



Revista Chilena de Historia Natural

ISSN: 0716-078X

editorial@revchilhistnat.com

Sociedad de Biología de Chile

Chile

LEPPE, MARCELO; MIHOC, MARITZA; VARELA, NATALIA; STINNESBECK,  
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Revista Chilena de Historia Natural, vol. 85, núm. 4, 2012, pp. 369-392

Sociedad de Biología de Chile

Santiago, Chile

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## SPECIAL FEATURE: 100 YEARS OF ANTARCTIC RESEARCH

## Evolution of the Austral-Antarctic flora during the Cretaceous: New insights from a paleobiogeographic perspective

### Evolución de la flora austral-antártica durante el Cretácico: Una nueva mirada desde una perspectiva paleobiogeográfica

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#### ABSTRACT

Forest environments have continuously existed in Antarctica since the late Paleozoic and only disappeared from this continent since the Neogene. Nevertheless, the structure of these forests underwent substantial evolutionary changes. During the late Cretaceous, forests dominated by conifers and pteridophytes were gradually replaced by angiosperm-dominated forests. Elements common to these Antarctic forests are important constituents of the recent Valdivian Forest. During the Turonian stage of the Late Cretaceous, the Antarctic Peninsula and Patagonia were reconnected by a land bridge after a separation since the end of the Jurassic. Using biogeographic tools applied to the palynological and leaf imprint record, outcrops of Campanian-Maastrichtian age were studied from the Snow Hill, James Ross and Seymour (Marambio) Islands in the James Ross basin, Antarctica; Skua Bay, Half Three Point, Price Point and Zamek Hill on King George Island, Antarctica, and Rocallosa Point, Cerro Guido, Las Chinas, Dorotea Hill, Cazador Hill and La Irene in Chilean-Argentinian Patagonia, comparing the current distribution and the paleogeography, as well as the influence of potential areas of endemism and vicariant events. The analysis indicates that vegetation evolved under environmental conditions subject to intense volcanic and climatic disturbances, with changes from a period with extreme greenhouse climate (Turonian-Campanian) to strong cooling during the Maastrichtian. We suggest that a continuous forest existed in southern South America and Antarctica, which was shaped during the Latest Cretaceous by the presence of marine basins and and intermittent connection and disconnection of the flora.

**Key words:** Antarctica, Cretaceous, Magellan's basin, paleobotany, Patagonia.

#### RESUMEN

Se sabe que al menos desde fines del Paleozoico ambientes boscosos habrían existido en la Antártica y habrían desaparecido de ella solo a fines del Terciario. Sin embargo, la estructura no ha sido la misma, evolucionando desde un bosque dominado por coníferas y pteridófitas durante el Cretácico Inferior, a bosques dominados por angiospermas a partir del Cretácico Superior, con elementos comunes a los constituyentes actuales de la Selva Valdiviana. Durante el Turoniano la Península Antártica y Patagonia se reunieron por un puente terrestre rompiendo millones de años de desconexión, y gracias a una variedad de ambientes de sedimentación, se han conservado numerosos vestigios de la flora que cubrió ambos subcontinentes. Mediante herramientas biogeográficas aplicadas al registro palinológico y de improntas foliares, afloramientos campaniano-maastrichtianos de islas Snow Hill, James Ross y Seymour (Marambio), en la cuenca de James Ross, Antártica; bahía Skúa, punta Half Three, punta Price y cerro Zamek, en la isla Rey Jorge, Antártica; y punta Rocallosa, cerro Guido, Las Chinas, cerro Dorotea, cerro Cazador y La Irene en la Patagonia chileno-argentina, se estudió la relación entre la distribución actual y la paleogeografía, considerando potenciales eventos vicariantes y áreas de endemismo establecidas. Reconstrucciones paleoecológicas muestran que los elencos vegetacionales habrían evolucionado en el marco de ambientes sometidos a intensa perturbación volcánica y climáticamente habrían estado sometidos a uno de los lapsos más cálidos de la historia natural, pero con fuertes pulsos de enfriamiento durante el Campaniano y Maastrichtiano. Se sostiene que entre el Maastrichtiano y el Eoceno, existió un continuo forestal entre Patagonia y Sudamérica que habría sido modelado por la presencia de las cuencas marinas finicretácicas y la intermitente conexión-desconexión de las floras.

**Palabras clave:** Antártica, Cretácico, cuenca de Magallanes, paleobotánica, Patagonia.

## INTRODUCTION

Forest ecosystems have existed in Antarctica since the Late Paleozoic (Axelrod 1984, Hunt & Poole 2003, Taylor et al. 1992) evolving mainly in conditions warmer than the present, until the Neogene (Cantrill 2001, Francis & Poole 2002), when a sharp drop in temperature occurred at the Oligo-Miocene boundary. The structure of vegetation, however, underwent considerable changes, from forests dominated by conifers and pteridophytes during the Early Cretaceous (Falcon-Lang et al. 2001) to forests dominated by angiosperms, similar to Valdivian forests of southern Chile. These last conditions gradually established during the Late Cretaceous, after the massive radiation of angiosperms throughout Gondwana. Common elements of these Upper Cretaceous floras of Antarctica are now well represented in different types of modern Chilean forests (Dutra & Batten 2000, Poole et al. 2001, Cantrill & Poole 2002, Leppe et al. 2007). Deposits of Late Cretaceous and Paleogene age are well recorded from the James Ross Basin and the Fildes Peninsula Group, King George Island, as well as from the Magallanes basin in southern Patagonia (Cantrill 1997, 2000, Torres et al. 1997, Césari et al. 1999). Paleocological reconstructions indicate that floristic casts have evolved in the context of environments under intense volcanic disturbance (Poole et al. 2001). Climatically, the Late Cretaceous was one of the warmest periods of the Phanerozoic, with warm pulses during the Turonian and cold events during the Maastrichtian (Huber 1998). Low temperatures near to the end of the Cretaceous were again followed by an increase in temperature, or climatic optimum, during the Paleocene and Eocene (Upchurch et al. 1998).

A terrestrial connection during the Campanian-Maastrichtian between South America and Antarctica is crucial to understand the establishment of a new structure in the austral vegetation. Upper Jurassic-Lower Cretaceous taxa evolved isolated in both Antarctic and Patagonian communities until the reestablishment of a terrestrial bridge between both landmasses during the Turonian (Pankhurst & Smellie 1983, Smellie et al. 1984). During the Campanian-Maastrichtian this connection led to a new mixed Antarctic-Patagonian biota predecessor of modern

southern South American temperate forests. Recently, new arguments have extended the discussion about the origins and persistence of these southern temperate biota, particularly of the Valdivian forest, a broadleaf and mixed forest ecoregion on the west coast of southern South America, mostly in Chile and western Argentina (Poole et al. 2003, Povilauskas et al. 2008). Several authors have pointed out that the Valdivian forest is the closest equivalent to Upper Cretaceous-Paleogene forests from Antarctica (Axelrod 1984, Francis & Poole 2002, Cantrill 2001, Poole et al. 2003), but this hypothesis was based only on a few taxa or localities. During the past 10 years, however, enormous volumes of multidisciplinary data were published on paleomagnetism, sedimentary provenance, paleobiogeography, molecular phylogeny and paleoecology, among many other disciplines. These datasets offer alternative or complementary explanations to the complex relationship between the geological and biological evolution of the Antarctic-Patagonian region, from which integrated studies have been scarce.

*Geological setting*

Movements of two major plates of the former Gondwana continent, South America and Antarctica, control the modern tectonic scenario in the region. These are in turn linked to four minor plates: Scotia, Drake, South Sandwich and South Shetland (Augusto et al. 2007). The Late Cretaceous was the time when the final breakup of Gondwana occurred and led to the isolation of Antarctica. Paleontological data indicate that the Antarctic Peninsula was adjacent to southern South America during almost all of the Mesozoic, allowing for an active migration and exchange of terrestrial faunal and floral assemblages. This interchange between South America and the Antarctic Peninsula ceased during the Paleogene when a shallow seaway developed, but the final continent separation did not occur until the early Neogene with the development of deep sea conditions in the Drake passage (Zinsmeister 1987).

The Austral Basin is located in southern South Patagonia and is composed of three sub-basins (Suarez et al. 2009). The Rocas Verdes Basin was active during the Late

Jurassic and Early Cretaceous and was formed by an extensional tectonic regime associated with the separation of southern Gondwana (Dalziel & Cortés 1972, Suarez 1979, Dalziel 1981). The closure of the Rocas Verdes Basin during the mid-Cretaceous was accompanied by the collision of the Cape Horn Microplate with South America (Dalziel 1981). This is the moment when deposition started in the Magallanes Basin (Suarez et al. 2009). The Magallanes Basin was initially filled with turbiditic siliciclastic sediment (Natland et al. 1974, Fildani et al. 2007, Pardo et al. 2012), with the proto-Andes as the main source of sediment infill (Fildani et al. 2007). The Upper Cretaceous sediment sequence of the Magallanes basin the Última Esperanza Province reflects gradual shallowing towards slope and subsequently to shallow marine environments prograding to the south. Deltaic environments first occurred in the Lago Argentino area. An example of the massive retrogradational marine deposits in the Magallanes Basin is exposed in the Tres Pasos Formation, Última Esperanza Province, equivalent to Rosa and Fuentes Formations in the Seno Skyring and Brunswick Peninsula area (Fig. 1). In this region deep marine environments were gradually replaced by

shallow marine and finally alluvial fan deposits known as Dorotea Formation, in Chile, or Cerro Cazador Formation in Argentina (Macellari et al. 1989, Malumián & Caramés 1997). These formations were assigned to the Upper Campanian-Maastrichtian based on ammonite occurrences (Macellari 1988, Macellari et al. 1989, Malumián & Caramés 1997). The top of the sediment sequence is still known as Cerro Dorotea Formation in Chile, while coeval sediments on the Argentinian side adjacent to the northern border of the Última Esperanza Province are known as the La Irene Formation. This latter unit corresponds to sandstone and conglomerate deposited in a meandering river environment. The Calafate Formation unconformably overlies the La Irene Formation (Macellari et al. 1989) and is now also considered to be Maastrichtian in age (Marensi et al. 2004). This unit represents alluvial to estuarine deposits and is equivalent to the top of the sediment sequence known from Cerro Guido and Las Chinas in the Última Esperanza Province.

