leaves from this region were described during the first half of the 20th century (Dusén, 1899; Berry, 1925, 1928, 1937, 1938; Fiori 1931, 1939, 1940). Some of these were never revised before, including those studied by Frenguelli (1941). In addition, the descriptions of those articles include terminology nowadays in disuse, and the illustrations lack the detail of current photographs. Hickey (1973) proposed the first Leaf Architecture Manual, where a linear terminology for descriptions was suggested in order to facilitate comparisons. Since then, some of the mentioned leaf megafloras were reviewed and/or studied again from new material from the same localities, but, in both cases, under this new methodology (e.g. Wilf *et al.*, 2003; Panti, 2014; Vento and Prámparo, 2018).

Frenguelli's (1941) leaf samples came from 10 localities from southwestern Patagonia, in Santa Cruz province, Argentina. A total of 36 impression/compression taxa (i.e. 9 gymnosperm and 27 angiosperm leaves) were reported by the author. However, he illustrated 19 of those fossil taxa, and provided descriptions of only 5. Moreover, some of the illustrations lack clear indications: for example, a rock piece that contains, according to the author, more than one type of leaf, is presented as a general image without indications of which leaf corresponds to each taxonomic unit (e.g., Frenguelli, 1941, p. 207, Plate V). Recently, Césari *et al.* (2015) described and illustrated one of the fossil-species of Frenguelli (1941): *Rubus primaverae* Frenguelli. Besides this, no further revision of the material was made.

In this manuscript a detailed revision of the angiosperm leaves published by Frenguelli (1941) is made. We include detailed descriptions and photographs of the samples. In addition, original geological and stratigraphic positions of the samples were reviewed (e.g. Malumián and Panza, 2000).

[Figure 1]

GEOLOGICAL SETTING

The Patagonian strata named by Frenguelli (1941) “estratos magellanianos” that crop out in southwestern Santa Cruz province, Argentina (Fig. 1), include sediments later referred to different geological formations (e.g. Malumián and Panza, 2000). These strata include Río Turbio (Eocene–Oligocene), Río Guillermo (Oligocene–Miocene) and Río Leona (Miocene) Formations (Fig. 2).

Río Turbio Formation

The Río Turbio Formation (Hünicken, 1955; Leanza, 1972; Nullo and Combina, 2002) is traditionally divided into lower and upper sections or members, and it is supported with an erosive discordance over the Cerro Dorotea Formation (Malumián and Caramés, 1997; Malumián and Panza, 2000). The evolution of both members represents a tidal system: the lower one with tidal channels and tidal platforms; and the upper with tidal channels, tidal delta and lagoon deposits (Malumián and Panza, 2000; Panti, 2010). Both members bear coal measures, and a glauconite bed at the base of the upper member is present (Malumián and Panza, 2000).

Based on paleontological information, the age proposed by most of the authors, following different proxies, for the Río Turbio Formation was Eocene (Malumián and Panza, 2000 and references therein). However, recent detritic zircon ages extend the deposition of the upper member up to the Oligocene (Fosdick *et al.*, 2015).

Fossil pollen grains from this stratigraphic unit were studied by Romero (1977), Romero and Zamaloa (1985), Romero and Castro (1986), Fernández *et al.* (2012), Fernández (2018); fossil leaves by Berry (1937), Hünicken (1955, 1967, 1995), Fernández *et al.* (2012),

Vento and Prámparo (2018), Panti (2010, 2014, in press); fossil woods by Ancíbor (1989, 1990), Brea (1993), Pujana (2008) and Pujana and Ruiz (2017, 2019).

Río Guillermo Formation

The Río Guillermo Formation (Leanza, 1972; Nullo and Combina, 2002) represents high energy fluvial systems. It is supported with an erosive discordance over the Río Turbio Formation with a thick conglomerate at the base (Malumián and Panza, 2000; Nullo and Combina, 2002). It is worth mentioning that Hünicken (1955) used the name "Río Guillermo strata" to include the nowadays formally defined Río Guillermo and Río Leona Formations which crop out in the surroundings of the Río Turbio city.

The age was usually considered Oligocene based on its stratigraphic position (Malumián and Panza, 2000; Vento *et al.*, 2016). According to recent zircon dating it extends up to the Oligocene–Miocene boundary (Fosdick *et al.*, 2011, 2015).

Fossil leaves from this stratigraphic unit were studied by Hünicken (1955, 1995), Panti (2011), Vento *et al.* (2016); fossil woods by Pujana (2008).

Río Leona Formation

The Río Leona Formation (Furqué and Camacho, 1972; Malumián and Panza, 2000; Nullo and Combina, 2002) includes the upper part of the "Río Guillermo strata" of Hünicken (1955). It crops out in southwestern Patagonia and represents continental deposition during the lower Miocene. Marenssi *et al.* (2005) have interpreted the paleoenvironment of the formation as representing different fluvial systems. The formation was supposed to have an Eocene–Miocene age based on different proxies (Malumián and Panza, 2000 and references therein; Barreda *et al.*, 2009; Malumián *et al.*, 2013). Recent isotopic ages indicate a lower Miocene age (Fosdick *et al.*, 2011, 2015).

Fossil pollen was studied by Barreda *et al.* (2009); fossil leaves by Césari *et al.* (2015); fossil woods by Pujana (2007, 2008, 2009a, b). In addition, fossil leaves and woods were reported in Chile by Torres *et al.* (2009, 2013) from outcrops assigned to this stratigraphic unit.

[Figure 2]

MATERIAL AND METHODS

Fossil specimens

The fossil leaves were collected by J. Brandmayr in the 1930s and studied by Frenguelli (1941). The collection contains 52 rock samples deposited in the Museo de La Plata (FCNyM), Buenos Aires province, Argentina, under the specimen numbers LPPB 4070–4121. They were assigned by Frenguelli (1941) to 9 gymnosperm and 27 angiosperm fossil leaf taxonomic units. Some of the fossil leaves were painted with varnish (e.g. Fig 6.1). Some of the fossils were originally documented as line drawings and photographs by Frenguelli (1941). The collection numbers, and the repository original book of the paleobotanical collection was checked and no discrepancies were found between it and Frenguelli (1941), although three specimens were not found (Appendix). The angiosperm leaves were described following the Manual of Leaf Architecture (Ellis *et al.*, 2009). However, some terminologies used such as those referring to vein course and relative thickness (gauge) of veins or divergence angle of secondaries were taken from Hickey (1973). The APG IV (2016) proposals for angiosperm classification were followed. For open nomenclature Bengston (1988) was followed.

158 The fossil leaves were observed and studied under binocular lens, where
159 microphotographs of the venation were taken. In addition, photographs with macro lens
160 (Canon 60D with macro EF 50 mm lens) were taken.

161 ***Origin of the fossil leaf collection***

162 Frenguelli (1941) mentioned that the fossils were collected in ten localities (Fig. 1): 1) one
163 kilometer southeast of Estancia (=Ea.) San José (*ca.* 51°32'34"S 72°21'50"W); 2) Río Turbio
164 valley between Ea. Primavera and Ea. Dorotea (*ca.* 51°31'36"S 72°14'11"W); 3) Ea.
165 Primavera (*ca.* 51°28'53"S 72°14'04"W); 4) Río Turbio valley, south of Ea. Primavera (*ca.*
166 51°29'18"S 72°15'58"W); 5) road between Ea. San José and Ea. Primavera (*ca.* 51°31'47"S
167 72°16'42"W); 6) one kilometer east of Ea. Dorotea (*ca.* 51°33'39"S 72°10'26"W); 7) upper
168 course of Turbio river, one kilometer upriver of Ea. Primavera (*ca.* 51°27'26"S 72°13'58"W);
169 8) near Ea. Rospentek (*ca.* 51°40'56"S 72° 8'47"W); 9) upper course of Turbio river,
170 between Ea. Primavera and 6th lot (*ca.* 51°27'45"S 72°10'25"W); 10) upper course of Turbio
171 river, near the previous locality (*ca.* 51°27'41"S 72° 9'35"W). He included these outcrops into
172 a grouped called “estratos magellanianos” and divided them into two subgroups: the lower
173 one,”B” which includes mostly marine localities (1 to 6), and the upper one “C” which
174 includes continental localities (7 to 10).

175 The stratigraphic units which crop out in each locality (based on the original map,
176 Frenguelli 1941, p. 174) were recognized in successive field trips, and by placing them in the
177 geological maps of Malumián and Panza (2000). The map provided by Frenguelli (1941)
178 lacks scale and details that would allow the outcrops to be placed in an exact position. In
179 addition, no detailed information was provided on the type of sediment that each one carries.

180 Based on this information, each of the ten localities was assigned to a stratigraphic
181 unit. In each of them the presence of leaves or leaf fragments was corroborated. In most of

the localities (except localities 9 and 10) an accurate stratigraphic position was proposed (see Discussion below). The diversity of the leaves of each locality was compared with new information of the stratigraphic units to check the consistency of the stratigraphic placement. Table 1 includes those localities with the proposed stratigraphic unit.

[Figure 3]

SYSTEMATIC PALEONTOLOGY

In the first part only the best preserved fossil species are described. After these descriptions are included species considered doubtful, with Discussion in each of them.

Clade EUDICOTS APG IV, 2016

Order ESCALLONIALES Link, 1829

Family ESCALLONIACEAE Brown ex. Dumortier, 1829

Genus ***Escallonia*** Mutis ex. Linnaeus, 1782

Type species. *Escallonia myrtilloides* Linnaeus, 1782

***Escallonia*?** sp.

Figure 4.1, 4.4

1941 *Escallonia* sp.; Frenguelli: 204, pl. 3: 4.

1967 *Escallonia* sp.; Hünicken: 185, 186, pl. 3, fig, 10.

Studied material. LPPB 4079.

Geographic and stratigraphic provenance. Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, lamina shape oblong, with slightly medial asymmetry, 5.0 cm long and 1.3 cm wide. Base asymmetrical, acute. Petiole thick, 1.0 cm long. Margin serrate, one order of teeth, cc/st in shape, 1 teeth/cm, regularly spaced and

separated by rounded sinuses. Primary venation pinnate. Midvein straight, stout distally but moderate proximally. Major secondaries veins brochidodromous. Secondary veins fine, 6 pairs, irregularly spaced, curved, inserted at acute angle (40–50°). Secondary veins decurrently attached to the midvein. Each tooth vascularized by a vein of the same caliber than a secondary originated in the brochidodromous archs, near the margin. The veins enter centrally in each tooth. Presence of intersecondary veins in some portions of the lamina. Venation of tertiary and higher order not preserved.

Discussion. The specimen is well preserved. Frenguelli (1941) described, illustrated (Plate 3, Fig. 4, p. 205) and proposed this fossil-species. It is characterized by the oblong lamina, the asymmetrical base, the serrated margin with irregular spaced teeth, and the brochidodromous secondary venation pattern. The new description agrees with the original, only the description of intersecondary veins, not mentioned by Frenguelli (1941), was added.

Other fossils from Patagonia were previously identified as *Escallonia* sp. Hünicken (1955, 1967) mentioned *Escallonia* sp. from the lower member of the Río Turbio Formation (fossiliferous locality Diquecito, stratigraphic level 't'). He described and illustrated it, but did not give specific determination due to the poor preservation of it. In addition, he mentioned the resemblance with Frenguelli's (1941) specimen. In the revision of Hünicken's (1955, 1967) material, Vento and Prámparo (2018) considered that the materials of Hünicken's (1955, 1967) and Frenguelli's (1941) are the same fossil species. We agree with this affirmation.

Although Frenguelli (1941) include this material in *Escallonia*, the preservation is too poor to include it in the genus. However, the margin type and the venation pattern can be observed in some genera of Escalloniaceae, like *Escallonia* and *Anopterus* Labill. Frenguelli (1941) compared this fossil species with the living *Escallonia rosea* Grisebach. Although

they share the main characters, *Escallonia rosea* has a much larger lamina and more number of teeth/cm.

Order LAURALES L. de Jussieu ex Berchtold and Presl., 1789

Family LAURACEAE L. de Jussieu, 1789

Genus ***Ocotea*** Aublet, 1775

***Type species*.** *Ocotea guianensis* Aublet, 1775

***Ocotea*?** sp.

Figure 4.2, 4.5

***Studied material*.** LPPB 4070-4071.

***Geographic and stratigraphic provenance*.** Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, lamina with medial symmetry, 6.4 cm long and 2.7 cm wide, concave and slightly asymmetric base, entire margin, petiole normal (0.4 cm long). Primary venation pinnate. Midvein straight and stout. Major secondary veins eucamptodromous. Secondary veins fine, only 2 pairs visible, extremely curved, inserted at acute angle (60–70°), decurrently attached to the midvein. Presence of intramarginal vein. No tertiary veins or higher order were observed.

***Discussion*.** Frenguelli (1941) included these samples in *Oreodaphne*? sp., but without providing any further information. Three fragmented specimens in the collection were found. This is coincident with the repository book of the paleobotanical collection. This taxonomic unit is characterized by a chordate base, entire margin, eucamptodromous secondary venation pattern, and intramarginal vein.

The most similar fossil-species from Patagonia is *Oreodaphne preacutifolia*, described from the middle Eocene of Río Pichileufú (Berry, 1938). The base shape,

secondary venation pattern and intramarginal vein are related to the material studied here. However, *Oreodaphne preacutifolia* has an asymmetrical lamina.

Although Frenguelli (1941) relates these specimens in Oreodaphne, its fragmentary state difficult to made an assignation. However, they shared many characters with some genera of the Lauraceae. It shares a similar venation pattern with *Oreodaphne acutifolia* Nees, but also with other Lauraceae living species: *Quiina acutangula* Aublet, *Q. tinifolia* Planch. and Triana and *Ocotea aciphylla* Nees. It is also similar to *Anopterus glandulosus* Labill., especially in the margin features.

Genus ***Persea*** Miller, 1754

Type species. *Persea americana* Miller, 1768

***Persea*?** sp.

Figures 4.3, 4.6

Studied material. LPPB 4107.

Geographic and stratigraphic provenance. Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape elliptic with medial symmetry, 4.1 cm long and 1.8 cm wide, retuse apex and entire margin. Primary venation pinnate. Midvein curved and stout. Major secondaries veins eucamptodromous. Secondaries thick, 3 pairs, irregularly spaced, curved, inserted at acute angle (40–50°). Secondary veins decurrently attached to the midvein in the proximal part of the lamina. Venation of tertiary and higher order not preserved.

Discussion. Frenguelli (1941) listed this taxonomic unit as *Persea microphylla* but without providing any further information. Only a single specimen in the collection with por preservation was found, which is coincident with the repository book. This fossil-species is

277 characterized by its entire margin, retuse apex and eucamptodromous secondary venation
278 pattern.

279 Although it is not mentioned in the original publication, it can be assumed that the
280 author included this specimen in *Persea* based on its similarities to *Persea microphylla*
281 described from the Paleocene–Eocene boundary of Lota-Coronel by Engelhardt (1891).
282 However, *Persea microphylla* has an acuminate apex and, therefore, it was not considered the
283 same taxon of Frenguelli's (1941) collection.