The Antarctic Peninsula allocates the remnants of a continental margin to the southeast and of a magmatic arc of Mesozoic age to the northwest, the latter resulting from the subduction of oceanic plate

Locality	MAGALLANES BASIN, PATAGONIA					ANTARCTIC PENINSULA				
	Argentina		Chile			King George Island				
	Lago Argentino	Última Esperanza	Skyring Bay	Strait of Magellan		Fildes Peninsula	Admiralty Bay	James Ross Island	Seymour Island	Snow Hill Island
Maastrichtian	Calafate Fm.	Cerro Dorotea Fm.		Rio Blanco Fm.		Jasper Hill	Zamek Fm.	Lopez de Bertodano Fm.	Lopez de Bertodano Fm.	Lopez de Bertodano Fm.
	Chorrillo Fm.	Cerro Cazador Fm.	Rocallosa Fm.	Santa Ana Fm.		Half Three Point Fm.				
70.6 ma	La Irene Fm.									
	Cerro Fortaleza Fm.									
Campanian	La Anita Fm.	Tres Pasos Fm.	Fuentes Fm.	San Isidro Fm.		Llano Point Fm.		Snow Hill Island Fm.	Snow Hill Island Fm.	Snow Hill Island Fm.
	Alta Vista Fm.		Rosa Fm.	Rosa Fm.						
83.5 ma										
Santonian	Cerro Toro Fm.	Cerro Toro Fm.	Barcarcel Fm.	Barcarcel Fm.				Santa Marta Fm.	Santa Marta Fm.	???
								Hidden Lake Fm.	???	
85.8 ma										
References	MACELLARI, 1988, MACERALLI <i>et al.</i> 1989, MALUMIAN <i>et al.</i> 1996		MACELLARI, 1988		BIRKENMAJER & ZASTAWNIAC 1989, BIRKENMAJER, 2001		HATHWAY, 2000	ELLIOT 1998, CRAME <i>et al.</i> 1991, RIDING & CRAME 2002	PIRRIE <i>et al.</i> 1996	

Fig. 1: Correlation of the main Upper Cretaceous Formations of the Magallanes Basin, considering both Argentinian and Chilean nomenclature, and James Ross Basin and King George Island of the Antarctic Peninsula. Macellari 1988, Macellari et al. 1989, Malumián et al. 1997, Birkenmajer & Zastawniak 1989, Birkenmajer 2001, Hathway 2000, Elliot 1988, Crame et al. 1991, Riding & Crame 2002 and Pirrie et al. 1997.

Correlación de las principales formaciones del Cretácico superior de la Cuenca de Magallanes (considerando la nomenclatura chilena y argentina) y la Península Antártica (considerando la cuenca de James Ross y la isla Rey Jorge). Macellari 1988, Macellari et al. 1989, Malumián et al. 1997, Birkenmajer & Zastawniak 1989, Birkenmajer 2001, Hathway 2000, Elliot 1988, Crame et al. 1991, Riding & Crame 2002 and Pirrie et al. 1997.

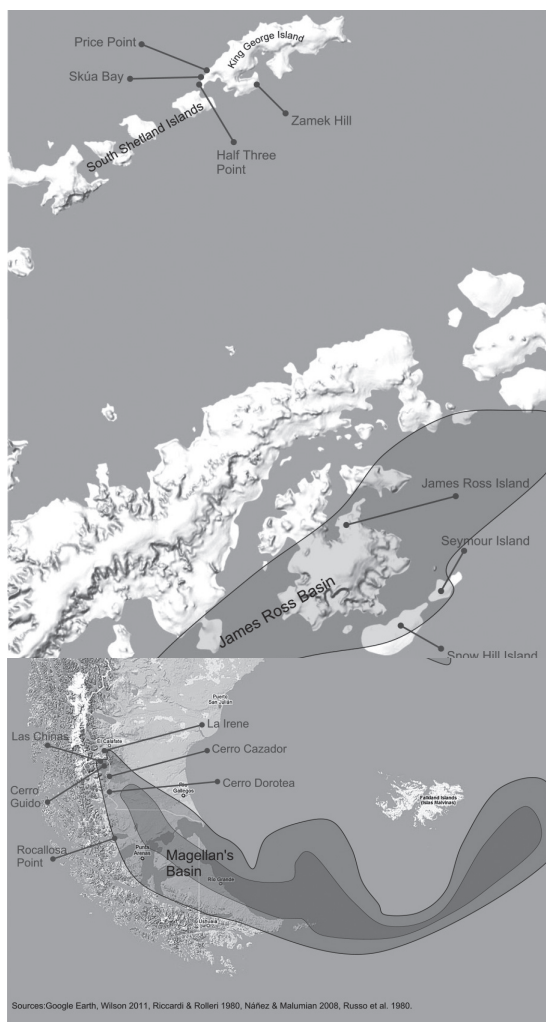


Fig. 2: Geographical location of sections studied here. Top: Antarctic localities; Below: Patagonian localities. Riccardi & Rolleri 1980, Russo et al. 1980, Nández & Malumian 2008.

La posición geográfica de las localidades estudiadas. Arriba: localidades antárticas; Abajo: localidades patagónicas. Riccardi & Rolleri 1980, Russo et al. 1980, Nández & Malumian 2008 2011.

beneath the Paleopacific margin (Fig. 2). The magmatic arc, as well as accretional complexes reflecting forearc and back-arc conditions, preserves a variety of paleoenvironments, many of which contain fossil plants (Poole & Cantrill 2006). Plant-bearing units include the Half Three Point Formation (Shen 1994) of Late Campanian or Campanian-Maastrichtian age (Cao 1992), a lacustrine deposit reflecting a subtropical humid climatic interval (Shen 1994). Campanian-Maastrichtian plants are

also known from Price Point, presenting a dominance of angiosperms, and from Skua Bay where the megafloora, though poorly preserved, is dominated by ferns. The Skua Bay flora may be slightly younger than assemblages identified in other Upper Cretaceous localities on King George Island, and they are markedly different to assemblages of the Zamek Hill Formation at Admiralty Bay, which is exceedingly rich in *Nothofagus* (Dutra & Batten 2000). In contrast, the James Ross Basin in the northeastern part of the Antarctic peninsula (Figs. 1-2) developed in a back-arc location in response to the south-eastward-directed subduction of proto-Pacific oceanic lithosphere beneath the Antarctic Peninsula magmatic arc (Pirrie et al. 1997). The basin fill constitutes a regressive megasequence (Nelson 1975, Ineson et al. 1986, Crame et al. 1991). For instance, the Aptian-Turonian of the basin is characterized by submarine fan deposits, whereas the Snow Hill Island Formation of late Campanian-early Maastrichtian age reflects a shallow shelf environment based on mollusc assemblages including the ammonite *Gunnarites antarcticus*. The Snow Hill Island Formation unconformably underlies the Maastrichtian López de

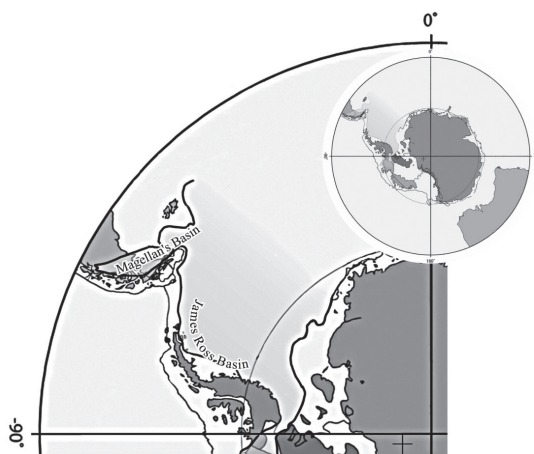
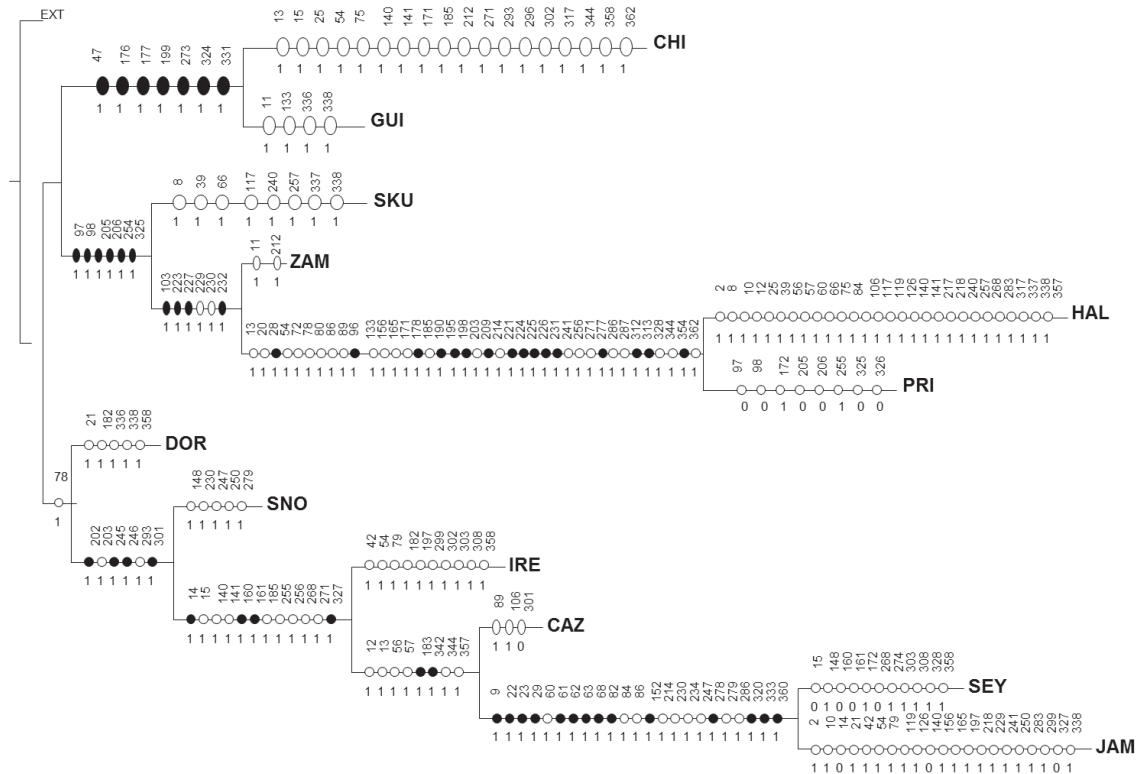


Fig. 3: Reconstruction of Austral basins of South America and the Antarctic Peninsula modified from Lawver et al. (2009). The continental connection during the Campanian and Maastrichtian is shown as an isthmus between the Antarctic Peninsula and Patagonia.

Reconstrucción de la Cuenca Austral modificada de Lawver et al. (2009). La conexión durante el Campaniano y Maastrichtiano se muestra como un istmo entre la península Antártica y Patagonia.



**Fig. 4:** Most parsimonious tree generated by PAE of taxa from Patagonia and the Antarctic Peninsula during the Campanian-Maastrichtian. (L: 292, CI: 51, RI: 54). Black dots represent synapomorphy and white dots homoplasy.

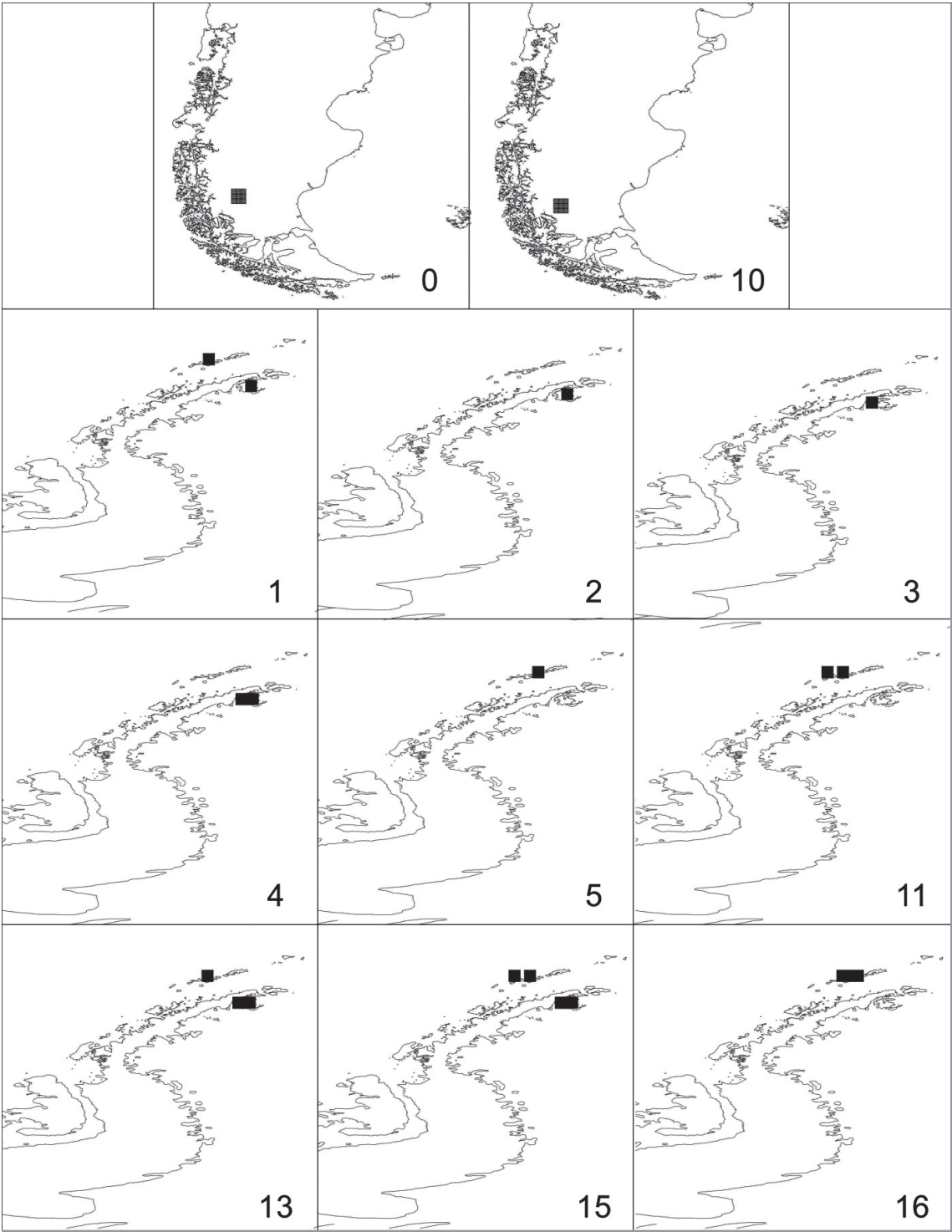
Árbol más parsimonioso generado por el PAE para taxa de Patagonia y la Península Antártica durante el lapso Campaniano Maastrichtiano. (L: 292, CI: 51, RI: 54). Puntos negros representan sinapomorfías y los blancos homoplasia.

Bertodano Formation, which is restricted to the northern tip of Snow Hill Island, to Seymour Island, and to a small exposure on Vega Island (Pirrie et al. 1997). This sequence thus represents one of the most complete Upper Cretaceous sections in the Southern hemisphere, with a wide record of paleoenvironments and diverse biota.

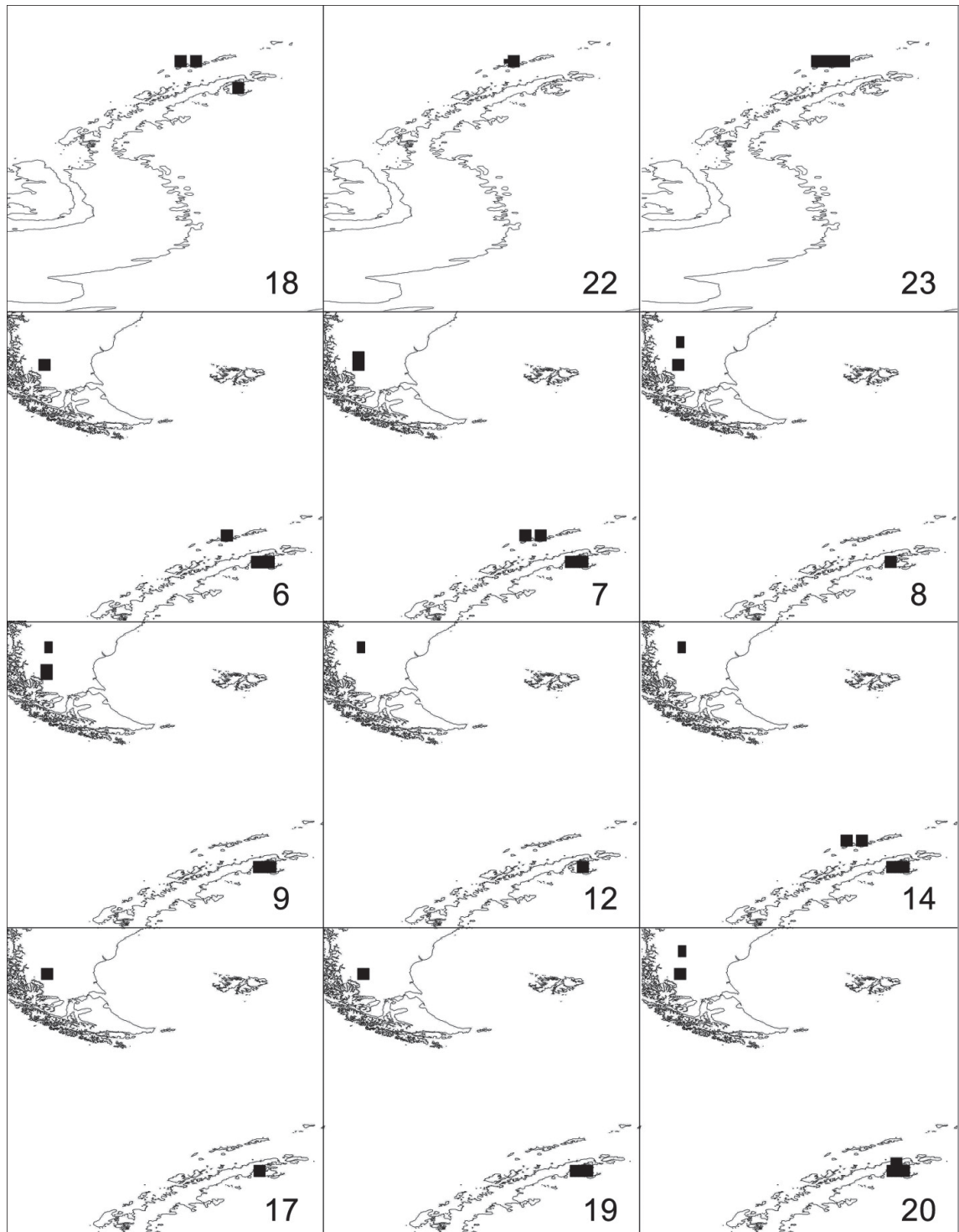
Here we suggest that biogeographic bridges connected Patagonia and the Antarctic Peninsula during the last interval of the Late Cretaceous (Fig. 2), generating one or more ancestral biota. The geographic continuity of Patagonia and the Antarctic Peninsula, currently disjointed by the Drake Passage, may partly explain the vicariant pattern and areas of endemism, but weather patterns differing between the western and eastern side of the isthmus may also have played an important role.