284 **[Figure 4]**

285 Other fossil leaves were placed in *Persea* across the Patagonia. Hünicken (1955)
286 mentioned *Persea microphylla* in the Río Turbio Formation but did not provide any
287 description or illustration. Hünicken (1967) described *Persea borrelloii* which was reviewed
288 by Vento and Prámparo (2018), who considered that the material was poorly preserved, so
289 they did not agree with the specific determination, but retained it in the genus *Persea*.
290 However, that fossil material is poorly preserved, and it was not possible to identify if it
291 corresponds to the same taxon studied here. The fossil leaves referred to *P. microphylla* of
292 Hünicken (1955) are not mentioned in Hünicken (1967) or in Vento and Prámparo (2018).

293 In addition, the identification as *Persea* made by Frenguelli (1941) is questionable,
294 due to the poor preservation of the specimen. However, several species of the Lauraceae have
295 similar characteristics of this fossil-species, such as *Persea ruizzi* Macbride, with a similar
296 venation pattern; and *Acrodiclidium salicifolium* (Sw.) Griseb., which also has a similar
297 venation pattern but a different apex.

298 Order FAGALES Engler, 1892

299 Family NOTHOFAGACEAE Kuprianova, 1962

Genus ***Nothofagus*** Blume, 1851

Type species. *Nothofagus antarctica* (Forster) Oersted, 1871

Nothofagus densinervosa Dusén, 1899

Figure 5.1, 5.4

1899 *Nothofagus densinervosa* Dusén; Dusén 1899: 99, pl. 9: 14–19.

1939 *Nothofagus densinervosa* Dusén; Fiori 1939: 67, pl. 1: 18.

1941 *Nothofagus densinervosa* Dusén; Frenguelli 1941: 206, pl. 4: 3.

1967 *Nothofagus* cf. *densinervosa* Dusén; Hünicken 1967: 168, pl. 2: 7.

1986 *Nothofagus densinervosa* Dusén; Tanai 1986: 575, pl. 12: 1–12.

2013 *Nothofagus densinervosa* Dusén; Tosolini *et al.* 2013, p. 14: 2K, 5B,G.

Studied material. LPPB 4084.

Geographic and stratigraphic provenance. Locality 9 of Frenguelli (1941). Río Guillermo/Río Leona Formations (Fig. 1–2, 3F, Table 1)

Description. Simple, microphyll leaves, lamina with medial symmetry, 4.5 cm long and 2.2 cm wide. Base symmetrical, acute, petiole normal (1.0 cm long). Apex was not preserved. Margin dentate, one order of teeth, cv/cv in shape, 6 teeth/cm, regularly spaced and separated by rounded sinuses. Primary venation pinnate. Midvein straight with moderate size. Major secondary veins craspedodromous. Secondaries fine, 10 pairs, regularly spaced, slightly curved near the margin, inserted at acute angle (50–60°) which smoothly increased proximally. Secondary veins decurrently attached to the midvein. Each tooth vascularized by a secondary vein that penetrates it basally and reaches their apex. No higher order of venation observed.

Discussion. This fossil-species was illustrated by Frenguelli (1941, Plate 4, Fig. 3, p. 206), but without providing description or the quantity of specimens assigned to it. A single

specimen in regular state of preservation was found. This coincides with what was written in the original book of the paleobotanical collection repository. Although the distal part of the lamina is not preserved, it can be related to *N. densinervosa* by: the dentate margin type, the high number of teeth/cm (six), and the basal vascularization of the teeth.

Hünicken (1955, 1967) described *N.* cf. *densinervosa*. His material is very similar to the leaves studied here, with the same dentate margin type, number of teeth frequency and the basal vascularization of the teeth.

This is the first record of *N. densinervosa* from the Río Guillermo Formation, but it was mentioned in other localities from Patagonia and Antarctica: Barrancas Carmen Silva (middle Miocene) locality (Dusén 1899), Seymour/Marambio Island (Paleocene) (Dusén, 1908; Tosolini *et al.*, 2013), Ñirihuau Formation (early-middle Miocene) (Fiori, 1939), and Brush Lake Formation (late Eocene-early Oligocene) (Tanai, 1986).

Nothofagus dicksonii (Dusén) Tanai, 1986

Figure 5.2, 5.5

1899 *Fagus dicksonii*; Dusén 1899: 95, pl. 8: 14–16.

1937 *Fagus dicksonii* Dusén 1899; Berry 1937: 93, pl. 18: 1.

1941 *Fagus dicksonii* Dusén 1899; Frenguelli 1941: 206, pl. 4: 1.

1986 *Nothofagus dicksonii* (Dusén) Tanai; Tanai 1986: 577, pl. 13: 4, 8, 13, 17.

2018 *Nothofagus* sp. cf. *N. dicksonii* (Dusén); Vento and Prámparo 2018: 6, pl. 4: F.

2019 *Nothofagus dicksonii* (Dusén); Panti 2019: 78, figs. 5A-B, 6H.

Studied material. LPPB 4090

Geographic and stratigraphic provenance. Locality 4 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple microphyll leaves, lamina shape elliptic with medial symmetry, 6.3 cm long and 4.1 cm wide. Base symmetrical, rounded, petiole normal (0.1 cm long). Apex not preserved. Margin deeply serrate, one order of teeth, cv/cv in shape, 2 teeth/cm, regularly spaced and separated by angular sinuses. One secondary vein per tooth. Primary venation pinnate. Midvein straight with moderate size, thinner in the apical part of the lamina. Major secondary veins craspedodromous. Secondaries fine, 5 pairs, regularly spaced, straight, inserted at acute angle (45–55°). Secondary veins decurrently attached to the midvein. Each tooth vascularized by a secondary vein that penetrates the tooth centrally and reaches the tooth apex. Venation of tertiary and higher order not preserved.

Discussion. This fossil-species was illustrated by Frenguelli (1941, Plate 4, Fig. 4, p. 206), but without providing description or the quantity of specimens assigned to it. In the collection and the repository book two references for this fossil-species were found. However, LPPB 4082 is a rock with several partial leaf remains and *N. dicksonii* is not pointed out, therefore it was not able to identify it (Fig. 8.6). We consider *Nothofagus dicksonii* only based on the LPPB 4090 specimen, characterized by its serrate margin with the deep sinuses, and the frequency of teeth per secondary.

Tanai (1986) considered that *F. dicksonii* has features that allow to be included in *Nothofagus*. Therefore, the materials studied here can be compared to the leaves described by Berry (1937) and Hünicken (1967), also from the Río Turbio Formation. These specimens have many similarities, like the serrate margin with deep sinuses, the frequency of teeth per secondary and the central vascularization of the teeth. Vento and Prámparo (2018) reviewed this same material but they refers with doubts to *Nothofagus* sp. cf. *N. dicksonii.* However, we include all the specimens in the same taxon.

Nothofagus dicksonii was recorded in other Patagonian outcrops such as Barrancas Carmen Silva locality (early-middle Miocene) (Dusén, 1899) and Brush Lake Formation (late Eocene-Early Oligocene) (Tanai, 1986).

[Figure 5]

Nothofagus elongata Dusén, 1899

Figure 5.3, 5.6

1899 *Nothofagus elongata*; Dusén: 97, pl. 10: 12–13

1899 *Nothofagus lanceolata;* Dusén: s/n, pl. 8: 13.

1899 *Nothofagus* cf. *N. obliqua* Mirbel; Dusén 1899: s/n, pl. 10: 1.

1937 *Nothofagus elongata*; Berry 1937: 94, pl. 18: 7.

1941 *Nothofagus lanceolata* Dusén, 1899; Frenguelli 1941: 206, pl. 4: 1.

1967 *Nothofagus* cf. *N. elongata*; Hünicken 1967: 166, pl. 2: 1.

1989 *Nothofagus elongata*; Durango de Cabrera and Vergel 1989: 4, pl. 1: 1–2.

2011 *Nothofagus elongata*; Panti 2011: 324, pl. 3: 5–8

2016 *Nothofagus elongata*; Vento *et al.* 2016: 5, pl. 1: b–c.

2019 *Nothofagus elongata*; Panti 2019: 76, figs. 4E-F, 6F.

Studied material. LPPB 4082; LPPB 4086; LPPB 4093.

Geographic and stratigraphic provenance. Locality 4 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple leaf, microphyll, lamina shape ovate with medial symmetry, 9.6 cm long and 3.3 cm wide. Apex acute, base symmetrical, acute. Margin serrate, two order of teeth, st/st in shape, 4 teeth/cm, regularly spaced and separated by angular sinuses. There are

2 teeth per secondary vein. Primary venation pinnate. Midvein straight with moderate size. Major secondary veins craspedodromous. Secondaries fine, 12 pairs, regularly spaced, straight, inserted at acute angle (50–60°), smoothly decreasing proximally. Secondary veins excurrently attached to the midvein. Each tooth vascularized by a secondary vein that penetrates the tooth through the basal side and reaches their apex. The adjacent inferior tooth vascularized by an outer secondary. No higher order of venation was observed.

***Discussion*.** Three well preserved specimens were found in the collection and in the repository book. *Nothofagus elongata* can be recognized by the serrate margin, with two orders of teeth, regularly spaced, the basal vascularization of them and the high number of secondaries (more than 10 pair of veins). Frenguelli (1941) recognized *N. elongata* (LPPB 4082 and 4093), and *N. lanceolata* (LPPB 4086). Following the Romero and Dibbern (1985) proposals, the latter one is considered a junior synonym of *N. elongata.* Therefore, the leaves identified by Frenguelli (1941) as *N. lanceolata* are referred to *N. elongata*. Neither species were described by the author, but the LPPB 4086 was photographed (Frenguelli, 1941, Plate 4, Fig. 1, p. 206).

Nothofagus elongata was identified before in the Río Turbio Formation by Berry (1937) and Hünicken (1955, 1967) and later revised by Vento and Prámparo (2018). Berry (1937) and Hünicken (1967) described and illustrated material referred to *N. elongata*, which are very similar to the specimens studied here. Hünicken (1955) and Vento and Prámparo (2018) mentioned the presence of this taxon but without describing or illustrating it. However, Vento and Prámparo (2018) mentioned that the specimens are very similar to those described in Vento *et al.* (2016) from the Río Guillermo Formation.

This fossil-species was also mentioned in other Patagonian outcrops: Barrancas Carmen Silva (middle Miocene) locality (Dusén, 1899), Cullen Formation (middle Miocene)

(Durango de Cabrera and Vergel, 1989), and Río Guillermo Formation (Panti, 2011; Vento *et al.*, 2016).

Nothofagus variabilis Dusén, 1899

Figure 5.7, 5.8

1899 *Nothofagus variabilis*; Dusén 1899: 96, pl. 9: 8–13.

1941 *Nothofagus variabilis*; Frenguelli 1941: 207, pl. 5: 1.

1967 *Nothofagus variabilis*; Hünicken 1967: 167, pl. 2: 3–6.

1986 *Nothofagus variabilis*; Tanai 1986: 579, pl. 14: 3–5, 8–12, 14.

2011 *Nothofagus variabilis*; Panti 2011: 324, pl. 3: 1–4.

2014 *Nothofagus variabilis*; Caviglia and Zamaloa 2014: 212, pl. 2: 8.

2016 *Nothofagus variabilis*; Vento *et al.* 2016: 5, pl. 1: f.

Studied material. LPPB 4081-4082; 4096 and 4104.

Geographic and stratigraphic provenance. Locality 3, 4 and 6 of Frenguelli (1941). Upper member of the Río Turbio Formation and Río Leona Formation (Fig. 1–2, 3B–C, Table 1).

Description. Simple, microphyll leaves, laminar shape ovate with medial symmetry, 6.1 cm long and 3.7 cm wide. Apex acute, base symmetrical, acute. Margin serrate, two orders of teeth, cv/cv in shape, 7 teeth/cm, irregularly spaced and separated by angular sinuses. There are 5 or 6 teeth per secondary vein. Primary venation pinnate. Midvein straight with moderate size. Major secondary veins craspedodromous. Secondaries fine, 6–8 pairs, regularly spaced, straight, inserted at acute angle (40–50°), consistent. Secondary veins decurrently attached to the midvein. Each tooth vascularized by a secondary vein that penetrates it distally, and reaches their apex. In addition, outer secondaries penetrate the inferior tooth, and the superior one. Venation of tertiary and higher order not preserved.

Discussion. Presence of this fossil-species is based on four regularly preserved specimens They can be identified by the margin serrate type, the two orders of teeth, the arrangement in higher structures and the basal vascularization. Frenguelli (1941) recognized 3 specimens of *N. variabilis*, not described but illustrated (LPPB 4082; p. 207, Plate V, Fig. 1). In addition, and according to Romero and Dibbern (1985) and Tanai (1986), the specimen identified as *N*. cf. *obliqua* (LPPB 4092) was included in *N. variabilis*.

Nothofagus variabilis was identified in the Río Turbio Formation by other authors (Berry, 1937; Hünicken, 1955, 1967; Vento and Prámparo, 2018). However, only Berry (1937) and Hünicken (1967) described and illustrated *N. variabilis*, and their leaves resemble the materials studied here. Hünicken (1955) and Vento and Prámparo (2018) mentioned the presence of this fossil-species but they did not describe or illustrate it, although the latter mentioned that the materials are very similar to the one described in Vento *et al.* (2016) from the Río Guillermo Formation.

One of the studied specimens (LPPB 4104) came from locality 6, an outcrop of the Río Leona Formation (Fig. 1, Table 1). This is the first record of *N. variabilis* from this formation. This fossil-species was mentioned several times in Patagonia: Barrancas Carmen Silva (middle Miocene) locality (Dusén, 1899), Brush Lake Formation (late Eocene-Early Oligocene) (Tanai, 1986), Río Guillermo Formation (Panti, 2011; Vento *et al.*, 2016) and Ñirihuau Formation (early-middle Miocene) (Caviglia and Zamaloa, 2014).

Order ROSALES Berchtold and Presl., 1820

Family ROSACEAE L. de Jussieu, 1789

Genus ***Acaena*** Mutis ex Linnaeus, 1771

Type species. *Acaena elongata* Linnaeus, 1771

Acaena brandmayri Frenguelli, 1941

Figure 6.1, 6.4

1941 *Acaena brandmayri*; Frenguelli 1941, 203, pl. 1: 2.

2011 *Acaena* cf. *brandmayri*; Panti 2011, 328–330, pl. 4: 5–6.

2016 *Acaena brandmayri*; Vento *et al.* 2016, p. 8, Plate 1: G.

***Studied material*.** LPPB 4101.

***Geographic and stratigraphic provenance*.** Locality 10 of Frenguelli (1941). Río Guillermo/Río Leona Formation (Fig. 1–2, Table1).

Description. Compound leaf. Each one of the leaflets are microphyll, laminar shape elliptic with medial symmetry, 2.5 to 4.2 cm long and 1.5 to 5.6 cm wide. Apex straight, base symmetrical, cuneate. Margin serrate, one order of teeth, st/st in shape, 3 teeth/cm, regularly spaced and separated by angular sinuses. One secondary vein per teeth. Primary venation pinnate. Midvein straight and stout. Major secondary veins craspedodromous. Secondaries thick, 7–8 pairs, regularly spaced, curved, inserted at acute angle (45–55°). Secondary veins excurrently attached to the midvein. Each tooth vascularized by a secondary vein that penetrates it centrally and reaches the apex. Venation of tertiary and higher order not preserved.