## METHODS

The biogeographic analysis presented here is based on fossil plant associations from Antarctic localities at Snow Hill Island, James Ross Island, Seymour (Marambio) Island, Skua Bay (King George Island), Half Three Point (King George Island), Price Point (King George Island) and Zamek Hill (King George Island), as well as from Patagonian localities at Rocallosa Point (Riesco Island), Guido Hill, Las Chinas, Dorotea Hill in Chile, and at Cazador Hill and La Irene in Argentina (Fig. 2). Las Chinas is a new locality not documented before. Six localities were studied during field campaigns from 2008 to 2011 (Las Chinas, Cerro Guido, Half Three Point, Skua Bay, Price Point and Cerro Dorotea). Distributional data of fossils and localities were obtained from the review of published articles, books and field campaigns (See Appendix). With this information at hand, a georeferenced record database was performed. A geographic distribution map of each taxon was obtained using ArcView GIS 3.2. Altogether, 4044 records were used. A total of 364 taxa were registered, 71 of which correspond to leaf imprints and 293 to palynomorphs.



(Fig. 5)



(Fig. 5)

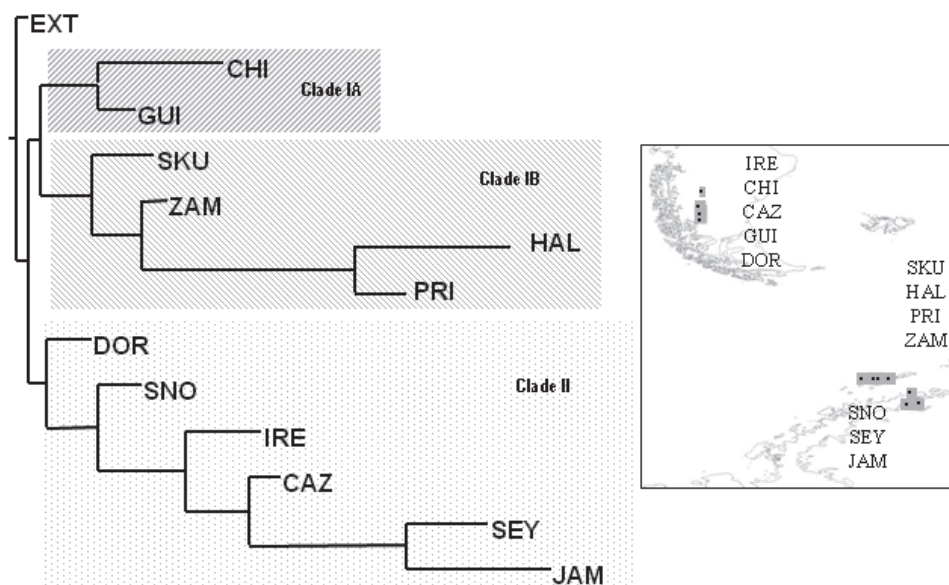
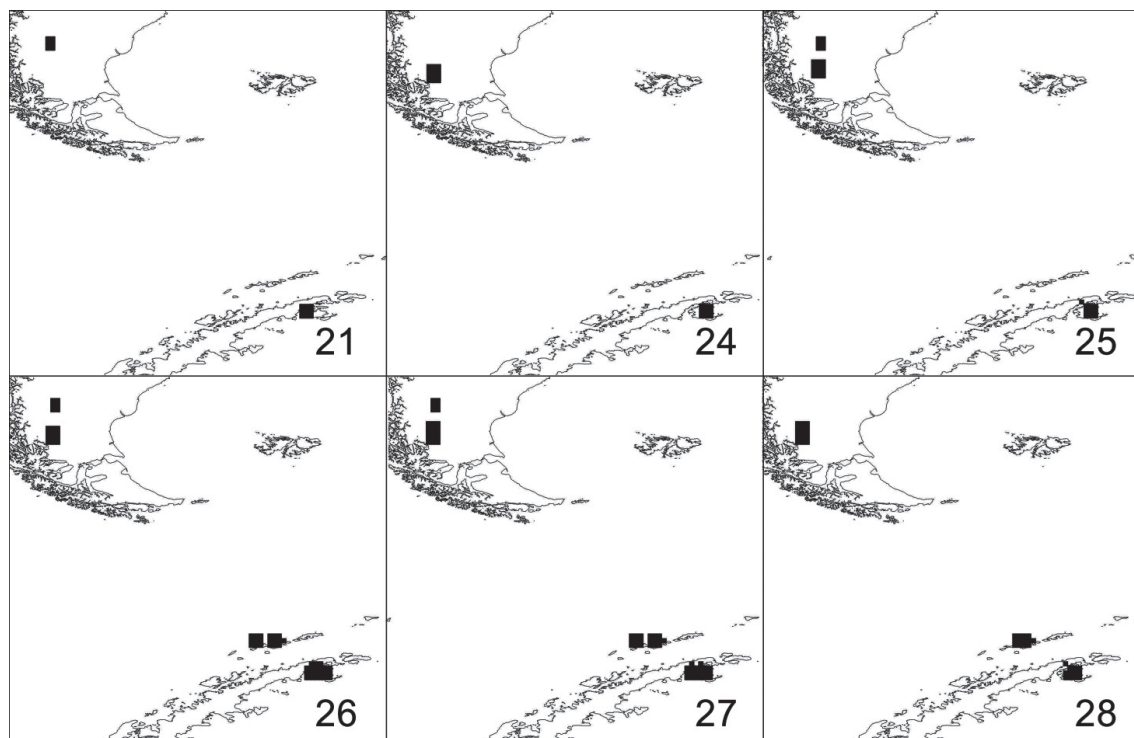


Fig. 5: Diagram of consensus areas (1-28) obtained by AE. The grid in each locality represents an area of  $0.25^\circ \times 0.25^\circ$ . The diagram shows localities considered here and areas obtained by PAE relationship, black points correspond to localities and gray dots represent the area considered in the consensus.

Diagrama de Áreas de consenso (1-28) obtenido por AE. La grilla en cada localidad representa un área de  $0.25^\circ \times 0.25^\circ$ . El esquema final muestra las localidades consideradas aquí y relación de áreas obtenidas por PAE, los puntos negros corresponden a la coordenada de la localidad considerada y los grises representan el área considerada en el consenso.

*Biogeographical analysis*

The floral diversity and relationships among each locality were analysed using the Parsimony Analysis of Endemicity (PAE) and the Analysis of Endemicity (AE). PAE comprises locations, optimizing the correlation between distributional patterns of taxa, using shared taxa among areas according to the most parsimonious solution (Morrone 1994, Posadas 1996). Rosen (1988) coded the presence or absence of taxa in an area as (1) or (0), respectively. This method is followed here. Our dataset includes 364 taxa of 13 areas (12 localities + 1 hypothetical area to root the tree) (Appendix). Data were analyzed with NONA 2.0 (Goloboff 1993) and WinClada (Nixon 1999) using a heuristic search (multiple TBR + TBR). The software was allowed to retain a maximum of 10000 trees with 100 replicates of random addition sequence and an initial 100 trees in each replication. Only informative characters were considered. If two or more resulting cladograms were equally parsimonious, a strict consensus cladogram was generated. The areas

of endemism identified and the possible relationships between the localities analyzed by PAE were compared with the result of AE. The AE was realized by the method of Szumik et al. (2002) and Szumik & Goloboff (2004). Basically, the method evaluates the consistency of the distribution range of species to a predefined area. The optimality criterion was implemented in NDM/VNDM programs (Goloboff 2005), using default parameters: sets of areas were saved with two or more endemic species (score >2), while sets of <0.90 worst fit were excluded. Optimal sets were chosen when the number of different endemic species was >40 %. Search for endemism was conducted using different proportions of radius size. The best score for endemism areas was used (fill: X = 90, Y = 90; to assume X = 50, Y = 50). Consensus areas were obtained using 30 % of similarity in species, compared to other areas in the consensus. A flexible consensus is used when at least 50 % of endemic species are in common.

TABLE 1

Areas of consensus for the analysis of flora obtained using, grids of 0.25° x 0.25°. For each area the following parameters are indicated: AI, including individual areas and endemic taxa present.

Áreas de consenso para el análisis de flora obtenidas usando grillas de 0.25° x 0.25°. Para cada área se indica: AI, áreas individuales incluidas y los taxa endémicos presentes.

AC	AI	N° Taxa
0	0	0, 5, 6, 8, 16, 30, 31, 32, 33, 34, 39, 41, 55, 66, 69, 76, 87, 92, 93, 94, 95, 99, 100, 101, 104, 105, 116, 117, 118, 125, 127, 135, 137, 138, 139, 142, 144, 145, 146, 153, 154, 158, 159, 162, 167, 168, 169, 207, 208, 240, 257, 260, 261, 262, 263, 264, 265, 266, 272, 282, 295, 316, 318, 337, 349, 361
1	1	2, 10, 119, 126, 218, 281
2	2	3, 4, 27, 35, 36, 42, 43, 45, 52, 53, 58, 59, 65, 74, 76, 81, 85, 90, 91, 112, 114, 120, 124, 128, 132, 136, 149, 150, 155, 157, 164, 165, 174, 179, 180, 181, 184, 189, 192, 196, 210, 213, 219, 239, 242, 244, 249, 251, 252, 275, 280, 284, 285, 288, 289, 290, 298, 300, 309, 310, 311, 321, 329, 330, 341, 359, 363
3	3	7, 24, 37, 64, 83, 107, 109, 121, 122, 131, 204, 276, 294, 334, 340, 345, 348, 355
4	4, 25, 26	9, 22, 23, 29, 62, 63, 82, 152, 278, 320, 333, 360
5	5	11, 13, 102, 108, 166, 194, 201, 222, 233, 235, 236, 237, 243, 248, 315
6	6	12, 56, 57, 357
7	7	1, 17, 19, 38, 47, 48, 49, 51, 67, 111, 115, 143, 151, 171, 175, 176, 177, 193, 199, 211, 215, 216, 259, 269, 273, 291, 292, 322, 323, 324, 331, 335
8	8	26, 88, 134, 173, 186, 228, 275, 283, 305, 339, 352
9	9	28, 89, 96, 178, 190, 195, 198, 209, 221, 224, 225, 226, 231, 277, 312, 313, 354
10	10	21, 70, 187, 307, 351
11	11	86, 214, 286
12	12, 15	97, 98, 205, 206, 220, 325