***Discussion*.** This fossil-species is based on one specimen well preserved. It is characterized by the leaf compound arrangement, the serrate margin type and the margin venation. It was proposed by Frenguelli (1941), and it was described and illustrated (Plate I, Fig. 1, p. 203). Moreover, the leaf compound arrangement, the elliptical shape of the leaflets, the serrate margin and the craspedodromous secondary venation are closely similar to extant species of *Acaena*.

Acaena brandmayri was also identified by Vento *et al.* (2016) from the Río Guillermo Formation. This record consists in a single leaflet that is similar with the ones studied here,

although they have differences in the base shape, acute and slightly asymmetrical. In addition, also in the Río Guillermo Formation, it was recorded "*Acaena*" cf. *Acaena brandmayri* (Panti, 2011). It is similar in the arrangement of the leaf and margin type. Although there are differences in the teeth shape, described as st/cv and the lower teeth frequency, it is considered to belong to *A. brandmayri*.

Caviglia and Zamaloa (2014) described *Acaena* sp. from the Pico Quemado locality, Ñirihuau Formation (lower–middle Miocene). It is similar to the specimen studied here in the characteristics of the leaf and the margin type. However, the material from Ñirihuau Formation has rounded apex and base shape, higher number of teeth/cm and smaller teeth.

[Figure 6]

Genus ***Rubus*** Linnaeus, 1753

Type species. *Rubus fruticosus* Linnaeus, 1753

Rubus primaverae Frenguelli 1941

1941 *Rubus primaverae*; Frenguelli 1941: 204, pl. 2: 1.

2015 *Rubus primaverae*; Césari *et al.* 2015: 148, pl. 2: 1–9.

Studied material. LPPB 4098, 4099, 4100.

Geographic and stratigraphic provenance. Locality 10 of Frenguelli (1941). Río Guillermo/Río Leona Formation (Fig. 1–2, Table1).

Discussion. Frenguelli (1941) proposed this new species based on three specimens well preserved that were illustrated and described. Later, Césari *et al.* (2015) described materials from the Río Leona Formation, including the specimens collected by Frenguelli (1941) referred to *Rubus primaverae*. Moreover, the specimen LPPB 4100 was photographed in the contribution (Césari *et al.* 2015, p.148, Plate III, Fig. 1-9). Therefore, we consider that no further descriptions are needed.

Order MALPIGHIALES L. de Jussieu ex. Berchtold and Presl., 1789

Family SALICACEAE Mirbel, 1815

Genus ***Azara*** Ruiz and Pavón, 1794

Type species. *Azara serrata* Ruiz and Pavón, 1794

***Azara celastriniformis*?** Berry, 1938

Figure 6.3, 6.6

1938 *Azara celastriniformis*; Berry 1938: 108, pl. 36: 7–9.

1941 *Azara celastriniformis*; Frenguelli 1941: 205, pl. 3: 2.

***Studied material*.** LPPB 4080, 4081.

***Geographic and stratigraphic provenance*.** Locality 10 of Frenguelli (1941). Río Guillermo/Río Leona Formation (Fig. 1–2, Table1).

***Description*.** Simple, microphyll leaves, laminar shape elliptic with medial symmetry, 5.5 cm long and 2.3 cm wide. Apex acute, base asymmetrical, rounded. Margin serrate, one order of teeth, prominent, cv/cv in shape, 2 teeth/cm, irregularly spaced and separated by angular sinuses. Primary venation pinnate. Midvein curved, stout in the distal part, and moderate proximally. Major secondary veins brochidodromous. Secondaries fine, 7 pairs, irregularly spaced, curved, inserted at acute angle (55–65°) smoothly increasing proximally. Secondary veins decurrently attached to the midvein. Each tooth vascularized by a vein with the size of a secondary that originates in the brochidodromous arch, and penetrates the tooth centrally reaching the apex. In some portions of the lamina tertiary veins observed, which are straight percurrents. Venation of higher order not preserved.

Discussion. This fossil-species was photographed by Frenguelli (1941, p. 205, Plate III, Fig. 2), but no description or quantity of specimens assigned to it was provided. Two specimens well preserved were found in the collection. This is coincident with the repository

book. They are characterized by the asymmetrical base, the teeth cv/cv shape, prominence, disposition, central vascularization and frequency, and the brochidodromous secondary venation pattern.

This fossil-species was first described from the middle Eocene Río Pichileufú locality (Berry, 1938). It has the same diagnostic characters as the leaves described here. It is worth mentioning that Río Pichileufú material is more abundant and shows a greater variability in some characters: the lamina shape can be also ovate; the apex shape can be also rounded; and the medial and base symmetry.

The laminar shape, apex and base, the serrate margin, teeth venation, teeth/cm frequency and secondary venation pattern are comparable with species of the living genus *Azara*, such as *Azara dentata* Ruiz and Pavón and *Azara lanceolata* Hook. Berry (1938) mentioned an enormous similarity with the living *Azara celastrina* Don from Chile. However, this species has entire or crenate margin.

Order SAPINDALES L. de Jussieu ex. Berchtold and Presl., 1789

Family SAPINDACEAE L. de Jussieu, 1789

Genus *Thouinia* Smith 1789

Type species. *Thouinia spectabilis* Smith, 1789

***Thouinia philippi*?** Engelhardt, 1891

Figure 6.2, 6.5

1891 *Thouinia philippii*; Engelhardt 1891, 671, pl. 9: 13; pl. 10: 4, 5.

1922 *Thouinia philippii*; Berry 1922, 140, pl. 4: 1, 2.

Studied material. LPPB 4115.

Geographic and stratigraphic provenance. Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table1).

Description. Simple, microphyll leaves, lamina shape oblong with medial symmetry, 14.1 cm long and 6.2 cm wide. Neither apex nor base preserved. Margin entire and sinuous. Primary venation pinnate. Midvein straight and stout. Major secondary veins brochidodromous. Secondaries fine, 13 pairs, regularly spaced, curved, inserted at acute angle (60–70°). Secondary veins decurrently attached. Venation of tertiary and higher order not preserved.

Discussion. Frenguelli (1941) listed this species (p. 186), but without providing any further information (i.e. description, illustration or number of specimens). A single specimen was found in a regular state of preservation in the collection. It is characterized by the oblong laminar shape, the entire and sinuous margin and the brochidodromous secondaries veins. These characters are very similar to the living *Thouinidium decandrum* Radlk.

Thouinia philippii was firstly described from the Paleocene/Eocene of Lota Coronel (Engelhardt, 1891), and it is found very similar to the sample studied here. *Thouinia philippii* was also described by Berry (1922) from the Paleocene of Arauco Concepción. These materials share the same characteristics with the ones described here, with an acuminate apex as in the material of Engelhardt (1891), but not preserved in the fossil leaves published by Frenguelli (1941).

The poor preservation of the studied specimen prevents the placement in *Thouinia* as was made by Frenguelli (1941). However, the sinuous and entire margin and the venation pattern are similar to some living *Thouinia* species, like *Thouinia acuminata* Watson. It is also similar to other species of the Sapindaceae, like *Thouinidium decandrum*, which was compared by Engelhardt (1891) with this fossil-species, and *Atalaya salicifolia* (DC.) Blume.

Order SAXIFRAGALES Berchtold and Presl., 1820

584 Family GROSSULARIACEAE P. de Candolle, 1805

585 Genus ***Ribes*** Linnaeus, 1753

586 ***Type species***. *Ribes rubrum* Linnaeus, 1753

587 *Ribes*? sp.

588 Figure 7.6, 7.7

589 1941 *Ribes* sp.; Frenguelli 1941: 203, pl. 1: 5.

590 ***Studied material*.** LPPB 4097.

591 ***Geographic and stratigraphic provenance*.** Locality 3 of Frenguelli (1941). Upper member
592 of the Río Turbio Formation (Fig. 1–2, 3B, Table1).

593 ***Description*.** Simple, microphyll leaf, palmately lobed, with 3 lobes, with medial
594 symmetry, 2.6 cm long and 3.7 cm wide. Each lobe elliptic, with rounded apex and entire.
595 Primary venation basal actinodromous or palinactinodromous. Midvein sinuous, thick. Major
596 secondary veins semicraspedodromous. Secondaries fine, 5–6 pairs, irregularly spaced,
597 curved, inserted at acute angle (70–80°). Secondary veins decurrently attached to the
598 midvein. Veins with the same thickness of a secondary came out from the brochidodromous
599 archs and reach the margin. Tertiary venation percurrent convex, with acute angle. No higher
600 order venation observed.

601 ***Discussion*.** This fossil-species is based on a well preserved single specimen. It is
602 characterized by the palmately lobed lamina disposition, the principal basal actinodromous
603 and the secondary palinactinodromous venation patterns. Frenguelli (1941) described this
604 fossil-species with an illustration (Plate I, Fig. 5, p. 203).

Frenguelli (1941) compared this taxon with *Ribes*? *palmatifolia*, described by Spegazzini (1924) -the exact provenance is unclear, but the author mentioned that it came from an Eocene deposit-. The leaves of Spegazzini (1924) are similar in the lamina shape and palmate with three lobes. However, they differ in the margin type, serrate in *Ribes*? *palmatifolia*, and entire in *Ribes* sp.

Frenguelli (1941) included these samples in *Ribes*, although the preservation of it is very poor. However, the leaf shape and the secondary venation pattern can be related to some species of *Ribes* of the Grossulariaceae, like *R. nigrum* L. and *R. magellanicum* Poir. Another similar species of the family is *Grossularia purpusii* (Koehne ex Blank.) Rydb.

[Figure 7]

Genus ***Escalloniiphyllum*** Dusén, 1899

Escalloniiphyllum sp. Dusén, 1899

Figure 7.1, 7.4

1899 *Escalloniiphyllum* sp.; Dusén 1899: 102, pl. 9: 5.

1941 *Escalloniiphyllum* sp.; Frenguelli 1941: 208, plate 6: 2

***Studied material*.** LPPB 4078.

Geographic and stratigraphic provenance. Locality 6 of Frenguelli (1941). Río Leona Formation (Fig. 1–2, 3C, Table1).

***Description*.** Simple, microphyll leaf, lamina shape ovate with medial symmetry, 3.1 cm long and 1.5 cm wide. Apex rounded, base symmetrical, truncate, petiole normal (1.0 cm long). Margin serrate, one order of teeth, st/cv in shape, 5 teeth/cm, regularly spaced and

separated by angular sinuses. Primary venation pinnate. Midvein straight, thick. Major secondary veins simple craspedodromous. Higher order veins were not observed.

Discussion. This fossil-species is based on a very well preserved single specimen. Its diagnostic characteristics are the truncate base and the serrate margin, with st/cv teeth and high frequency per cm. This specimen was illustrated but not described by Frenguelli (1941) and named as *Escalloniiphyllum* sp.

The fossil-genus *Escalloniiphyllum* was created by Dusén (1899) based on a leaf from the late Oligocene Río Cóndor locality, which he named *Escalloniiphyllum* sp. Later, Frenguelli (1941) recognized the same shape of the lamina and apex, and the same margin type between LPPB 4078 and the specimens studied by Dusén (1899), and also used the same taxon name, i.e. *Escalloniiphyllum* sp. Although the material from Río Cóndor has only the proximal part of the lamina preserved, the margin is closely comparable with the holotype. Dusén (1899) compared it with the living *Escallonia serrata*, but there are several differences: in the living species the lamina shape is oblong, the base is cuneate, and the teeth are st/st in shape with lower frequency per cm.

When this fossil-genus was created by Dusén (1899) no diagnosis or fossil-species was assigned to it. More well preserved specimens are needed to propose a new fossil-species.

Genus ***Hydrangeiphyllum*** Dusén, 1899

Hydrangeiphyllum affine Dusén, 1899

Type species. *Hydrangeiphyllum affine* Dusén, 1899

Figure 7.2, 7.5

1899 *Hydrangeiphyllum affine*; Dusén 1899: 102, pl. 10: 5.

650 ***Studied material*.** LPPB 4076.

651 ***Geographic and stratigraphic provenance*.** Locality 5 of Frenguelli (1941). Upper member
652 of the Río Turbio Formation (Fig. 1–2, Table1).

653 ***Description***. Simple, microphyll leaves, lamina shape elliptic, with medial symmetry,
654 4.9 cm long and 2.1 cm wide. Apex rounded in shape, base symmetrical, rounded. Margin
655 entire. Primary venation pinnate. Midvein straight, thick. Major secondary veins
656 brochidodromous. Secondaries thick, 5 pairs, regularly spaced, curved, inserted at acute angle
657 (50–60°) smoothly increasing proximally. Secondary veins decurrently attached to the
658 midvein. Minor archs originated besides the principal brochidodromous ones, with veins of
659 the same caliber than a secondary. Tertiary veins reticulate, composite admedial. Exterior
660 tertiary veins terminate at the margin. Quaternary veins irregular reticulate, thick. No higher
661 order venation observed.

662 ***Discussion***. This fossil-species was identified from a single specimen well preserved,
663 and it is characterized by the lamina shape, entire margin and secondary venation pattern.
664 Frenguelli (1941) did not describe or illustrate it.

665 Dusén (1899) described it originally from the Barrancas Carmen Silva locality
666 (lower–middle Miocene). His material is very similar to the one studied here, although there
667 are some differences, such as the midvein course, sinuous in Barrancas Carmen Silva
668 specimen. The author mentioned the similarity with extant *Hydrangea scandens*. However,
669 these living species have an acute apex and base, unlike the fossil-species described here.

670 **Angiosperm incertae sedis 1**

671 Figure 7.3

672 1891 *Mespilodaphne longifolia* Engelhardt*;* Engelhardt 1891: 653, pl. 4: 1.

673 1941 *Mespilodaphne longifolia* Engelhardt 1891; Frenguelli 1941: 203, pl. 1: 3.

1955 *Mesphilodaphne longifolia* Engelhardt; Hünicken 1955, pp. 44, 72, 114, 115.

1967 cf. *Mesphilodaphne longifolia* Engelhardt; Hünicken 1967, p. 177, pl. 4, Fig. 3.

2018 Angiosperm sp.; Vento and Prámparo 2018, p. 23, pl. 10, Fig. D.

Studied material. LPPB 4072; LPPB 4073; LPPB 4074.

Geographic and stratigraphic provenance. Locality 2 of Frenguelli (1941). Río Guillermo Formation (Fig. 1–2, 3A, Table1).

Description. Simple, microphyll leaves, laminar shape elliptic with medial symmetry, 13.8 cm long and 7.4 cm wide. Apex acuminate in shape, base not preserved. Margin entire. Primary venation pinnate. Midvein straight and stout. Major secondary veins brochidodromous. Secondaries fine, regularly spaced, curved, inserted at acute angle (60–70°). Secondary veins decurrently attached to the midvein. Presence of intersecondary, perpendicular to the midvein, usually one per intercostal area. Tertiary veins percurrents straight, acute and consistent. Presence of intramarginal vein, where exterior tertiary veins terminate. Quaternary veins irregularly reticulate, thin.

Discussion. This taxonomic unit is based on three well preserved specimens. Frenguelli (1941) included these fossils in *Mespilodaphne longifolia* Engelhardt. This taxonomic unit is characterized by the great lamina size, the acute apex with drip tip ending, the entire margin and the brochidodromous secondary venation pattern, with intramarginal and intersecondary veins (Engelhardt, 1891). Frenguelli (1941) did not describe these veins, and it was represented by a single drawing.

Mespilodaphne longifolia was originally described by Engelhardt (1891) from the Paleocene/Eocene boundary of Lota Coronel in Chile. It is very similar to the material described here, and typical characters can be observed (e.g. lamina size, venation patterns, apex shape). The author compared it with extant *Ocotea pretiosa* Bentham and Hooker which

is very similar in all the typical characters, although it has an ovate lamina. *Ocotea* was recently synonymized with *Mespilodaphne* (Assis and Mello-Silva, 2010).

Hünicken (1955) mentioned the presence of *Mespilodaphne longifolia* from the Río Turbio Formation, but without providing any illustration or description. Later, Hünicken (1967) described and illustrated this material. Although the author did not consider that it was similar to the specimens studied here, several similarities can be observed, like the lamina size and shape, the primary and secondary venation pattern and the acute with drip tip apex.

Vento and Prámparo (2018) made the revision of the Hünicken (1955, 1967) materials, and considered that due to the lack of base, tertiary and higher venation it is not possible to make an assignation, therefore, they did not include them in the Lauraceae, but they retained the materials in the taxonomic unit "Angiosperm sp.". Also, the authors did not consider that "Angiosperm sp." is the same taxon that the ones studied by Frenguelli (1941). We disagree with this affirmation, and we believe that there are several characters to consider the materials of Frenguelli (1941), Engelhardt (1891) and Hünicken (1955, 1967) as the same taxonomic unit: the acuminate and straight apex, the entire margin, the brochidodromous secondary venation and the presence of intersecondary and intramarginal veins.

Doubtful fossil species

Angiosperm incertae sedis 2

Figure 8.1

Studied material. LPPB 4017

Geographic and stratigraphic provenance. Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table1).

Description. Simple, microphyll leaves, 5.6 cm long and 4.4 cm wide. Apex straight, base not preserved. Margin entire. Primary venation pinnate. Midvein sinuous and normal.

Major secondary veins brochidodromous. Secondaries fine, irregularly spaced, curved, inserted at acute angle (65–75°). Secondary veins decurrently attached to the midvein. Presence of intersecondary, perpendicular to the midvein, usually one per intercostal area. Tertiary veins seems percurrents straight, acute and consistent. No higher order venation can be observed.

Discussion. The specimen LPPB 4017, listed as *Doliocarpus oblongifolia* is poorly preserved, only preserving the apical part of the lamina. Frenguelli (1941) listed this species, but did not provide a description or an illustration. It is characterized by its entire margin and brochidodromous secondary venation.

Doliocarpus oblongifolia was defined by Engelhardt (1891) from leaves collected from the Paleocene–Eocene boundary of Lota Coronel in Chile. Noteworthy, these materials differ from LPPB 4017 in the margin serrate, the semicraspedodromous venation and the absence of proximal part of the lamina. Therefore, the specimen cannot be included into *Doliocarpus oblongifolia*.

The material studied here does not resemble the leaves of extant *Dolicarpus*, which are usually dentate, and/or with craspedodromous and regular secondary venation. Therefore, this specimen remains with uncertain botanical affinity.

Nothofagus sp. 1

Figure 8.2

Studied material. LPPB 4082 4093.

Geographic and stratigraphic provenance. Locality 4 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, 4.3 to 5.1 cm long and 2.4 to 3.1 cm wide. Apex straight, base not preserved. Margin not observable. Primary venation pinnate. Midvein

straight and normal. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (55–65°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. Frenguelli (1941) mentioned these specimens as "*Fagus integrifolia"* but did not describe them. *Fagus integrifolia* is currently regarded as a junior synonymy of *Nothofagus subferruginea* (Tanai, 1986). According to Frenguelli (1941), this fossil-species is illustrated in the Plate V (p. 207), but the picture represents a large rock (LPPB 4082) with several partially preserved leaf imprints. The author did not indicate which of the partial leaves "Fagus integrifolia" were. The other specimen, which was not illustrated by Frenguelli (1941), is a fragmented leaf, with only the apical part preserved, but with no margin or further detail. In conclusion, the material studied here can be related to *Nothofagus*, but it does not allow a specific identification.

[Figure 8]

Nothofagus sp. 2

Figure 8.6

Studied material. LPPB 4082, 4091, 4093, 4096, 4104.

Geographic and stratigraphic provenance. Localities 3, 4 and 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, 3B, Table 1).

Description. Simple, microphyll leaves, 5.3 to 5.8 cm long and 3.1 to 3.8 cm wide. Apex straight, base rounded and symmetric. Margin not observable. Primary venation pinnate. Midvein straight and normal. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (60–70°). Secondary veins decurrently

attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. Frenguelli (1941) mentioned these specimens as "*Fagus subferruginea"* but did not describe them. **"***F. subferruginea"* (=*Nothofagus subferruginea* (Dusén) Tanai) was identified by Frenguelli (1941) based on several specimens poorly preserved. It was photographed (p. 207) but not described. However, the illustration of this species is the same as "*F. integrifolia"* (p. 207, Plate V, LPPB 4082), and the problem is the same: it was not possible to identify which fragmentary leaf was considered as "*F. subferruginea*" by the author. The specimens LPPB 4096 and LPPB 4104 show numerous incomplete leaves remains, poorly preserved, with no discernible characters for specific determination. And the pieces LPPB 4091 and LPPB 4093 lack preserved margins, which prevents further identification. Therefore, these materials can be related to *Nothofagus*, but they do not allow a specific identification.

Nothofagus sp. 3

Figures 8.6

Studied material. LPPB 4082, 4101.

Geographic and stratigraphic provenance. Localities 4 and 10 of Frenguelli (1941). Upper member of the Río Turbio Formation and Río Guillermo/Río Leona Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape elliptic and symmetric, 2.3 to 3.2 cm long and 2.9 to 3.3 cm wide. Apex rounded, base rounded and symmetric. Margin not observable. Primary venation pinnate. Midvein straight and normal. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (50–

60°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. Frenguelli (1941) mentioned these specimens as *Nothofagus australis* but did not describe them. The specimen LPPB 4082 is a rock fragment with several partial leaf remains, as it was mentioned above (see Discussion in *Nothofagus* sp. 1). Although Frenguelli (1941) affirmed the presence of *N. australis* (p. 207, Plate V), it was not possible to identify it. The other one (LPPB 4101) lacks the margin. Therefore, the leaves can be related to *Nothofagus*, but they do not allow a specific identification.

Nothofagus* cf. *crenulata Dusén, 1899

Studied material. LPPB 4081, 4099, 4100.

Geographic and stratigraphic provenance. Locality 10 of Frenguelli (1941). Río Guillermo/Río Leona Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape elliptic and symmetric, 4.3 to 5.1 cm long and 2.7 to 3.1 cm wide. Apex rounded, base rounded and symmetric. Margin not observable, probably crenate. Primary venation pinnate. Midvein straight and normal. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (65°–75°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. Three specimens are referred to *Nothofagus crenulata*. However, all of them are poorly preserved and without preserved margins. This latter character is diagnostic of the fossil-species (Romero and Dibbern, 1985; Tanai, 1986). The specimen LPPB 4100 was supposedly illustrated (Frenguelli, 1941, p. 204, Plate I), although *N. crenulata* was not identified among the leaves in the rock. In addition, the specimen LPPB 4081 was listed as

containing *N. crenulata*, but the only fossil leaf in the rock is the counterpart of *Azara celastriniformis*.

Nothofagus* cf. *magelhaenica (Engelhardt) Dusén, 1899

Studied material. LPPB 4081.

Geographic and stratigraphic provenance. Locality 10 of Frenguelli (1941). Río Guillermo/Río Leona Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape probably elliptic and symmetric, 5.4 to 6.1 cm long and 3.7 to 4. cm wide. Apex straight, base not preserved. Margin probably serrate. Primary venation pinnate. Midvein straight and stout. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (60°–70°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. The one specimen is poorly preserved, where the diagnostic characters such as the ovate shape of the lamina, serrate margin with two order of teeth, irregularly spaced, st/st in shape, and presence of outer secondary venation (Dusén, 1899; Romero and Dibbern, 1985) were not observed. This fossil-species was not described or illustrated by Frenguelli (1941), but *N. magelhaenica* appears identified in the Río Leona Formation (Césari *et al.*, 2015) and in the río Turbio Formation (Panti, 2019). However, a comparison is not possible due to the poor state of the studied specimen.

Nothofagus sp. 4

Figures 8.3

Studied material. LPPB 4083, 4085, 4109, 4117

Geographic and stratigraphic provenance. Localities 2, 3, 6, 7, 8, and 9 of Frenguelli (1941). Upper member of the Río Turbio Formation, Río Guillermo Formation and Río Leona Formation (Fig. 1–2, 3A–F, Table 1).

Description. Simple, microphyll leaves, laminar shape probably elliptic and symmetric, 4.3 to 5.5 cm long and 1.9 to 2.3 cm wide. Apex straight, base rounded and symmetric. Margin probably serrate. Primary venation pinnate. Midvein slightly curved and normal. Major secondary veins craspedodromous. Secondaries fine, regularly spaced, straight, inserted at acute angle (60°–70°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. Frenguelli (1941) mentioned these specimens as *Nothofagus simplicidens* but did not describe them. This taxonomic unit was identified based on specimens poorly preserved. Although several general characters can be identified, such as the shape of the lamina, apex and/or base, the margin type and its vascularization are not clear in any of them. In addition, the specimen LPPB 4083 seems to have an entire margin. We consider that with the exception of this last specimen, the other three belong to an indeterminate fossil-species of *Nothofagus*.

Camphoromea speciosa Engelhardt, 1891

Figure 8.4

Studied material. LPPB 4075.

Geographic and stratigraphic provenance. Locality 5 of Frenguelli (1941). Upper member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape probably elliptic and symmetric, 7.5 cm long and 4.7 cm wide. Apex not preserved, base probably rounded.

Margin not preserved. Primary venation pinnate. Midvein straight and normal. Major secondary veins craspedodromous or brochidodromous, poor preservation. Secondaries fine, regularly spaced, straight, inserted at acute angle (65°–75°). Secondary veins decurrently attached to the midvein. It can´t be observed how are inserted in the margin. Higher order venation not observable.

Discussion. This fossil-species was listed in Frenguelli (1941, p. 186), but not illustrated or described. It was identified in the collection from a single specimen, coincident with the repository book.

It can be assumed that the assignation made by Frenguelli (1941) of *Camphoromea speciosa* was based on the Engelhardt's (1891) species, described from the Paleocene–Eocene boundary of Lota Coronel. It is characterized by its apex acute, base rounded, entire margin and eucamptodromous secondary venation. Unfortunately, the specimen studied here is poorly preserved, with apex, base and margin not preserved. In addition, the secondaries veins appeared to be brochidodromous and not eucamptodromous. Hünicken (1955) also mentioned this species in the Río Turbio Formation, but without providing any description or illustration.

Hoffmannia protogea Engelhardt, 1891

Studied material. Not found.

Discussion. This fossil-species was listed in Frenguelli (1941, p. 186), but not illustrated or described. Unfortunately, this fossil-species does not appear in the repository book, and it was not found in the collection.

Coprosoma incerta Berry, 1938

Figure 8.5

Studied material. LPPB 4116.

Geographic and stratigraphic provenance. Locality 1 of Frenguelli (1941). Lower member of the Río Turbio Formation (Fig. 1–2, Table 1).

Description. Simple, microphyll leaves, laminar shape elliptic and slightly asymmetric, 6.3 cm long and 2.2 cm wide. Apex straight, base rounded and symmetric. Margin entire. Midvein straight and stout. Higher order venation not observable.

Discussion. This taxon was listed in Frenguelli (1941, p. 186), but not illustrated or described. It was identified in the collection from a single specimen, coincident with the repository book. However, this single specimen is poorly preserved, making its assignation very difficult. It has a probably elliptic lamina, with acute apex entire margin, prominent midvein and not preserved secondary venation.

Coprosoma incerta was first described from the middle Eocene of Río Pichileufú (Berry, 1938), but its preservation is also very poor, which made impossible to determinate if they belong to the same taxon.

DISCUSSION

Frenguelli (1941) mentioned 27 angiosperm leaf taxonomic units. The revised specimens were placed in 7 fossil-species, 18 in open nomenclature and the remaining two were synonymized to another genus. Eleven of the samples in the collection are described for the first time (i.e.,*Ocotea?* sp., *Persea?* sp., *Nothofagus densinervosa*, *N. dicksonii*, *N. elongata*, *N. variabilis*, *Thouinia philippii?*, *Azara celastriniformis?*, *Escalloniiphyllum* sp., *Hydrangeiphyllum affine* and Angiosperm incertae sedis 1). In addition, four of them are photographed for the first time (*Ocotea?* sp., *Persea?* sp., *Thouinia philippii?*, *Hydrangeiphyllum affine*). On the other hand, some original identifications are questioned, based on the poor preservation of the specimens (Angiosperm incertae sedis 2, *Nothofagus*

sp. 1, *N.* sp. 2, *N.* sp. 3, *N.* sp. 4, *Nothofagus* cf. *magelhaenic*a, *N.* cf. *crenulata*, *Camphoromea speciosa* and *Coprosoma incerta*), and one fossil-species probably has been lost (*Hoffmannia protogea*). These results were summarized in Table 1. Moreover, there are several specimens in the collection that were not found (see Appendix).

After this revision, the following families were confirmed: Escalloniaceae, Lauraceae, Nothofagaceae, and Sapindaceae in the Río Turbio Formation; Lauraceae, Nothofagaceae, Grossulariaceae, Rosaceae and Salicaceae in the Río Guillermo Formation; and Nothofagaceae in the Río Leona Formation. There are three different taxonomic units identified that remain with uncertain botanical affinities: Angiosperm incertae sedis 1 (Río Guillermo Fm.), *Escalloniiphyllum* sp. (Río Leona Fm.) and *Hydrangeiphyllum affine* (Río Turbio Fm.).

Stratigraphic position of the localities

Frenguelli described the strata as “estratos magellanianos” and placed the ten fossiliferous localities stratigraphically ascending from 1 to 10 (Frenguelli, 1941, Fig. 2). Consequently, according to his proposal, locality 1 is the oldest and locality 10 is the youngest one. However, after our stratigraphic placement of the localities we found that the most suitable ascending stratigraphic order is 1-(3/4/5/7)-2-(9/10)-(6/8) (Table 1). The numbers of the localities inside the parenthesis indicate that they are approximately coeval.

[TABLE 1]

Río Turbio Formation

The Río Turbio Formation has one of the most diverse leaf paleofloras in Patagonia, with around 30 families and 80 species recognized (Hünicken, 1955, 1967, 1995; Panti, 2014; 2019; Vento and Prámparo, 2018). The assemblage includes a mix of neotropical and

subantarctic taxa, with *Nothofagus* as the principal component. Consequently, the Río Turbio is characterized as a mixed paleoflora (Romero, 1978, 1986; Troncoso and Romero, 1998; Hinojosa and Villagrán, 2005).

The Río Turbio Formation leaves described by Frenguelli (1941) include a mix of families that agrees with the mixed paleoflora. Typical megathermal taxa are found, like the representatives of the Lauraceae and Sapindaceae, and several *Nothofagus* species (Table 1). In addition, the report of *Thouinia philippii?* is the first Sapindaceae record from the unit. *Hydrangeiphyllum affine* Dusén is also documented for the first time, but its botanical affinity remains uncertain.