AC	AI	N° Taxa
13	13	111, 113, 129, 130, 147, 188, 238, 297, 302, 306, 314, 318
14	14	156, 165, 241
15	16	253, 303, 308
16	17	44, 46, 79, 197, 299
17	18	202, 245, 246, 293
18	19, 20, 21	103, 223, 227, 232, 254
19	22	14, 327, 358
20	23	15, 160, 161
21	24, 27	20, 78, 171, 185, 203, 256, 271

## RESULTS

Both the PAE and AE showed results consistent among them (Figs. 4 and 5, Table 1). The heuristic search results in a single most parsimonious tree (Length [L] 292, Consistency Index [CI] 51 and Retention Index [RI] 54; [Fig. 4]). The cladogram is divided in two main branches: one cluster grouping to Patagonia and King George Island localities in one branch, and Patagonian and James Ross Basin localities in the second. Some elements are exclusive for the Las Chinas and Cerro Guido outcrops, among them *S. sehuensis*, *Cinnamomum*, *Taeniopteris*, *Menispermities*, *P. innopinatus* and other *Laurophyllum* taxa. This is an expected result because of the geographical proximity and stratigraphic affinities between both regions. The clade IB clustered all King George Island localities which share six synapomorphic species of the following genera: *Dicotylophyllum*, *Monimiophyllum*, *Phyllites* and *Sterculia*. A conspicuous difference exists between the two main branches of Clade I: Clade IA includes the Patagonian localities Las Chinas and Cerro Guido, and Clade IB contains the King George Island outcrops. This latter (Clade IB) contains several taxa related to Nothofagaceae, among them leaves of *Nothofagus cretense* and pollen of *Nothofagidites*. Nothofagaceae are absent in Clade IA. The AE analysis generated 33 endemism areas (Fig. 5, Table 1). The consensus of these areas provided 29 ACs (Fig. 5, Table 1, Appendix). The links between Antarctic and Patagonian

localities are supported by several EA (AC 6 to 12, 14, 17, 19, 20, 21, 24 to 29, Fig. 5), even though nearby localities such as the Cerro Guido-Las Chinas complex and Dorotea-La Irene, show important differences in their fossil plant composition. The discovery of EAs for the Antarctic Peninsula and Patagonia (AC 0, 10 in Patagonia; 1 to 5, 11, 13, 15, 16, 18, 22, 23 in Antarctica; Fig. 5) is also important to note, because it represents a probable heritage of the vicariant event previous to the Campanian-Maastrichtian.

## DISCUSSION

A land bridge between Patagonia and the Antarctic Peninsula is considered to be crucial for the genetic flux between the two continents of terrestrial plants. It is known that CO<sub>2</sub> reached maximum levels during the early Late Cretaceous and that the region was exposed to westerly winds (Elliot 1988, Del Valle et al. 1992, Hathway 2000). A mountainous terrain is suggested from the proximity to the island arc and may have led to orographic rainfall, moderating temperature extremes and distributing precipitation throughout the year. These were appropriate conditions for the rapid establishment and expansion of a Valdivian type forest. Climatic conditions changed in the Early Campanian and again in the Late Maastrichtian due to the continuous subduction and aggregation of land on the western side of the Antarctic Peninsula (South Shetlands), in addition to a decrease in the global atmospheric

levels of CO<sub>2</sub>. These changing environmental conditions could explain the ring-growth pattern in fossil wood from the western part of the isthmus (Francis 1991). On the eastern side, the James Ross Basin was more protected and the changes were less accentuated. The first records of *Nothofagidites* in Patagonia and Oceania are from the Maastrichtian (Menéndez & Caccavari de Filici 1975, Romero 1978, Mcloughlin 2001), endorsing the idea of a terrestrial continuity of South America, Antarctica and Australia-New Zealand with a common biogeographic province (Case 1988).

Nothofagaceae are known to occur on the Antarctic Peninsula since the Campanian (Zastawniak & Szafer 1990, Francis 1991, Dutra 1997, Dutra & Batten 2000, Dutra 2001, Dutra 2005). The group successfully infiltrated gymnosperm-dominated forest ecosystems, with some opportunistic species of *Nothofagus* competing for openings in the canopy. This strategy, commonly known as “gap dynamics” (Veblen et al. 1983, Hill 1992, 1994, Veblen et al. 1996), is currently observed in modern Valdivian forests, especially in Andean forests with repeated volcanic disturbance. Species supporting Clades I and II in the present analysis may be related to this strategy, using special microclimatic conditions. From an ecological perspective, both share typical elements of the Valdivian Forests: a canopy dominated by angiosperms and subordinate presence of gymnosperms, and an understory mainly composed of Myrtaceae, Liliaceae, and Sapotaceae, and ferns such as Blechnaceae and Dicksoniaceae. The sites located in the Tethyan margin, exposed to southern oceanic conditions, are clustered in Clade I and are dominated by angiosperms with subordinated elements of gymnosperms, shrubby ferns and angiosperms. This vegetation significantly differs from the eastern flora (Clade II), which exhibits subtropical taxa mixed with cold temperate elements. This contradictory results regarding Clade II may be explained by a difference in climatic conditions. While floral assemblages lumped in Clade II were exposed to the South Atlantic-Weddell currents, and, westerly winds and moist or/and a previous vicariant event differentially isolated Patagonian plants of Clade I from the northwestern Antarctic Peninsula (South Shetland Islands) and the northeastern Antarctic Peninsula

(James Ross Basin). Unfortunately, the subductive activity along the western border of the Antarctic Peninsula may have erased physical evidence for this hypothesis along the western border of the Magallanes Basin. Clades IA and IB share morphotypes of Sterculiaceae, neotropical trees and shrubs, which were abundant in Cretaceous Patagonian localities. Clade II clusters the Patagonian localities of Dorotea, La Irene and Cazador Hill with the James Ross Basin localities of Seymour Island, James Ross Island and Snow Hill Island. This clade is supported by a few palynomorphs, with Snow Hill Island and Dorotea sites in a basal position. Seymour Island and James Ross Island are well structured with numerous synapomorphic species of Olacaceae, Proteaceae, Bombacaceae, Podocarpaceae, Aquilafoliaceae and Casuarinaceae. Some are tropical in origin, such as Olacaceae, a Gondwana group of mangroves with a wide record during the Paleogene of South America, New Zealand and Africa (Muller 1981); they indicate megathermal and high rainfall conditions. Other taxa, such as Bombacaceae and Aquilafoliaceae were subtropical to tropical elements of the Maastrichtian-Danian (Prámparo et al. 2007). Proteaceae, as well the conifers *Araucariacites*, *Microcarcharidites* and *Dacrycarpus*, show temperate affinities. Clade IIA also contains *Arecipites*, a taxon with affinities to Palmae (Poole et al. 2005), Arecaceae or Liliaceae (Macphail & Cantrill 2006), even though their simple type of pollen has frequently been assigned to tree ferns such as *Cyathidites* and palms. *Arecipites* is frequently used as a climate proxy indicative of warm conditions and intolerance to long and cold freezing winters (Box 1981). Nevertheless, this interpretation may be erroneous, because other similar families such as Liliaceae, produce structurally identical types of pollen (Erdtman 1971, Skog 1988). Indeed, Palmae have been reported in the same area of Antarctica by Askin (1992), even including *Monosulcites minutiscabratus* (Baldoni & Barrera 1986) and *Longaperites* (Baldoni & Medina 1989). Modern Palmae are present in cool-temperate Austral ecosystems, among them the Chilean *Jubaea chilensis*, near Valparaíso, or *Rhopalostylis sapida*, the Nikau palm, in New Zealand and the Chatham Islands.

In both, PAE and AE analyses, nearby localities such as the Cerro Guido-Las Chinas complex and Dorotea-La Irene show important differences in their floral composition. This reinforces the idea that coeval sedimentary environments differed at short distance. *Nothofagaceae* are completely absent at Cerro Guido and Las Chinas and are the dominant element in the Dorotea-La Irene assemblages. This important difference may result from diverging microclimates, similar to the differences that today exist between the western and eastern side of the Patagonian Andes. It is nevertheless evident that localities to the west of the hypothetical isthmus between South America and Antarctica are linked, and that a similar link existed between sites located to the east, such as the James Ross Basin, Dorotea and La Irene. However, these biotical differences may reflect another condition: that the outcrops of the Chinas-Cerro Guido may represent the instant before the massive invasion of *Nothofagus* from Antarctica to Patagonia. Therefore, Dorotea and La Irene outcrops belong to the end-Maastrichtian interval. Unfortunately, the physical evidence for the western bridge is lost today due to the subduction. The mix of tropical and temperate South American-Australian Antarctic taxa in Maastrichtian localities of northern Magallanes basin is also noteworthy and this area likely represents the “birth place” for the Valdivian forest.

**ACKNOWLEDGEMENTS:** We are grateful to the crew of “Estancia Cerro Guido” for their support for our field campaigns to this area, the logistic team of the Chilean Antarctic Institute and the Chilean Navy for their important role in the Antarctic campaigns and to FONDECYT 11080223 (2009-2011), BMBF CHL 10A/09 for their financial support. We also thank Prof. Sylvia Palma-Heldt for her collaborative efforts to improve Chilean palaeobotany.

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## APPENDIX

Data matrix used for the PAE and AE analyses. First column: taxa number (character). Second column: Scientific name of taxa. Third column: presence/absence matrix in localities EXT, Outgroup; IRE, La Irene; CHI, Las Chinas; CAZ, C° Cazador; DOR, Dorotea; GUI, C° Guido; SNO, Snow Hill Island; SEY, Seymour Island; JAM, James Ross Island; SKU, Skua Bay; HAL, Half Three Point; PRI, Price Point and ZAM, Zamek Hill (The letters A-M correspond to the sequence of localities above).

Matriz de datos utilizada para los análisis PAE y AE. Primera columna: el número de taxa (caracteres). Segunda columna: nombre taxa. Tercera columna: matriz de presencia/ausencia en localidades EXT, Outgroup; IRE, La Irene; CHI, Las Chinas; CAZ, C° Cazador; DOR, Dorotea; GUI, C° Guido; SNO, Snow Hill Island; SEY, Seymour Island; JAM, James Ross Island; SKU, Skua Bay; HAL, Half Three Point; PRI, Price Point and ZAM, Zamek Hill (Las letras A-M se corresponden con las localidades en el orden indicado).

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
0	<i>Abiineaeipollenites microalatus</i> Delcourt & Sprumont	0	0	0	0	0	0	0	0	0	0	1	0	0
2	<i>Aequitriradites spinulosus</i> Cookson & Dettmann	0	0	0	0	0	0	0	0	1	0	1	0	0
3	<i>Ailanthipites</i> sp. Wodehouse	0	0	0	0	0	0	0	0	1	0	0	0	0
4	<i>Alisporites grandis</i> (Cookson ) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
5	<i>Alsophilidites kerguelensis</i> Cookson	0	0	0	0	0	0	0	0	0	0	1	0	0
6	<i>Alsophilidites</i> sp. Cookson	0	0	0	0	0	0	0	0	0	0	1	0	0
7	<i>Amosopollis cruciformis</i> Cookson & Balme	0	0	0	0	0	0	0	1	0	0	0	0	0
8	<i>Anacardites pichileufensis</i> Berry	0	0	0	0	0	0	0	0	0	1	1	0	0
9	<i>Anacolosidites sectus</i> Partridge	0	0	0	0	0	0	0	1	1	0	0	0	0
10	<i>Appendicisporites</i> sp. Saad & Ghazaly	0	0	0	0	0	0	0	0	1	0	1	0	0
12	<i>Araucariacites australis</i> Cookson	0	0	0	1	0	0	0	1	1	0	1	0	0
14	<i>Araucariacites</i> sp. Courtinat & Jenny	0	0	1	1	0	0	0	1	1	0	1	1	0
15	<i>Arecipites minutiscabratus</i> (McIntyre ) Milne	0	1	0	1	0	0	0	1	0	0	0	0	0
16	<i>Arecipites</i> sp. Wodehouse	0	1	1	1	0	0	0	0	1	0	0	0	0
17	<i>Asterisporites</i> sp. Venkatachala & Rawat	0	0	0	0	0	0	0	0	0	0	1	0	0
19	<i>Baculatisporites comaumensis</i> (Cookson ) Potonie	0	1	0	1	1	0	0	1	1	0	0	0	0
20	<i>Baculatisporites kachaikensis</i> Llorens & Archangelsky	0	0	1	0	0	0	0	0	0	0	0	0	0
21	<i>Baculatisporites</i> sp. Pflug & Thomson	0	1	0	0	1	0	0	1	1	0	1	1	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
22	<i>Baculatisporites turbioensis</i> Archangelsky	0	0	0	0	1	0	0	0	1	0	0	0	0
23	<i>Beaupreaidites elegansiformis</i> Cookson	0	0	0	0	0	0	0	1	1	0	0	0	0
24	<i>Beaupreaidites</i> sp. Cookson ex R. Potonié	0	0	0	0	0	0	0	1	1	0	0	0	0
25	<i>Beaupreaidites verrucosus</i> Cookson	0	0	0	0	0	0	0	1	0	0	0	0	0
27	<i>Biretisporites</i> sp. cf. <i>potoniaei</i> Delcourt & Sprumont	0	0	1	1	0	0	0	0	1	0	1	0	0
26	<i>Biretisporites spectabilis</i> Dettmann	0	0	0	1	0	0	0	0	0	0	0	0	0
28	<i>Biryisporites</i> sp. Delcourt & Sprumont	0	0	0	0	0	0	0	0	1	0	0	0	0
30	<i>Bombacacidites bombaxoides</i> Couper	0	0	0	0	0	0	0	1	1	0	0	0	0
31	<i>Brachysporisporites antarcticus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
32	<i>Brachysporisporites grandus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
33	<i>Brachysporisporites longovatus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
34	<i>Brachysporisporites ovoidus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
35	<i>Brachysporisporites</i> sp. Lange & Smith	0	0	0	0	0	0	0	0	0	0	1	0	0
36	<i>Brassospora</i> sp. Hill and Read	0	0	0	0	0	0	0	0	1	0	0	0	0
37	<i>Camarazonosporites ambigens</i> (Fradkina) Playford	0	0	0	0	0	0	0	0	1	0	0	0	0
38	<i>Camarazonosporites ohaiensis</i> (Couper)	0	0	0	0	0	0	0	1	0	0	0	0	0
42	<i>Ceratosporites equalis</i> Cookson & Dettmann	0	1	0	0	0	0	0	1	1	0	0	0	0
43	<i>Cibotiumspora</i> sp. Jersey & Raine	0	0	0	0	0	0	0	0	0	0	1	0	0
44	<i>Cicatricosisporites australiensis</i> (Cookson) Potonié	0	1	0	0	0	0	0	0	1	0	0	0	0
45	<i>Cicatricosisporites hughesii</i> Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
46	<i>Cicatricosisporites</i> sp. Potonié & Gellyich	0	1	0	0	0	0	1	0	1	0	0	0	0
48	<i>Cingulatisporites scabratus</i> Thomson	0	0	0	0	0	0	0	0	1	0	0	0	0
47	<i>Cingutriteles australis</i> Pierce	0	0	0	0	0	0	0	0	1	0	0	0	0
53	<i>Classopollis</i> sp. Danzé-Corsin & Laveine	0	0	1	0	0	0	0	0	0	0	0	0	0
55	<i>Clavamonocolpites polygonalis</i> Askin	0	0	0	0	0	0	0	0	1	0	0	0	0
54	<i>Clavatipollenites hughesii</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
56	<i>Clavatipollenites</i> sp. González-Guzmán	0	1	1	0	0	0	0	0	1	0	1	1	0
57	<i>Clavifera jachromensis</i> Bolchovitina	0	0	0	0	0	0	0	0	0	0	1	0	0
58	<i>Clavifera</i> sp. Bolchovitina	0	0	0	1	0	0	0	1	1	0	1	0	0
59	<i>Clavifera triplex</i> (Bolkhovitina) Bolkhovitina	0	0	0	1	0	0	0	1	1	0	1	0	0
60	<i>Compositoipollenites tarragoensis</i> Truswell y Owens	0	0	0	0	0	0	0	0	1	0	0	0	0
61	<i>Contignisporites cooksoniae</i> (Balme) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
64	<i>Cranwellia</i> sp. Srivastava	0	0	0	0	0	0	0	1	1	0	1	0	0
65	<i>Cranwellia striata</i> (Couper) Srivastava	0	0	0	0	0	0	0	1	1	0	0	0	0
62	<i>Cranwellipollis palisadus</i> (Couper)	0	0	0	0	0	0	0	1	1	0	0	0	0
63	<i>Cranwellipollis</i> sp. Martin y Harris	0	0	0	0	0	0	0	1	1	0	0	0	0
66	<i>Cranwellipollis subpalisadus</i> (Couper) Martin y Harris	0	0	0	0	0	0	0	1	0	0	0	0	0
67	<i>Crybelosporites striatus</i> (Cookson y Dettmann) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
70	<i>Cupanieidites orthoteicus</i> Cookson & Pike	0	0	0	0	0	0	0	1	1	0	0	0	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
71	<i>Cupulisporonites megaporus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
75	<i>Cyatheacidites annulatus</i> Cookson	0	0	0	1	0	0	0	0	1	0	0	0	0
72	<i>Cyatheacidites</i> sp. L. C. Cookson ex R. Potonié	0	0	0	1	0	0	0	0	1	0	1	1	0
73	<i>Cyathidites australis</i> Couper	0	0	0	1	0	0	0	0	1	0	0	0	0
74	<i>Cyathidites concavus</i> (Bolkhovitina ) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
75	<i>Cyathidites minor</i> Couper	0	1	1	1	1	0	0	1	1	0	1	0	0
76	<i>Cyathidites pulchellus</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
78	<i>Cyathidites</i> sp. R. A. Couper	0	1	0	1	1	0	1	1	1	0	1	1	0
79	<i>Cycadopites nitidus</i> Balme	0	1	0	0	0	0	0	0	1	0	0	0	0
80	<i>Cycadopites</i> sp. Wodehouse	0	1	0	0	0	0	0	1	1	0	1	1	0
81	<i>Cyclusphaera</i> sp. W. C. Elsik	0	0	0	0	0	0	0	0	1	0	0	0	0
82	<i>Dacrycarpites australiensis</i> Cookson & Pike	0	0	0	0	0	0	0	1	1	0	0	0	0
83	<i>Dacrycarpus</i> sp. J. Arnold Arbor	0	0	0	0	0	0	0	1	0	0	0	0	0
84	<i>Dacrydium</i> sp. Lambert	0	0	0	0	0	0	0	1	1	0	1	0	0
85	<i>Dacrydiumites florinii</i> Cookson & Pike	0	0	0	0	0	0	0	0	1	0	0	0	0
86	<i>Dacrydiumites</i> sp. Hekel	0	0	0	0	0	0	0	1	1	0	1	1	0
87	<i>Deltoidospora hallii</i> Miner	0	0	0	0	0	0	0	0	0	0	1	0	0
88	<i>Deltoidospora microlepioides</i> (Krutzsch) Wang	0	0	0	0	0	0	0	0	0	0	1	0	0
89	<i>Deltoidospora</i> sp. Danzé-Corsin & Laveine	0	0	0	1	0	0	0	0	0	0	1	1	0
90	<i>Delwynites tuberculatus</i> Askin	0	0	0	0	0	0	0	0	1	0	0	0	0
91	<i>Densoisporites velatus</i> Weyland & Krieger	0	0	0	0	0	0	0	0	1	0	0	0	0
92	<i>Dicellaesporites antarcticus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
93	<i>Dicellaesporites oblongatus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
94	<i>Dicellaesporites popovii</i> Elsik	0	0	0	0	0	0	0	0	0	0	1	0	0
95	<i>Dicellaesporites</i> sp. (Elsik) Sheffy & Dilcher	0	0	0	0	0	0	0	0	0	0	1	0	0
99	<i>Diporicellaesporites antarcticus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
100	<i>Diporicellaesporites</i> sp. Elsik	0	0	0	0	0	0	0	0	0	0	1	0	0
101	<i>Diporicellaesporites stenosis</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
104	<i>Dyadosporites obscurus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
105	<i>Dyadosporites</i> sp. T. van der Hammen & Clarke	0	0	0	0	0	0	0	0	0	0	1	0	0
106	<i>Echinosporis</i> sp. Krutzsch	0	0	0	1	0	0	0	0	0	0	1	0	0
107	<i>Echitriporites</i> sp. T. van der Hammen	0	0	0	0	0	0	0	1	0	0	0	0	0
110	<i>Ephedripites notensis</i> (Cookson) Krutzsch	0	0	0	0	0	0	0	0	1	0	0	0	0
111	<i>Equisetosporites</i> sp. Daugherty	0	1	0	0	0	0	0	0	0	0	0	0	0
113	<i>Ericipites scabratus</i> Harris	0	1	0	0	0	0	0	0	0	0	0	0	0
114	<i>Ericipites</i> sp. Wodehouse	0	0	0	0	0	0	0	0	1	0	0	0	0
115	<i>Exesisporites</i> sp. Elsik	0	0	1	0	0	0	0	0	0	0	0	0	0
116	<i>Extrapunctatosporis</i> sp. Krutzsch	0	0	0	0	0	0	0	0	0	0	1	0	0
119	<i>Foraminisporis dailyi</i> (Cookson & Dettmann) Dettmann	0	0	0	0	0	0	0	0	1	0	1	0	0