Berry (1937) was the first author who described material from the Río Turbio Formation. However, there are few coincidences with Frenguelli's (1941) collection: only two *Nothofagus* fossil-species (*N. elongata* and *N. variabilis*). Recently, some paleobotanical contributions were made in the region. Panti (2014) described several Myrtaceae leaves from the Río Turbio Formation. According to Panti (2014), the family is well represented by 12 taxa, and, among others, the high diversity of this family is an evidence of a warm climate in the area (Menéndez, 1971; Troncoso and Romero, 1998). Myrtaceae are absent in Frenguelli's (1941) collection. In addition, Vento and Prámparo (2018) reviewed the Hünicken's Río Turbio fossil leaves (1955, 1967). Most of taxa described by Frenguelli (1941) were also found by Vento and Prámparo (2018), like *Escallonia?* sp., *Nothofagus variabilis* and *N. elongata*, but it is worth mentioning that Vento and Prámparo (2018) described a larger collection, and the fossiliferous localities of Vento and Prámparo (2018) and Frenguelli (1941) are not the same.

Locality 1: One kilometer southeast of Ea. San José. According to its position, it corresponds to the lower member of the Río Turbio Formation and it is now included into the

955 city limits. One kilometer to the south of this locality a few plant remains were found in field
956 trips and also close to locality 1 is an outcrop with many fossil plants of the stratigraphic
957 level “s” of Hünicken (1955) which were revised by Vento and Prámparo (2018).
958 Fossiliferous localities B30, B31 and B32 of Hünicken (1955, p.110–111) with a few plants
959 are also close to locality 1.

960 Localities 3, 4, 5 and 7: These fossiliferous localities crop out along the national road
961 40, and include sediments of the upper member of the Río Turbio Formation. Locality 3 (Fig.
962 3B) is close to Um11 and Um15 of Panti (in press) and according to Hünicken (1955, p.36)
963 corresponds to the stratigraphic level “d”. Locality 7 (Fig. 3D) is very close to the outcrop
964 described by Berry (1937), to the Um9 and Um9a of Panti (in press) and to a plant locality of
965 level “d” of Hünicken (1955).

966 ***Río Guillermo Formation***

967 The Río Guillermo paleoflora has been characterized by a cool-temperate climate, dominated
968 by Nothofagaceae elements, and few Neotropical representatives (Troncoso and Romero,
969 1998; Panti, 2010). Almost 20 taxa from 5 families were described (Panti, 2011; Hünicken,
970 1995; Vento *et al.*, 2016).

971 In the Frenguelli (1941) collection the taxa found agree with this characterization
972 (Table 1). In addition, some of the specimens described here belong to families previously
973 unreported in the stratigraphic unit: Grossulariaceae (*Ribes?* sp.), Lauraceae (*Ocotea?* sp.)
974 and Salicaceae (*Azara celastriniformis?* sp.). Moreover, *N. densinervosa* is reported for the
975 first time. The record of Grossulariaceae and Salicaceae, typical subantarctic families,
976 reinforce the cool-temperate climate postulated for the paleoflora.

977 Panti (2011) studied leaves of this formation collected in four localities and concluded
978 that the Río Guillermo paleoflora was dominated by cool-temperate taxa, principally
979 *Nothofagus*. Vento *et al.* (2016) and Hünicken (1995) described an assemblage from a single
980 locality, Ea. Tres Marías, stratigraphic level 'm' which coincides with Panti's (2011) "RG7
981 and RG8". This locality is north of the Frenguelli's localities. Vento *et al.* (2016) and
982 Hünicken (1995) found the same families identified by Panti (2011): Nothofagaceae,
983 Rosaceae and Myrtaceae. Although the localities studied by Hünicken (1955, 1995), Panti
984 (2011) and Vento *et al.* (2016) and those of Frenguelli (1941) are different, many taxa are
985 coincident among these assemblages. *Acaena brandmayri* is present in all the works
986 (Frenguelli 1941; Panti 2011; Vento *et al.* 2016) except from Hünicken (1995).

987 Locality 2: Small outcrops with plant remains of the Río Guillermo Formation were
988 found (Fig. 3A) apparently close to this locality. Their locations in the geological map of
989 Malumián and Panza (2000) indicate that they are most probably outcrops of the Río
990 Guillermo Formation.

991 Localities 9 and 10: Small, partially covered outcrops (no more than 6–7 meters thick)
992 with fragmented plant remains were found nearby these fossiliferous localities (Fig 3F). They
993 seem to be part of the Río Guillermo Formation or the base of the Río Leona formation, but
994 the small size of the outcrops prevents assigning them with precision. In addition, the
995 geological map of Malumián and Panza (2000) do not cover these outcrops.

996

997 ***Río Leona Formation***

998 In the Río Leona Formation, pollen, wood and leaf assemblages were studied. Several
999 families were recognized: Araucariaceae, Podocarpaceae, Polypodiaceae, Anacardiaceae,

Asteraceae, Atherospermataceae, Casuarinaceae, Chloranthaceae, Euphorbiaceae, Fabaceae, Gunneraceae, Loranthaceae, Menyanthaceae, Myrtaceae, Misodendraceae, Nothofagaceae, Onagraceae, Poaceae, Proteaceae, Restionaceae and Rosaceae (Barreda *et al.*, 2009; Pujana, 2007, 2008, 2009a, b; Césari *et al.*, 2015). Based on its composition, it was proposed a humid and temperate climate (Barreda *et al.*, 2009).

In the collection of Frenguelli (1941), two unpublished taxa were identified from this stratigraphic unit: *Nothofagus variabilis* and *Escalloniiphyllum* sp. (Table 1). Césari *et al.* (2015) studied the paleoflora of the Río Leona Formation and identified 17 taxonomic units and 6 families. The material studied from the Frenguelli's collection represents new evidence of the paleoflora of the Río Leona Formation.

Locality 6: Outcrop one kilometer east of Ea. Dorotea. Some well-preserved fossil leaves were found in this locality in an outcrop nearby a stream. In addition, a tuff level of the Río Leona Formation (Malumián and Panza 2000) was observed (Fig. 3C).

Locality 8: Ea. Rospenteck. Outcrops were checked along the national route 40 near Ea. Rospenteck (Fig. 3E). Some fossil leaves were found.

Value of the revision

It is worth mentioning the importance of carrying out revisions of early 20th century publications. In particular, the contribution made by Frenguelli (1941) contains a great number of taxa, but only a few of them were illustrated and even less were described. Some contributions focused in taxonomy were recently done (e.g. Vento *et al.* 2016; Vento and Prámparo 2018), and they make reference to the pioneer article of Frenguelli (1941). However, none of them could make a reliable paleofloristic comparison due to the fact of the scarce morphological and stratigraphic information provided by the author. Hence, through

the revision carried out here, new information is given, including new descriptions and illustrations made using modern techniques and methodologies, which for some specimens represent the first published description or illustration, achieving the main objective proposed. In second place, this new information attempts to make improvements in future morphological comparisons, and gives new botanical assignments, in order to continue characterizing the paleofloras that inhabited Patagonia in the past.

CONCLUSIONS

Only a few taxa were described and illustrated in the Frenguelli's collection. In this contribution the entire collection of angiosperms was revised, illustrated and described. In addition, the stratigraphic framework proposed allows to place the localities where the leaves of Frenguelli were collected into three well-defined formations: Río Turbio, Río Guillermo, and Río Leona. Moreover, the paleoflorisitc information of these geological units was increased after the systematic review: It was identified a new family in the Río Turbio Formation (Sapindaceae), three new families in the Río Guillermo Formation (Grossulariaceae, Lauraceae and Salicaceae), and two new fossil-taxa to the Río Leona Formation flora (*Nothofagus variabilis* and *Escalloniiyphyllum* sp.).

Frenguelli's localities span an age range of more than 20 Ma, where many floristic turnovers happened. This was observed in the leaf diversity and composition of the different formations. The Río Turbio Formation (Eocene–Oligocene) bears fossil leaves of the mixed paleoflora type, which is the Nothofagaceae plus tropical/subtropical families like Sapindaceae. The Río Guillermo and Río Leona Formations (Oligocene–Miocene) bear fossil leaves of a cool-temperate climate with a dominance of the Nothofagaceae.

ACKNOWLEDGMENTS

The authors would like to thank Claudio Morel and Patricio Knight, in charge of the paleobotanical collection in the Museo de Ciencias Naturales de La Plata, Eliana Coturel, for the help on the illustration of the material, and E. J. Romero and anonymous reviewer for their valuable comments and efforts to improve the manuscript. The funds for the present contribution were provided by CONICET.

REFERENCES

APG IV. 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20.

Ancíbor, E. 1989. Determinación xilológica de una raíz petrificada de Proteaceae de la Formación Río Turbio (Eoceno), Santa Cruz, Argentina. *Ameghiniana* 25: 289–295.

Ancíbor, E. 1990. Determinación xilológica de la madera fósil de una fagácea, de la Formación Río Turbio (Eoceno), Santa Cruz, Argentina. *Ameghiniana* 27: 179–184.

Assis, L.C.S., and Mello-Silva Renato, R. 2010. Two new species of *Ocotea* (Lauraceae) from the Brazilian Restinga. *Novon* 20: 124–128.

Barreda, V.D., and Palazzesi, L. 2007. Patagonian vegetation turnovers during the Paleogene–early Neogene: Origin of Arid-Adapted Floras. *Botanical Review* 73: 31–50.

Barreda, V.D., Palazzesi, L., and Marenssi, S.A., 2009. Palynological record of the Paleogene Río Leona Formation (southernmost South America): stratigraphical and paleoenvironmental implications. *Review of Palaeobotany and Palynology* 154: 22–33.

Bengston, P. 1988. Open nomenclature. *Palaeontology* 31: 223–227.

Berry, E.W. 1922. The flora of the Concepción-Arauco coal measures of Chile. *The Johns Hopkins University Studies in Geology* 4: 73–143

Berry, E.W. 1925. A Miocene flora from Patagonia. *The Johns Hopkins University Studies in Geology* 6: 183–233.

Berry, E.W. 1928. Tertiary fossil plants from the Argentine Republic. *Proceedings US National Museum* 73: 1–27.

Berry, E.W. 1937. Eocene plants from Río Turbio in the territory of Santa Cruz, Patagonia. *The Johns Hopkins University Studies in Geology* 12: 91–97.

Berry, E.W. 1938. Tertiary flora from the Río Pichileufú. Argentina. *Geological Society of America, Special Papers* 12: 1–149.

Brea, M. 1993. Inferencias paleoclimáticas a partir del estudio de los anillos de crecimiento de leños fósiles de la Formación Río Turbio, Santa Cruz, Argentina. I. *Nothofagoxylon paraprocera* Ancíbor, 1990. *Ameghiniana* 30: 135–141.

Caviglia, N., and Zamaloa, M.C. 2014. Flora angiospérmica de Pico Quemado, Formación Ñirihuau (Oligoceno tardío), provincia de Río Negro, Argentina. *Ameghiniana* 51: 209–225.

Césari, S.N., Panti, C., Pujana, R.R., Francis, J.E., and Marenssi, S.A. 2015. The late Oligocene flora from the Río Leona Formation, Argentinian Patagonia. *Review of Palaeobotany and Palynology* 216: 143–158.

Cuitiño, J.I., Fernícola, J.C., Kohn, M.J., Trayler, R., Naipauer, M., Bargo, M.S., Kay, R.F., and Vizcaíno, S.F. 2016. U-Pb geochronology of the Santa Cruz Formation (early Miocene) at the Río Bote and Río Santa Cruz (southernmost Patagonia, Argentina): Implications for the

correlation of fossil vertebrate localities. *Journal of South American Earth Sciences* 70: 198–210.

Durango de Cabrera, J., and Vergel, M. 1989. Contribución al conocimiento de las hojas de Fagaceae de la Formación Cullen, Terciario del territorio nacional de Tierra del Fuego, República Argentina. *Acta Geológica Lilloana* 17: 549–565.

Dusén, P. 1899. Über die tertiäre Flora der Magellanslander. *Wissenchtaftliche- Ergebnisse der Schwedischen Expedition nach der Magellanslandern, 1895–1897,* 1: 84–107.

Dusén, P. 1908. Über Die Tertiare Flora der Seymour Insel. *Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition 1901–1903,* 3: 1–27.

Ellis, B., Daly, D., Hickey, L.J., Johnson, K.R., Mitchell, J.D., Wilf, P., and Wing, S.L. 2009. *Manual of Leaf Architecture*. Cornell University Press, Ithaca 190 p.

Engelhardt, H. 1891. Ueber Tertiärpflanzen von Chile. *Senckenberg Naturwissenschaftlichen Gesellschaft Abhandlungen.* 16 (4): 629-692. Fernández, D.A. 2018. [*Análisis paleoflorístico de la Fm. Río Turbio (Eoceno de la provincia de Santa Cruz) y su relación con los cambios paleoclimáticos globales: evidencias esporopolínicas*. Tesis Doctoral, Facultad de Ciencias Naturales y Museo, Universidad de La Plata, Buenos Aires, 235 p. Unpublished].

Fernández, D.A., Panti, C., Palazzesi, L., and Barreda, V.D. 2012. La presencia de una familia neotropical (Malpighiaceae) en el extremo más austral de Sudamérica durante el Eoceno. *Revista Brasileira de Paleontologia* 15: 386–391.

Fiori, A. 1931. Fillite terziare della Patagonia. I. Fillite della riva meridionalle del Lago Nahuel Huapí. *Giornale di Geologia* 6: 101–116.

1111 Fiori, A. 1939. Fillite terziare della Patagonia. II. Fillite del Río Ñirihuau. *Giornale di*
1112 *Geologia* 13: 1–27.

1113 Fiori, A. 1940. Fillite terziare della Patagonia. III. Fillite del Río Chenqueniyeu. *Giornale di*
1114 *Geologia* 14: 93–133.

1115 Fosdick, J.C., Grove, M., Graham, S.A., Hourigan, J.K., Lovera, O., and Romans, B.W.
1116 2015. Detrital thermochronologic record of burial heating and sediment recycling in the
1117 Magallanes foreland basin, Patagonian Andes. *Basin Research* 27: 546–572.

1118 Fosdick, J.C., Romans, B.W., Fildani, A., Bernhardt, A., Calderón, M., and Graham, S.A.
1119 2011. Kinematic evolution of the Patagonian retroarc fold-and-thrust belt and Magallanes
1120 foreland basin, Chile and Argentina, 51° 30'S. *Bulletin of the Geological Society of America*
1121 123: 1679–1698.

1122 Frenguelli, J. 1941. Nuevos elementos florísticos del Magellaniano de Patagonia austral.
1123 *Notas del Museo de La Plata, Geología* 30: 173–202.

1124 Furqué, G., and Camacho, H.H. 1972. El Cretácico Superior y Terciario de la región austral
1125 del lago Argentino, provincia de Santa Cruz. *Cuartas Jornadas Geológicas Argentinas*
1126 (Córdoba), *Actas* 4: 61–75.

1127 Hickey, L.J. 1973. Classification of the architecture of dicotyledonous leaves. *American*
1128 *Journal of Botany* 60: 17–33.

1129 Hinojosa, L.F., and Villagrán, C. 2005. Did South American Mixed Paleofloras evolve under
1130 termal equability or in the absence of an effective Andean barrier during the Cenozoic?
1131 *Palaeogeography, Palaeoclimatology and Palaeoecology* 217: 1–23.