Nº taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
120	<i>Foraminisporis asymmetricus</i> (Cookson & Dettmann) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
121	<i>Forcipites sabulosus</i> (Dettmann & Playford ) Dettmann & Jarzen	0	0	0	0	0	0	0	1	0	0	0	0	0
122	<i>Forcipites</i> sp. cf. <i>longus</i> (Stover & Evans) Dettmann & Jarzen	0	0	0	0	0	0	0	1	0	0	0	0	0
123	<i>Forcipites</i> sp. Dettmann & Jarzen	0	0	0	1	0	0	0	1	0	0	0	0	0
124	<i>Foveogleicheniidites confossus</i> (Hedlund) Norvick & Burger	0	0	0	0	0	0	0	0	1	0	0	0	0
125	<i>Foveotrilletes scrobiculatus</i> (Ross) Potonie´	0	0	0	0	0	0	0	0	0	0	1	0	0
126	<i>Foveotrilletes</i> sp. Puri	0	0	0	0	0	0	0	0	1	0	1	0	0
127	<i>Fractisporonites</i> sp. Clarke	0	0	0	0	0	0	0	0	0	0	1	0	0
128	<i>Fuscospora</i> sp. Hill & Read	0	0	0	0	0	0	0	0	1	0	0	0	0
129	<i>Gabonisporites</i> sp. Boltenhagen	0	1	0	0	0	0	0	0	0	0	0	0	0
130	<i>Gammerroites psilasaccus</i> Archangelsky	0	1	0	0	0	0	0	0	0	0	0	0	0
132	<i>Gemmamonocolpites pilulus</i> Askin	0	0	0	0	0	0	0	0	1	0	0	0	0
134	<i>Gleicheniidites aptianus</i> Llorens	0	0	0	1	0	0	0	0	0	0	0	0	0
135	<i>Gleicheniidites campanianus</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
136	<i>Gleicheniidites cercinidites</i> (Cookson) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
137	<i>Gleicheniidites delcourtii</i> Doring	0	0	0	0	0	0	0	0	0	0	1	0	0
138	<i>Gleicheniidites fildesensis</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
139	<i>Gleicheniidites pachydermus</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
140	<i>Gleicheniidites senonicus</i> Ross	0	1	1	1	0	0	0	1	0	0	1	0	0
141	<i>Gleicheniidites</i> sp. Grigoreva	0	1	1	1	0	0	0	1	1	0	1	0	0
142	<i>Gleicheniidites trivalis</i> Brotzen	0	0	0	0	0	0	0	0	0	0	1	0	0
143	<i>Gleichenites sanmartini</i> Halle emend. Herbst	0	0	1	0	0	0	0	0	0	0	0	0	0
144	<i>Gnetaceaepollenites ellipticus</i> Thiergart	0	0	0	0	0	0	0	0	0	0	1	0	0
145	<i>Gnetaceaepollenites</i> sp. Thiergart	0	0	0	0	0	0	0	0	0	0	1	0	0
146	<i>Gothanipollis bassensis</i> Stover & Partridge	0	0	0	0	0	0	0	0	0	0	1	0	0
147	<i>Granulatisporites</i> sp. Wilson	0	1	0	0	0	0	0	0	0	0	0	0	0
148	<i>Grapnelispora evansii</i> Stover & Partridge	0	0	0	0	0	0	1	1	0	0	0	0	0
149	<i>Haloragacidites harrisii</i> (Couper) Harris	0	0	0	0	0	0	0	0	1	0	0	0	0
150	<i>Herkosporites elliotii</i> Stover	0	0	0	0	0	0	0	0	1	0	0	0	0
152	<i>Illexpollenites</i> sp. Partridge	0	0	0	0	0	0	0	1	1	0	0	0	0
153	<i>Inapertisporites obpyriformis</i> Sheffy & Dilcher	0	0	0	0	0	0	0	0	0	0	1	0	0
154	<i>Inapertisporites solidus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
155	<i>Inaperturopollenites laevigatus</i> Takahashi	0	0	0	0	0	0	0	0	1	0	0	0	0
156	<i>Inaperturopollenites</i> sp. Pflug & Thomson	0	0	0	0	0	0	0	0	1	0	1	1	0
157	<i>Interulobites intraverrucatus</i> (Brenner) Phillips & Felix	0	0	0	0	0	0	0	0	1	0	0	0	0
158	<i>Involutisporonites crassus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
159	<i>Involutisporonites</i> sp. Clarke	0	0	0	0	0	0	0	0	0	0	1	0	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
160	<i>Ischyosporites</i> sp. Balme	0	1	0	1	0	0	0	0	1	0	0	0	0
161	<i>Ischyosporites volkheimeri</i> Filatoff	0	1	0	1	0	0	0	0	1	0	0	0	0
162	<i>Klukisporites antarcticus</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
163	<i>Klukisporites pseudoreticulatus</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
164	<i>Klukisporites scaberis</i> (Cookson & Dettmann) Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
165	<i>Klukisporites</i> sp. Couper	0	0	0	0	0	0	0	0	1	0	1	1	0
167	<i>Lacrimasporonites scabratus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
168	<i>Lacrimasporonites</i> sp. Clarke	0	0	0	0	0	0	0	0	0	0	1	0	0
169	<i>Lacrimasporonites tenuus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
170	<i>Laevigatosporites ovatus</i> Wilson & Webster	0	1	0	1	1	0	0	1	1	0	0	0	0
171	<i>Laevigatosporites</i> sp. Tschudy & Van Lonen	0	1	1	1	1	0	0	1	1	0	1	1	0
174	<i>Laurelites dorotensis</i> Nishida	0	0	0	0	1	0	0	0	0	0	0	0	0
175	<i>Laurelites jamesrossii</i> Poole & Francis	0	0	0	0	0	0	0	0	1	0	0	0	0
179	<i>Leiotriletes</i> sp. (Naumova) Potonié & Kremp	0	0	0	0	0	0	0	0	0	0	1	1	0
180	<i>Leptolepidites macroverrucosus</i> Schulz	0	0	0	0	0	0	0	0	1	0	0	0	0
181	<i>Leptolepidites tumulosus</i> (Doring) Srivastava	0	0	0	0	0	0	0	0	1	0	0	0	0
182	<i>Leptolepidites verrucatus</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
183	<i>Liliacidites</i> cf. <i>variegatus</i> Couper	0	1	0	0	1	0	0	0	0	0	0	0	0
184	<i>Liliacidites kaitangataensis</i> Couper	0	0	0	1	0	0	0	1	1	0	0	0	0
185	<i>Liliacidites lanceolatus</i> Stover	0	0	0	0	0	0	0	0	1	0	0	0	0
187	<i>Liliacidites</i> sp. cf. <i>regularis</i> Archangelsky	0	1	1	1	0	0	0	1	1	0	1	1	0
186	<i>Liliacidites</i> sp. Couper	0	0	0	1	0	0	0	0	0	0	0	0	0
188	<i>Liliacidites variegatus</i> Couper	0	0	0	1	0	0	0	0	1	0	0	0	0
189	<i>Longapertites</i> sp. Van Hoeken-Klinkenberg	0	1	0	0	0	0	0	0	0	0	0	0	0
191	<i>Lycopodiumsporites</i> sp. Danzé-Corsin y Laveine	0	0	0	0	0	0	0	0	0	0	1	1	0
193	<i>Lygistepollenites florinii</i> (Cookson y Pike) Stover & Evans	0	0	0	1	0	0	0	1	0	0	0	0	0
192	<i>Lygisterpollenites balmei</i> (Cookson) Stover & Evans	0	0	0	0	0	0	0	0	1	0	0	0	0
196	<i>Malvacipollis</i> sp. Harris	0	0	0	0	0	0	0	0	0	0	1	1	0
197	<i>Matonisporites cooksoniae</i> Dettmann	0	0	0	0	0	0	0	0	1	0	0	0	0
198	<i>Matonisporites</i> sp. Couper	0	1	0	0	0	0	0	0	1	0	0	0	0
199	<i>Meliapollis</i> sp. Couper	0	0	0	0	0	0	0	0	0	0	1	1	0
202	<i>Microcachryidites antarcticus</i> Cookson	0	1	0	1	0	0	1	1	1	0	0	0	0
203	<i>Microcachryidites</i> sp. Cookson	0	1	0	1	0	0	1	1	1	0	1	1	0
207	<i>Multinodisporites praecultus</i> Chlonova	0	0	0	0	0	0	0	0	0	0	1	0	0
208	<i>Multicellaesporites ovatus</i> Sheffy & Dilcher	0	0	0	0	0	0	0	0	0	0	1	0	0
209	<i>Multicellaesporites</i> sp. (Elsik) Sheffy & Dilcher	0	0	0	0	0	0	0	0	0	0	1	1	0
210	<i>Multinodisporites praecultus</i> A. F. Chlonova	0	0	0	0	0	0	0	0	1	0	0	0	0
213	<i>Myrtaceidites eugenioides</i> Cookson & Pike	0	0	0	0	0	0	0	0	1	0	0	0	0