1132 Hünicken, M.A. 1955. Depósitos neocretácicos y terciarios del extremo SSW de Santa Cruz.
1133 Cuenca carbonífera de Río Turbio. *Revista del Museo Argentino de Ciencias Naturales,*
1134 *Ciencias Geológicas* 4: 1–164.

1135 Hünicken, M.A. 1967. Flora terciaria de los estratos de Río Turbio, Santa Cruz (niveles
1136 plantíferos del arroyo Santa Flavia). *Revista de La Facultad de Ciencias Exactas, Físicas y*
1137 *Naturales de Córdoba* 27: 139–227.

1138 Hünicken, M.A. 1995. Floras cretácicas y terciarias. In: P.N. Stipanicic and M.A. Hünicken
1139 (Eds.), *Revisión y actualización de la obra paleobotánica de Kurtz en la República Argentina*
1140 *(I, II, III, IV, V, VI y VII).* Academia Nacional de Ciencias de Córdoba, Córdoba, p. 199–226.

1141 Leanza, A.F. 1972. Andes patagónicos australes. In: A.F. Leanza (Ed.), *Geología regional*
1142 *argentina*. Academia Nacional de Ciencias de Córdoba, Córdoba, p. 689–706.

1143 Malumián, N., and Caramés, A., 1997. Upper Campanian–Paleogene from the Río Turbio
1144 coal measures in southern Argentina: Micropaleontology and the Paleocene/Eocene
1145 boundary. *Journal of South American Earth Sciences* 10: 189–201.

1146 Malumián, N., and Panza, J. 2000. Hoja geológica 5172-III Yacimiento Río Turbio. *Boletín*
1147 *de los Servicios Geológicos Mineros Argentinos* 247: 1–108.

1148 Malumián, N., Hromic, T., and Nañez, C. 2013. El Paleógeno de la Cuenca de Magallanes:
1149 bioestratigrafía y discontuinidades. *Anales Instituto Patagonia* 41: 29–52.

1150 Marenssi, S.A., Limarino, C.O., Tripaldi, A., and Net, L.I. 2005. Fluvial systems variations in
1151 the Río Leona Formation: Tectonic and eustatic controls on the Oligocene evolution of the
1152 Austral (Magallanes) Basin, southernmost Argentina. *Journal of South American Earth*
1153 *Sciences* 19: 359–372.

1154 Menéndez, C. 1971. Floras terciarias de la Argentina. *Ameghiniana* 8: 357–370.

1155 Nullo, F.E., and Combina, A.M. 2002. Sedimentitas terciarias continentales. *XV Congreso*
1156 *Geológico Argentino* (Buenos Aires), *Actas* 1–13.

1157 Panti, C. 2010. [*Diversidad Florística durante el Paleógeno en Patagonia Austral.* Tesis
1158 Doctoral, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos
1159 Aires, 290 p. Unpublished.].

1160 Panti, C. 2011. Análisis paleoflorístico de la Formación Río Guillermo (Eoceno tardío–
1161 Oligoceno temprano?), Santa Cruz, Argentina. *Ameghiniana* 48: 320–335.

1162 Panti, C. 2014. Myrtaceae fossil leaves from the Río Turbio Formation (middle Eocene),
1163 Santa Cruz Province, Argentina. *Historical Biology* 28: 459–469.

1164 Panti, C. 2018. Fossil leaves of subtropical lineages in the Eocene–?Oligocene of southern
1165 Patagonia. *Historical Biology* doi.org/10.1080/08912963.2018.1488934.

1166 Panti, C. 2019. Southern beech (Nothofagaceae) fossil leaves from the Río Turbio Formation
1167 (Eocene–? Oligocene), Santa Cruz Province, Argentina. *Revista del Museo Argentino de*
1168 *Ciencias Naturales*, n.s. 21 (1): 69-85.

1169 Pujana, R.R. 2007. New fossil woods of Proteaceae from the Oligocene of southern
1170 Patagonia. *Australian Systematic Botany* 20: 119–125.

1171 Pujana, R.R. 2008. [*Estudio paleoxilológico del Paleógeno de Patagonia austral*
1172 *(Formaciones Río Leona, Río Guillermo y Río Turbio) y Antártida (Formación La Meseta).*
1173 Tesis Doctoral, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires,
1174 Argentina, 182 p. Unpublished.].

1175 Pujana, R.R. 2009a. Fossil woods from the Oligocene of southwestern Patagonia (Río Leona
1176 Formation). Atherospermataceae, Myrtaceae, Leguminosae and Anacardiaceae. *Ameghiniana*
1177 46: 523–535.

1178 Pujana, R.R., 2009b. Fossil woods from the Oligocene of southwestern Patagonia (Río Leona
1179 Formation). Rosaceae and Nothofagaceae. *Ameghiniana* 46: 621–636.

1180 Pujana, R.R., and Ruiz, D.P. 2017. *Podocarpoxylon* Gothan reviewed in the light of a new
1181 species from the Eocene of Patagonia. *IAWA Journal* 38: 220–244.

1182 Pujana, R.R., and Ruiz, D.P. 2019. Fossil woods from the Eocene–Oligocene (Río Turbio
1183 Formation) of southwestern Patagonia (Santa Cruz Province, Argentina). *IAWA Journal* 40:
1184 596–626.

1185 Pujana, R.R., Panti, C., Cuitiño, J.I., García Massino, J.L., and Mirabelli, S.L. 2015. A new
1186 megaflora (fossil wood, and leaves) from the Miocene of southwestern Patagonia.
1187 *Ameghiniana* 52: 350–366.

1188 Romero, E.J. 1977. *Polen de gimnospermas y fagáceas de la Formación Río Turbio*
1189 *(Eoceno), Santa Cruz, Argentina.* Fundación para la Educación, la Ciencia y la Cultura,
1190 Buenos Aires, 207 p.

1191 Romero, E.J. 1978. Paleoecología y Paleofitogeografía de las tafofloras del Cenofítico de
1192 Argentina y áreas vecinas. *Ameghiniana* 15: 209–227.

1193 Romero, E.J. 1986. Paleogene phytogeography and climatology of South America. *Annals of*
1194 *the Missouri Botanical Garden* 73: 449–461.

1195 Romero, E.J., and Zamaloa, M.C. 1985. Polen de angiospermas de la Formación Río Turbio
1196 (Eoceno), provincia de Santa Cruz, República Argentina. *Ameghiniana* 22: 43–51.

1197 Romero, E.J., and Dibbern, M.C., 1985. A review of the species described as *Fagus* and
1198 *Nothofagus* by Dusén. *Palaeontographica B* 197, 123–137.

1199 Romero, E.J., and Castro, M.J. 1986. Material fúngico y granos de polen de angiospermas de
1200 la Formación Río Turbio (Eoceno), provincia de Santa Cruz, República Argentina.
1201 *Ameghiniana* 23: 101–118.

1202 Spegazzini, C. 1924. Sobre algunas impresiones vegetales eocénicas de Patagonia.
1203 *Comunicaciones del Museo Nacional de Historia Natural* 2: 95–107.

1204 Tanai, T. 1986. Phytogeographic and phylogenetic history of the genus *Nothofagus* Bl.
1205 (Fagaceae) in the Southern hemisphere. *Journal Faculty of Sciences, Hokkaido University* 4:
1206 505–582.

1207 Torres, T., Cisterna, M., Llanos, A., Galleguillos, H., and Le Roux, J. 2009. Nuevos registros
1208 de *Nothofagus* Bl. en Sierra Baguales, Ultima Esperanza, Patagonia, Chile. *XII Congreso*
1209 *Geológico Chileno* (Santiago), *Actas*: 1–4.

1210 Torres, T., Gutiérrez, N.M., Bostelmann, J.E., Le Roux, J.P., Oyarzún, J.L., Ugalde, R.,
1211 Otero, R., and Herve, F. 2013. Exceptionally preserved fossil flora of the Río Leona
1212 Formation in Sierra Baguales, Magallanes, Chile: Insights into the early Neogene Patagonian
1213 ecosystems. *Bollettino di Geofisica* 54: 352–355.

1214 Tosolini, A.M., Cantrill, D., and Frances, J. 2013. Paleocene flora from Seymour Island,
1215 Antartica, Revision of Dusén's (1908) angiosperm taxa. *Alcheringa* 37: 1–26.

1216 Troncoso, A., and Romero, E.J. 1998. Evolución de las comunidades florísticas en el extremo
1217 sur de Sudamérica durante el Cenofítico. *VI Congreso Latinoamericano de Botánica*
1218 (Missouri), *Proceedings*, p. 149–172.

1219 Vento, B., Gandolfo, M.A., Nixon, K.C., and Prámparo, M. 2016. Paleofloristic assemblage
1220 from the Paleogene Río Guillermo Formation, Argentina: Preliminary results of phylogenetic.
1221 *Historical Biology* 29: 93–107.

1222 Vento, B., and Prámparo, M. 2018. Angiosperm association from the Río Turbio Formation
1223 (Eocene–?Oligocene) Santa Cruz, Argentina: revision of Hünicken's (1955) fossil leaves
1224 collection. *Alcheringa* 42: 125–153.

1225 Wilf, P., Cúneo, N.R., Johnson, K.R., Hicks, J.F., Wing, S.L., and Obradovich, J.D. 2003.
1226 High plant diversity in Eocene South America: Evidence from Patagonia. *Science* 300: 122–
1227 125.

Figure 1. 1, Map showing the Río Turbio region. **2,** satellite image showing the approximate position of the fossiliferous localities. Numbers correspond to original Frenguelli's (1941) localities.

Figure 2. Stratigraphic chart, names corresponds to the formations or stratigraphic units in the Río Turbio region. Squares indicate the approximately stratigraphic position of the ten Frenguelli's localities. Circles and squares indicate radiometric dating. Black circles taken from Fosdick *et al.* (2015), volcanic ash and dacite. Gray circles from Fosdick *et al.* (2011), detritic zircones. Black squares from Cuitiño *et al.* 2016. *Arroyo de Los Ciervos strata is not a formally defined formation (see Pujana *et al.* 2015).

Figure 3. Outcrops close to original Frenguelli's localities. **1,** locality 2, Río Guillermo Formation. **2,** locality 3, upper member of the Río Turbio Formation. **3,** locality 6, Río Leona Formation. **4,** locality 7, upper member of the Río Turbio Formation. **5,** locality 8, Río Leona Formation. **6,** locality 9, Río Guillermo/Río Leona Formations.

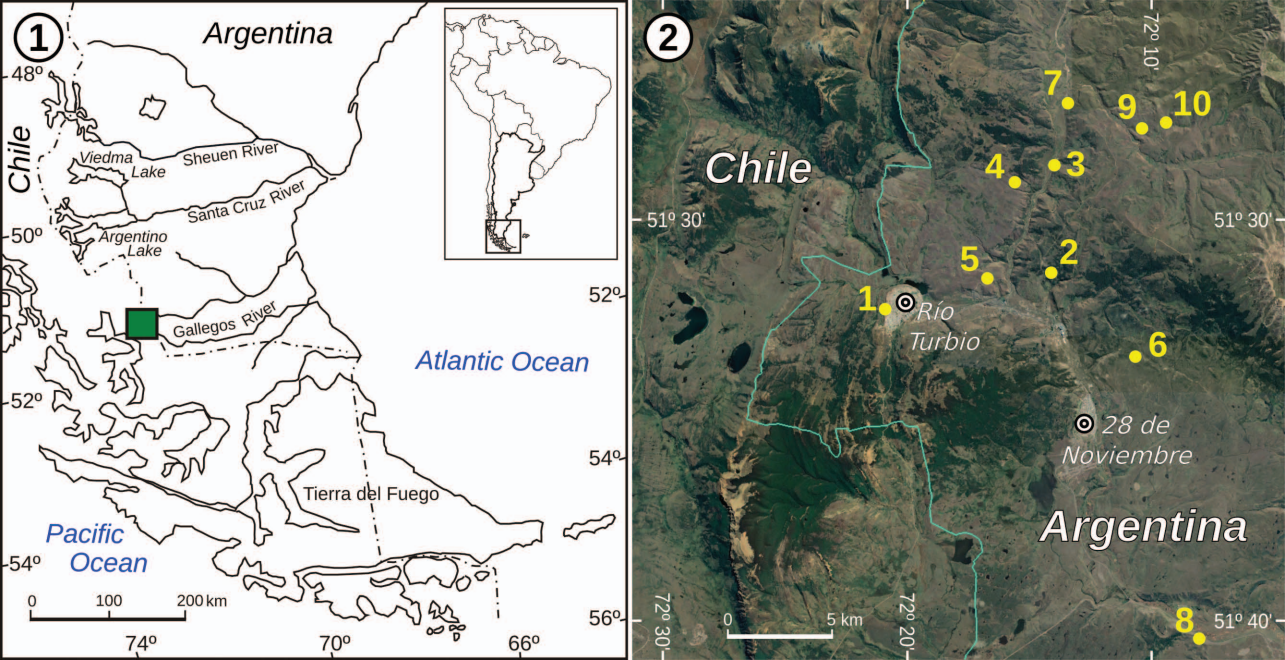
Figure 4. 1, 4. *Escallonia*? sp., LPPB 4079. **1**, general view. **4**, venation detail. **2, 5.** *Ocotea*? sp., LPPB 4071. **2**, General view. **5**, venation detail. **3**, **6**. *Persea*? sp. Engelhardt, LPPB 4107. **3**, General view. **6**, venation detail. General view. Scale bars= 1 cm (general view); 0.5 cm (venation detail).

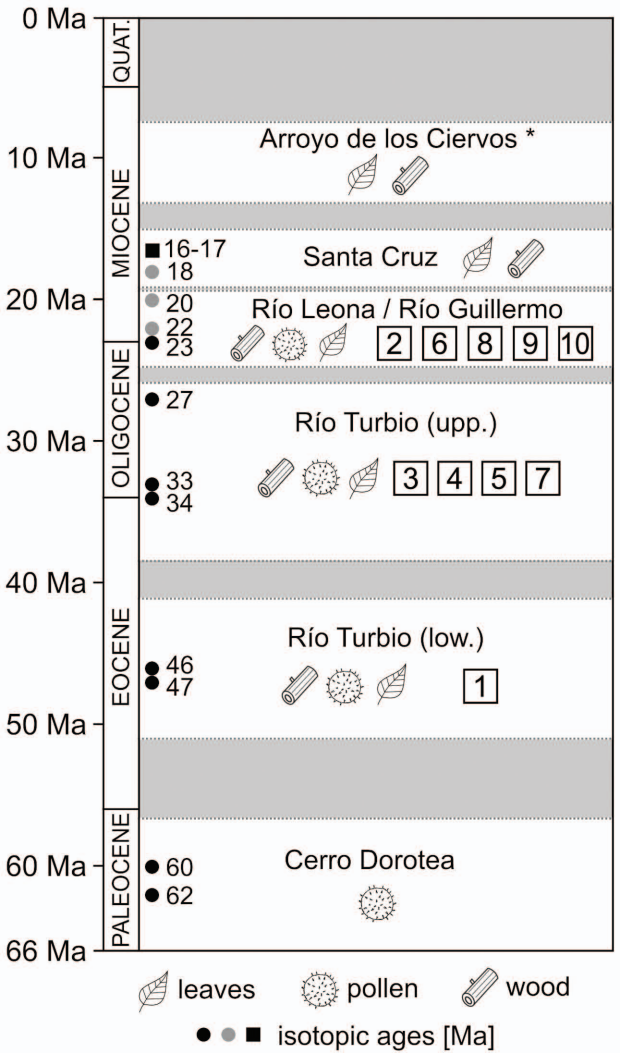
Figure 5. **1**, **4**. *Nothofagus densinervosa* Dusén, LPPB 4084. **1**, general view. **4**, venation detail. **2**, **5**. *Nothofagus dicksonii* (Dusén) Tanai, LPPB 4090. **2**, general view. **5**, venation detail. **3, 6.** *Nothofagus elongata* Dusén, LPPB 4082. **3**, general view. **6**, venation detail. **7, 8.** *Nothofagus variabilis* Dusén, LPPB 4082. **7**, general view. **8**, venation detail. Scale bars= 1 cm (general view); 0.5 cm (venation detail).

Figure 6. 1, **4**. *Acaena brandmayri* Frenguelli, LPPB 4101. **1**, general view. **4**, venation detail. **2**, **5**. *Thouinia philippii*? Engelhardt, LPPB 4115. **2**, general view. **5**, venation detail. **3, 6.** *Azara celastriniformis*? Berry, LPPB 4081. **3**, general view. **6**, venation detail. Scale bars= 1 cm (general view); 0.5 cm (venation detail).

Figure 7. 1, **4**. *Escalloniiphyllum* sp., LPPB 4078. **1**, general view. **4,** venation detail. **2, 5.** *Hydrangeiphyllum affine* Dusén, LPPB 4076. **2**, general view. **5,** venation detail. **3**. angiosperm incertae sedis 1, LPPB 4072. **6, 7**. *Ribes* sp., LPPB 4097. **6**, general view. **7**, venation detail. Scale bars= 1 cm (general view); 0.5 cm (venation detail).

Figure 8. **1**, angiosperm incertae sedis 2, LPPB 4017. **2**, *Nothofagus* sp. 1, LPPB 4091. **3**, *Nothofagus* sp. 4, LPPB 4109. **4**, *Camphoromea speciosa* Engelhardt, LPPB 4075. **5**, *Coprosoma incerta* Berry, LPPB 4116. **6**, fragment of rock with several partial remains of leaves, LPPB 4082. Scale bars= 1 cm.

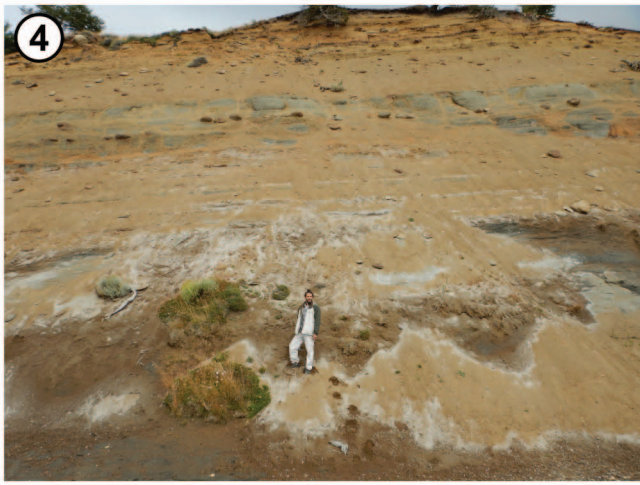

1
Argentina
Chile
48º
50º
52º
54º
56º
74º
70º
66º
Viedma Lake
Sheuen River
Santa Cruz River
Argentino Lake
Gallegos River
Atlantic Ocean
Tierra del Fuego
Pacific Ocean
0
100
200 km
2
Chile
Argentina
72º 10'
51º 30'
72º 30'
72º 20'
51º 40'
0
5 km
1
2
3
4
5
6
7
8
9
10
Río Turbio
28 de Noviembre

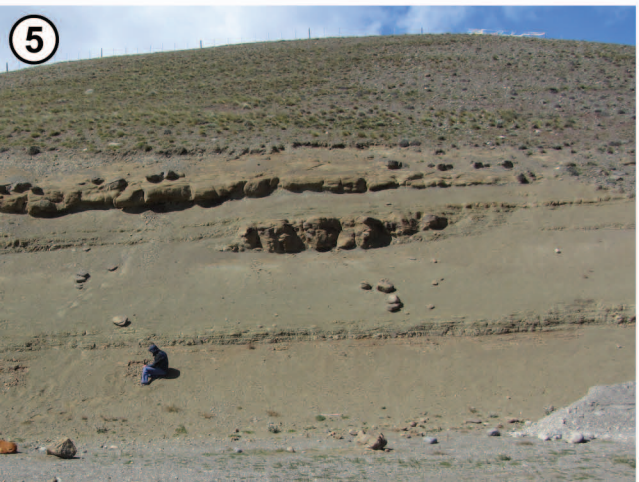

0 Ma
10 Ma
20 Ma
30 Ma
40 Ma
50 Ma
60 Ma
66 Ma
QUAT.
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
Arroyo de los Ciervos *
16-17
18
Santa Cruz
20
22
23
Río Leona / Río Guillermo
2
6
8
9
10
27
Río Turbio (upp.)
33
34
3
4
5
7
Río Turbio (low.)
46
47
1
60
62
Cerro Dorotea
leaves
pollen
wood
isotopic ages [Ma]


1

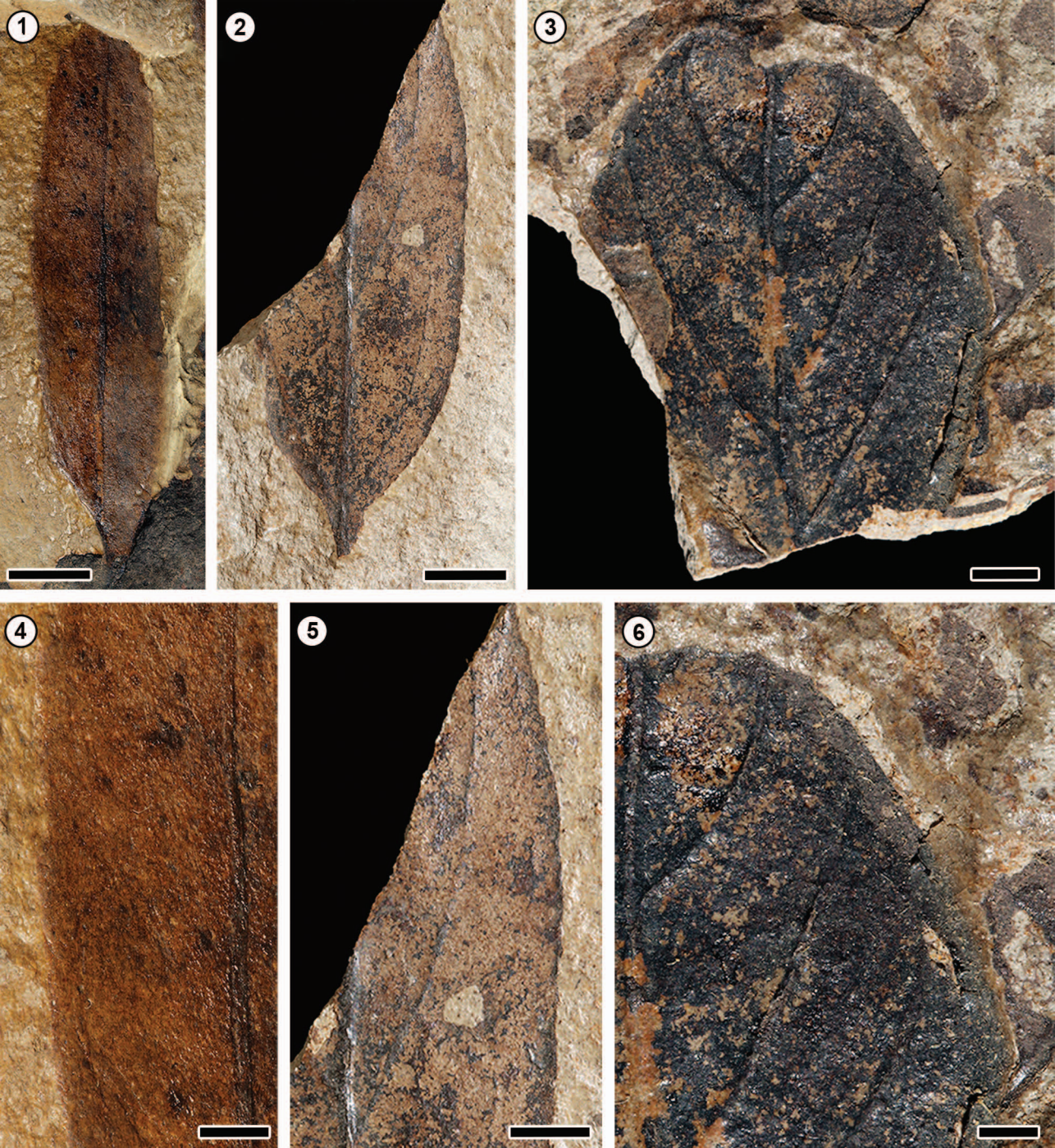

2

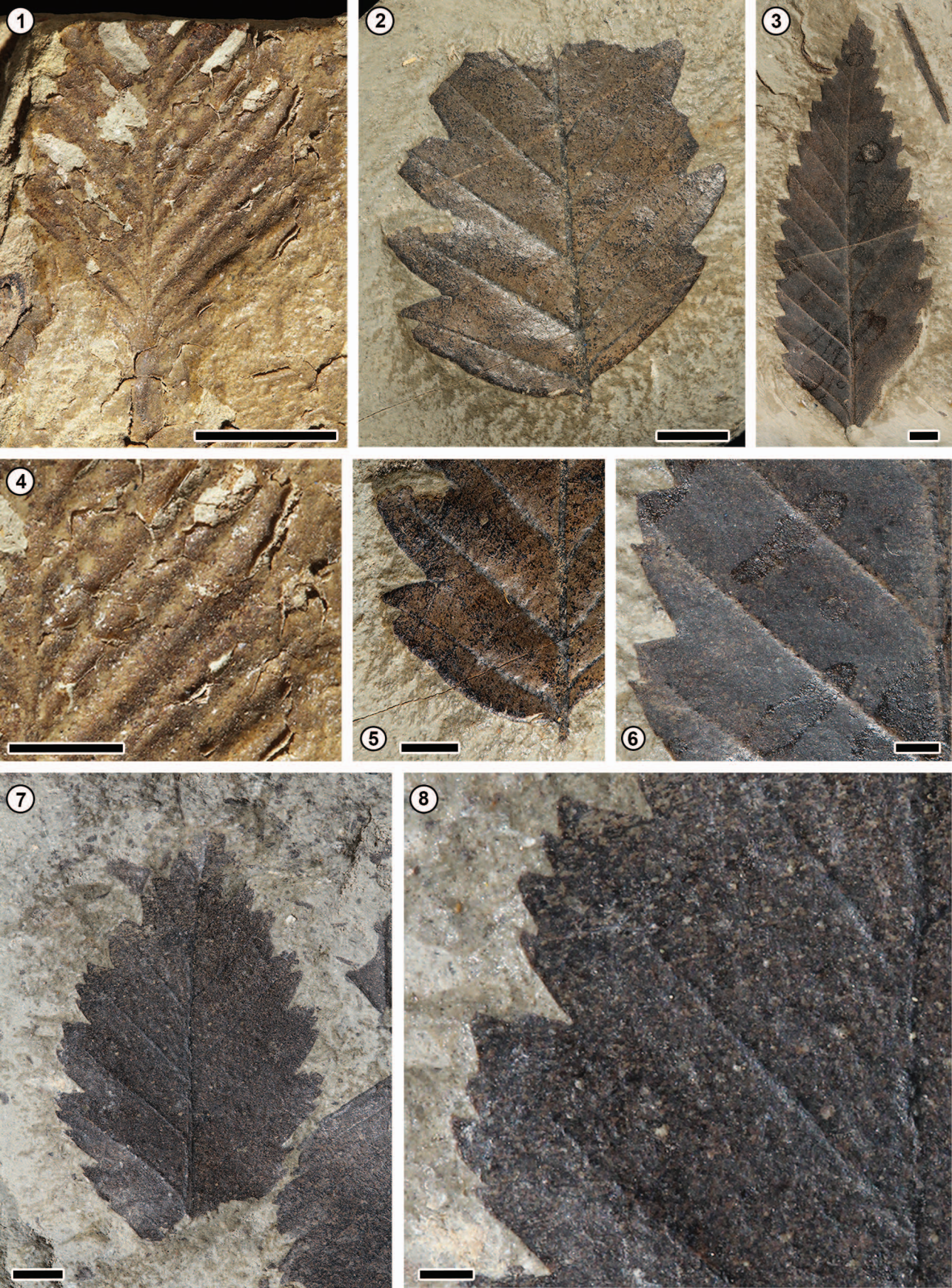

3


4


5


6


1
2
3
4
5
6


1
2
3
4
5
6
7
8


1
2
3
4
5
6

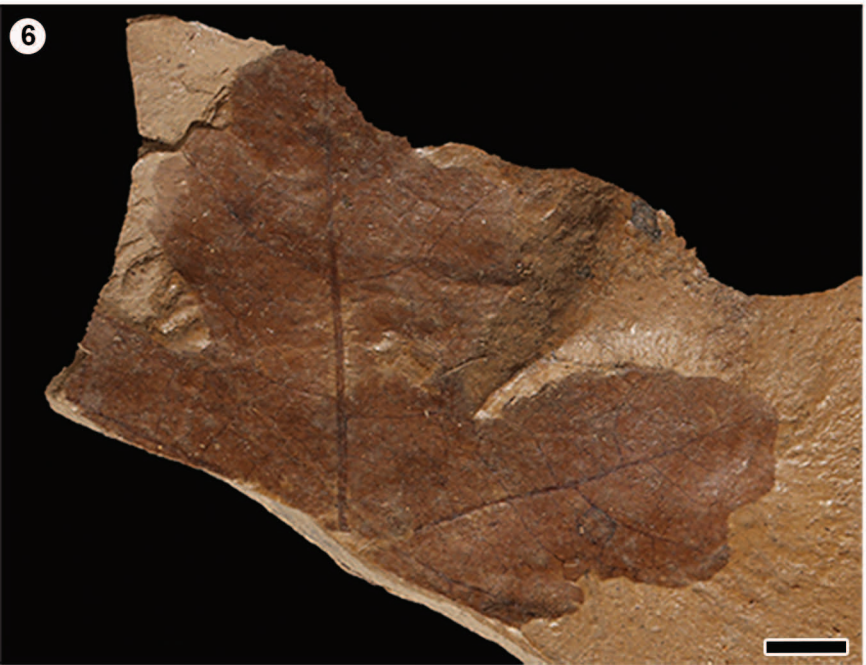

1


2


3


4


5


6


7

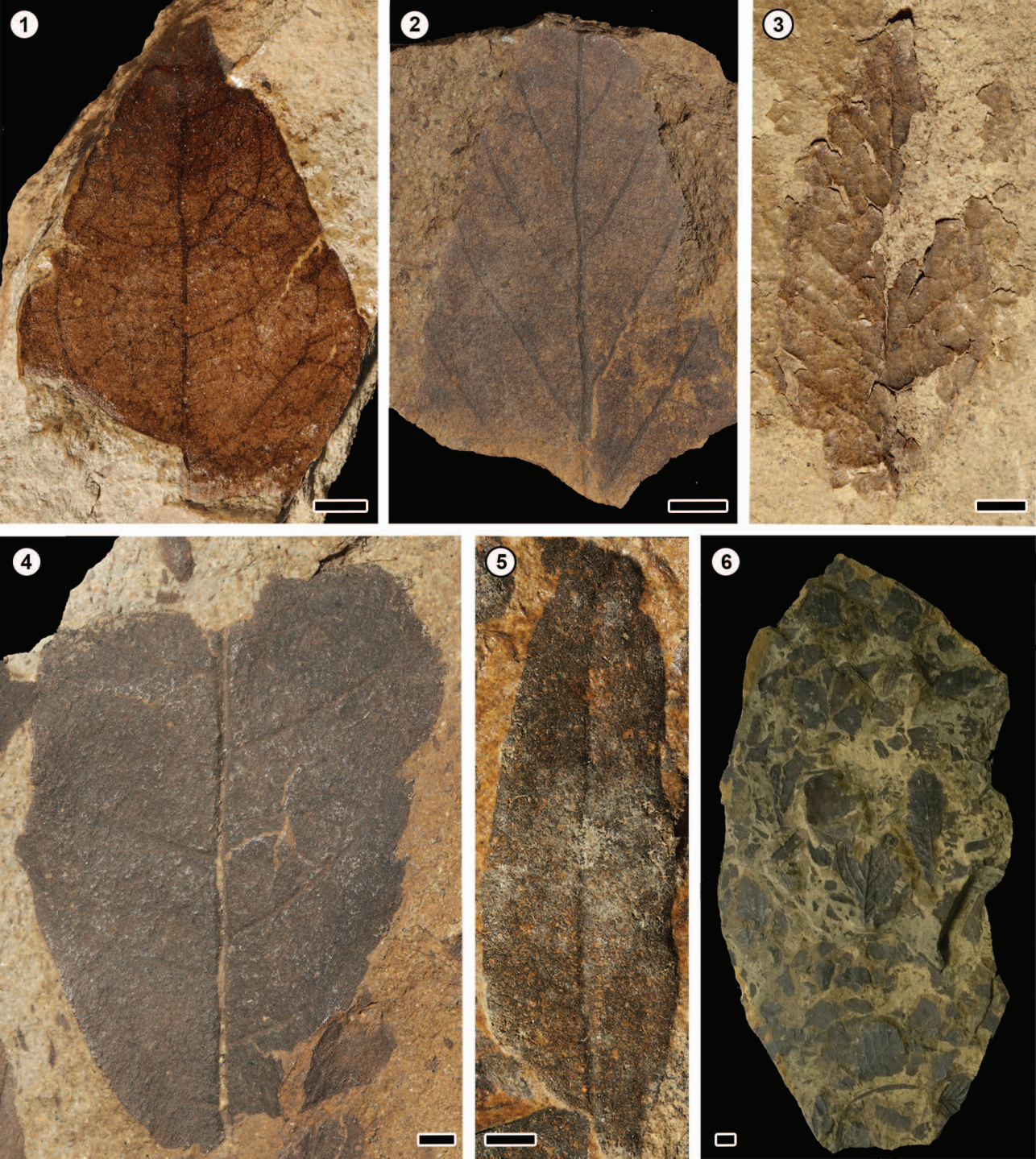

1
2
3
4
5
6

TABLE 1. Systematic revision of Frenguelli's (1941) collection

Frenguelli (1941)	*Originally*	*Present work*	*Family*	*Procedence*	*Other occurrences*
Acaena brandmayri	*Described, illustrated and drawn*	*Accepted*	*Rosaceae*	*Río Guillermo Fm. (10)*	-
Azara celastriniformis	*Illustrated but not described*	Azara celastriniformis?	*Salicaceae*	*Río Guillermo Fm. (10)*	*Berry, 1938*
Camphoromea speciosa	*Neither described or illustrated*	*Doubtful: very bad preservation*	*Lauraceae*	*Río Turbio Fm. (5)*	*Engelhardt, 1891; Troncoso, 1992; Troncoso et al., 2002*
Coprosoma incerta	*Neither described or illustrated*	*Doubtful: very bad preservation*	*Rubiaceae*	*Río Turbio Fm. (1)*	*Berry, 1938*
Doliocarpus oblongifolia	*Neither described or illustrated*	*Angiosperm indet. 2*	*Dilleniaceae*	*Río Turbio Fm. (5)*	*Engelhardt, 1891*
Escallonia sp.	*Described, illustrated and drawn*	Escallonia? sp.	*Escalloniaceae*	*Río Turbio Fm. (5)*	-
Escalloniiphyllum sp.	*Illustrated but not described*	*Accepted*	*Indet*	*Río Leona (6)*	*Dusén, 1899*
Fagus dicksonii	*Illustrated but not described*	N. dicksonii	*Nothofagaceae*	*Río Turbio Fm. (4)*	*Dusén, 1899; Berry, 1937; Tanai, 1986*
Fagus integrifolia	*Illustrated but not described*	Nothofagus sp. 1	*Fagaceae*	*Río Turbio Fm. (4)*	*Dusén, 1899; Berry, 1937; Durango de Cabrera and Vergel, 1989*
Fagus subferruginea	*Illustrated but not described*	Nothofagus sp. 2	*Fagaceae*	*Río Turbio Fm. (3, 4, 5)*	*Dusén, 1899; Berry, 1928; Berry, 1937; Hünicken, 1967*
Hydrangeiphyllum affine	*Neither described or illustrated*	*Accepted*	*Indet*	*Río Turbio Fm. (5)*	*Dusén, 1899*
Hoffmania protogea	*Neither described or illustrated*	*Doubtful: lost material*	*Rubiaceae*	*Río Turbio Fm. (1)*	*Engelhardt, 1891; Berry, 1922; Berry, 1938*
Mespilodaphne longifolia	*Illustrated and drawn, but no described*	*Angiosperm indet. 1*	*Indet.*	*Río Guillermo Fm. (2)*	*Engelhardt, 1891*
N. australis	*Illustrated but not described*	Nothofagus sp. 3	*Nothofagaceae*	*Río Turbio and Río Guillermo Fm. (4, 10)*	*Dusén, 1899; Fiori, 1939*
N. crenulata	*Illustrated but not described*	N. cf. crenulata	*Nothofagaceae*	*Río Guillermo Fm. (10)*	*Dusén, 1899; Tanai, 1986; Durango de Cabrera and Vergel, 1989; Vento et al., 2016*

Nothofagus densinervosa	*Illustrated but not described*	*Accepted*	*Nothofagaceae*	*Río Guillermo Fm. (9)*	*Dusén, 1899; 1908; Fiori, 1939; Hünicken, 1967; Tanai, 1986; Tosolini et al., 2013*
N. elongata	*Illustrated but not described*	*Accepted*	*Nothofagaceae*	*Río Turbio Fm. (4, 6)*	*Dusén, 1899; Berry, 1937; Hünicken, 1967; Durango de Cabrera and Vergel, 1989; Panti, 2011; Vento et al., 2016*
N. lanceolata	*Illustrated but not described*	*sin.* N. elongata	*Nothofagaceae*	*Río Turbio Fm. (4)*	-
N. magelhaenica	*Illustrated but not described*	N. cf. magelhaenica	*Nothofagaceae*	*Río Guillermo Fm. (10)*	*Engelhardt, 1891; Dusén, 1899;Tanai, 1986; Caviglia and Zamaloa, 2014; César et al., 2015*
N. cfr. obliqua	*Illustrated but not described*	*sin.* N. variabilis	*Nothofagaceae*	*Río Leona (6)*	-
N. simplicidens	*Illustrated but not described*	Nothofagus sp. 4	*Nothofagaceae*	*Río Turbio, Río Guillermo and Río Leona Fm. (2, 3, 6, 7, 8, 9)*	*Dusén, 1899; Berry, 1928; Fiori, 1939; Tanai, 1986; Durango de Cabrera and Vergel, 1989; Panti, 2011; Caviglia and Zamaloa, 2014; César et al., 2015*
N. variabilis	*Illustrated but not described*	*Accepted*	*Nothofagaceae*	*Río Turbio and Río Leona Fm. (3, 4, 6)*	*Dusén, 1899; Hünicken, 1967; Tanai, 1986; Panti, 2011; Caviglia and Zamaloa, 2014; Vento et al., 2016*
Oreodaphne? sp.	*Neither described or illustrated*	Ocotea? sp.	*Lauraceae*	*Río Turbio Fm. (5)*	-
Persea cf. microphylla	*Neither described or illustrated*	Persea? sp.	*Lauraceae*	*Río Turbio Fm. (5)*	-
Ribes sp.	*Described, illustrated and drawn*	Ribes? sp.	*Grossulariaceae*	*Río Guillermo Fm. (3)*	-
Rubus primaverae	*Described, illustrated and drawn*	*Accepted*	*Rosaceae*	*Río Guillermo Fm. (10)*	*César et al., 2015*
Thouinia philippi	*Neither described or illustrated*	Thouinia philippi?	*Sapindaceae*	*Río Turbio Fm. (5)*	*Engelhardt, 1891; Berry, 1922*

Appendix. List of the specimens found in Frenguelli (1941) collection

Collection number	***Taxon/taxa***	***Provenance***	***Illustration***	***Observations***
4070	Oreodaphne? sp.	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4071	Oreodaphne? sp.	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4072	Mespilodaphne longifolia	*Río Turbio valley between Ea. Primavera and Ea. Dorotea (2)*	*Not illustrated*	
4073	Mespilodaphne longifolia	*Río Turbio valley between Ea. Primavera and Ea. Dorotea (2)*	*Not illustrated*	
4074	Mespilodaphne longifolia	*Río Turbio valley between Ea. Primavera and Ea. Dorotea (2)*	*Drawn by Frenguelli (1941) in Plate 1, fig. 3*	
4075	Camphoromea speciosa	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4076	Hydrangeiphyllum affine	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4077	Doliocarpus oblongifolia	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4078	Escalloniiphyllum sp.	*outcrop one km east of Ea. Dorotea (6)*	*Illustrated by Frenguelli (1941) in Plate 6, fig. 2*	
4079	Escallonia sp.	*Downroad between Ea. San José and Ea. Primavera (5)*	*Drawn and illustrated bt Frenguelli (1941) in Plate 1, fig. 4 and Plate 3, fig. 4*	
4080	Azara celastriniformis	*Upper course of Turbio river(10)*	*Illustrated by Frenguelli (1941) in Plate 3, fig. 2*	
4081	Nothofagus crenulata, N. magelhaenica and N. variabilis	*Upper course of Turbio river (10)*	*Not illustrated*	
4082	N. variabilis, N. australis, N. lanceolata and N. elongata	*Río Turbio valley, south of Ea. Primavera (4)*	*Illustrated by Frenguelli (1941) in Plate 5*	
4083	N. simplicidens	*Río Turbio valley between Ea. Primavera and Ea. Dorotea (2)*	*Illustrated by Frenguelli (1941) in Plate 4, fig. 2*	
4084	N. densinervosa	*Upper course of Turbio river, between Ea. Primavera and 6th lot (9)*	*Illustrated by Frenguelli (1941) in Plate 4, fig. 3*	
4085	N. simplicidens	*Upper course of Turbio river, between Ea. Primavera and 6th lot (9)*	*Not illustrated*	
4086	N. lanceolata and N. simplicidens	*Río Turbio valley, south of Ea. Primavera (4)*	*Illustrated by Frenguelli (1941) in Plate 4, fig. 1*	
4087	N. lanceolata	*Río Turbio valley, south of Ea. Primavera (4)*	*Not illustrated*	*Material not found*
4088	N. simplicidens	*Río Turbio valley, south of Ea. Primavera (4)*	*Not illustrated*	*Material not found*
4089	N. variabilis	*Río Turbio valley, south of Ea. Primavera (4)*	*Not illustrated*	*Material not found*
4090	N. dicksoni	*Río Turbio valley, south of Ea. Primavera (4)*	*Illustrated by Frenguelli (1941) in Plate 4, fig. 4*	
4091	F. subferruginea	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4092	N. cfr. obliqua	*Outcrop one km east of Ea. Dorotea (6)*	*Not illustrated*	
4093	N. elongata and Fagus sp.	*Outcrop one km east of Ea. Dorotea (6)*	*Illustrated by Frenguelli (1941) in Plate 8, fig. 1*	

4094	Pteris ñirihuaensis	*Río Turbio valley, south of Ea. Primavera (4)*	*Not illustrated*	
4095	F. subferruginea, N. variabilis and Pteris ñirihuaensis	*Ea. Primavera (3)*	*Not illustrated*	*Material not found*
4096	N. variabilis, Fagus subferruginea and Dryopteris? sp.	*Ea. Primavera (3)*	*Illustrated by Frenguelli (1941) in Plate 6, fig. 1 and Plate 8, fig. 2*	
4097	Ribes sp.	*Ea. Primavera (3)*	*Drawn by Frenguelli (1941) in Plate 1, fig. 5*	
4098	Rubus primaverae	*Upper course of Turbio river (10)*	*Drawn by Frenguelli (1941) in Plate 1, fig. 1. Illustrated by César et al. (2015)*	
4099	Rubus primaverae	*Upper course of Turbio river (10)*	*Not illustrated*	
4100	Rubus primaverae	*Upper course of Turbio river (10)*	*Drawn by Frenguelli (1941) in Plate 1, fig. 5; and illustrated in Plate 2*	
4101	Acaena brandmayri and N. australis	*Upper course of Turbio river (10)*	*Drawn by Frenguelli (1941) in Plate 1, fig. 3; and illustrated in Plate 3, fig. 3*	
4102	Saxegothopsis fueguianus	*Outcrop one km east of Ea. Dorotea (6)*	*Not illustrated*	
4103	Saxegothopsis fueguianus	*Outcrop one km east of Ea. Dorotea (6)*	*Not illustrated*	
4104	N. variabilis, Fagus sp. and Filicites sp.	*Outcrop one km east of Ea. Dorotea (6)*	*Not illustrated*	
4105	Pecopteris buhsei	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4106	Pecopteris buhsei	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4107	Persea cf. microphylla	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4108	Pteris sp.	*Downroad between Ea. San José and Ea. Primavera (5)*	*Illustrated by Frenguelli (1941) in Plate 6, fig. 4*	*noted as LPPB 4018*
4109	N. simplicidens	*Upper course of Turbio river, one km upriver of Ea. Primavera (7)*	*Not illustrated*	
4110	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*	
4111	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Illustrated by Frenguelli (1941) in Plate 7*	
4112	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*	
4113	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Illustrated by Frenguelli (1941) in Plate 7*	
4114	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Illustrated by Frenguelli (1941) in Plate 7*	
4115	Thouinia philippii	*Downroad between Ea. San José and Ea. Primavera (5)*	*Not illustrated*	
4116	Coprosoma incerta	*One km southeast of Estancia (=Ea.) San José . (1)*	*Not illustrated*	
4117	N. simplicidens	*Upper course of Turbio river, one km upriver of Ea. Primavera (7)*	*Not illustrated*	
4118	Scirpites sp.	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*	
4119	Scirpites sp.	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*	
4120	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*	

4121	Blechnum turbioense	*Outcrop near Ea. Rospentek (8)*	*Not illustrated*