214	<i>Myrtaceidites</i> sp. Cookson & Pike	0	0	0	0	0	0	0	1	1	0	1	1	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
217	<i>Neoraistrickia</i> sp. Potonié	0	0	0	1	0	0	0	0	1	0	1	0	0
218	<i>Neoraistrickia truncata</i> (Cookson) Potonie	0	0	0	0	0	0	0	0	1	0	1	0	0
219	<i>Nodosisporites</i> cf. <i>cremimurus</i> (Srivastava) Davies	0	0	0	0	0	0	0	0	1	0	0	0	0
220	<i>Nothofagidites brachyspinulosus</i> (Cookson) Harris	0	0	0	0	0	0	0	0	0	0	1	0	1
221	<i>Nothofagidites brassi</i> Archangelsky	0	0	0	0	0	0	0	0	0	0	1	1	0
222	<i>Nothofagidites</i> cf. <i>N. emarcidus</i> (Cookson) Harris & Truswell	0	0	0	0	0	0	0	0	0	0	0	0	1
223	<i>Nothofagidites endurus</i> Stover & Evans	0	0	0	0	0	0	0	0	0	0	1	1	1
224	<i>Nothofagidites falcatus</i> (Cookson) Hekel	0	0	0	0	0	0	0	0	0	0	1	1	0
225	<i>Nothofagidites fuegiensis</i> Menéndez & Caccavari de Filice	0	0	0	0	0	0	0	0	0	0	1	1	0
226	<i>Nothofagidites fusca</i> Cranwell Hekel	0	0	0	0	0	0	0	0	0	0	1	1	0
227	<i>Nothofagidites rocaensis</i> Romero	0	0	0	0	0	0	0	0	0	0	1	1	1
228	<i>Nothofagidites saraensis</i> Menéndez & Caccavari de Filice	0	0	0	1	0	0	0	0	0	0	0	0	0
229	<i>Nothofagidites senectus</i> Dettmann & Playford	0	0	0	0	0	0	0	0	1	0	1	1	1
230	<i>Nothofagidites</i> sp. Pocknall	0	0	0	0	0	0	1	1	1	0	1	1	1
231	<i>Nothofagidites visserensis</i> Romero	0	0	0	0	0	0	0	0	0	0	1	1	0
238	<i>Nyssapollenites</i> cf. <i>squamosus</i> Dettmann	0	1	0	0	0	0	0	0	0	0	0	0	0
239	<i>Ornamentifera</i> sp. Bolchovitina	0	0	0	0	0	0	0	0	1	0	0	0	0
241	<i>Osmundacidites</i> sp. Couper	0	0	0	0	0	0	0	0	1	0	1	1	0
242	<i>Osmundacidites wellmanii</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
244	<i>Peninsulapollis askinae</i> Dettmann & Jarzen	0	0	0	0	0	0	0	0	1	0	0	0	0
245	<i>Peninsulapollis gillii</i> (Cookson) Dettmann & Jarzen	0	1	0	1	0	0	1	1	1	0	0	0	0
246	<i>Peninsulapollis</i> sp. Dettmann & Jarzen	0	1	0	1	0	0	1	1	1	0	0	0	0
247	<i>Peninsulapollis truswelliae</i> Dettmann & Jarzen	0	0	0	0	0	0	1	1	1	0	0	0	0
249	<i>Periporopollenites</i> sp. Pflug & Thomson	0	0	0	0	0	0	0	0	1	0	0	0	0
250	<i>Perotriletes</i> cf. <i>P. pseudoreticulatus</i> Couper	0	0	0	0	0	0	1	0	1	0	0	0	0
251	<i>Perotriletes laceratus</i> (Norris) Rumeau	0	0	0	0	0	0	0	0	1	0	0	0	0
252	<i>Perotriletes linearis</i> (Cookson & Dettmann) Evans	0	0	0	0	0	0	0	0	1	0	0	0	0
253	<i>Perotriletes majus</i> (Cookson & Dettmann) Evans	0	1	0	0	0	0	0	1	1	0	0	0	0
254	<i>Phyllites</i> sp. Brongniart	0	0	0	0	0	0	0	0	0	1	1	1	1
255	<i>Phyllocladidites mawsonii</i> Cookson ex Couper	0	1	0	1	0	0	0	1	1	0	0	1	0
256	<i>Phyllocladidites</i> sp. Cookson	0	1	0	1	0	0	0	1	1	0	1	1	0
260	<i>Plicifera decora</i> (Chlonova) Bolchovitina	0	0	0	0	0	0	0	0	0	0	1	0	0
261	<i>Plicifera delicata</i> (Bolchovitina) Bolchovitina	0	0	0	0	0	0	0	0	0	0	1	0	0
262	<i>Plicifera</i> sp. Raine	0	0	0	0	0	0	0	0	0	0	1	0	0
263	<i>Plicifera trialatus</i> Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
264	<i>Pluricellaesporites antarcticus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
265	<i>Pluricellaesporites ocellatus</i> Song & Cao	0	0	0	0	0	0	0	0	0	0	1	0	0
266	<i>Pluricellaesporites</i> sp. T. van der Hammen	0	0	0	0	0	0	0	0	0	0	1	0	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
267	<i>Podocarpidites elegans</i> Romero	0	1	0	1	0	0	0	0	0	0	0	0	0
268	<i>Podocarpidites ellipticus</i> Cookson	0	1	0	1	0	0	0	0	1	0	1	0	0
269	<i>Podocarpidites marwickii</i> Couper	0	0	1	0	0	0	0	0	0	0	0	0	0
270	<i>Podocarpidites microreticuloidatus</i> Cookson	0	0	0	1	0	0	0	0	0	0	0	0	0
271	<i>Podocarpidites</i> sp. Cookson	0	1	1	1	0	0	0	1	1	0	1	1	0
275	<i>Podosporites microsaccatus</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
276	<i>Podosporites</i> sp. Rao	0	0	0	0	0	0	0	1	0	0	0	0	0
277	<i>Podozamites pinnatus</i> Cantrill	0	0	0	0	0	0	0	0	0	0	1	1	0
278	<i>Polycolpites langstonii</i> Stover	0	0	0	0	0	0	0	1	1	0	0	0	0
279	<i>Polycolpites</i> sp. Couper & Harris	0	0	0	0	0	0	1	1	1	0	0	0	0
280	<i>Polypodiaceisporites elegans</i> Archangelsky & Gamorro	0	0	0	0	0	0	0	0	1	0	0	0	0
281	<i>Polypodiidites speciosus</i> (Harris) Archangelsky	0	0	0	1	0	0	0	0	0	0	0	0	0
282	<i>Polypodiisporites favus</i> (Potonie) Potonie	0	0	0	0	0	0	0	0	0	0	1	0	0
283	<i>Polypodiisporites</i> sp. Pocknall	0	0	0	0	0	0	0	0	1	0	1	0	0
284	<i>Propylipollis annularis</i> (Cookson) Martin & Harris	0	0	0	0	0	0	0	0	1	0	0	0	0
285	<i>Propylipollis concretus</i> (Harris) Martin & Harris	0	0	0	0	0	0	0	0	1	0	0	0	0
286	<i>Propylipollis</i> sp. Martin & Harris	0	0	0	0	0	0	0	1	1	0	1	1	0
287	<i>Proteacidites</i> sp. Cookson	0	1	0	0	0	0	0	1	1	0	1	1	0
288	<i>Proteacidites stipplatus</i> Partridge	0	0	0	0	0	0	0	0	1	0	0	0	0
289	<i>Proteacidites subscabratus</i> Couper	0	0	0	0	0	0	0	0	1	0	0	0	0
290	<i>Proteacidites truncatus</i> Cookson	0	0	0	0	0	0	0	0	1	0	0	0	0
293	<i>Psilatricolporites</i> sp. T. van der Hammen ex T. van der Hammen & T. A. Wymstra	0	1	1	1	0	0	1	1	1	0	0	0	0
295	<i>Reduviasporonites</i> sp. Wilson	0	0	0	0	0	0	0	0	0	0	1	0	0
296	<i>Reticuloidosporites</i> cf. <i>tenellis</i> Krutzsch	0	0	1	1	0	0	0	0	1	0	0	0	0
297	<i>Retidiporites camachoi</i> Archangelsky	0	1	0	0	0	0	0	0	0	0	0	0	0
298	<i>Retistephanocolporites</i> sp. T. van der Hammen & Wymstra	0	0	0	0	0	0	0	0	1	0	0	0	0
299	<i>Retitriteles austroclavatidites</i> Cookson	0	1	0	0	0	0	0	0	1	0	0	0	0
300	<i>Retitriteles</i> cf. <i>eminulus</i> (Dettmann) Srivastava	0	0	0	0	0	0	0	0	1	0	0	0	0
301	<i>Retitriteles</i> sp. Pierce	0	1	0	0	0	0	1	1	1	0	0	0	0
302	<i>Rhoipites</i> cf. <i>minusculus</i> Archangelsky	0	1	1	0	0	0	0	0	0	0	0	0	0
303	<i>Rhoipites</i> sp. cf. <i>microreticulatus</i> (Harris) Macphail et al.	0	1	1	0	0	0	0	1	0	0	0	0	0
304	<i>Rhoipites</i> sp. Wodehouse	0	0	0	0	0	0	0	1	0	0	0	0	0
305	<i>Rousea microreticulata</i> Archangelsky	0	0	0	1	0	0	0	0	0	0	0	0	0
306	<i>Rousea patagonica</i> Archangelsky	0	1	0	0	0	0	0	0	0	0	0	0	0
307	<i>Rousea</i> sp. Srivastava	0	0	0	1	0	0	0	0	1	0	0	0	0
308	<i>Rouseisporites reticulatus</i> Pocock	0	1	0	0	0	0	0	1	0	0	0	0	0
309	<i>Rugulatisporites mallatus</i> Stover	0	0	0	0	0	0	0	0	1	0	0	0	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
310	<i>Rugulatisporites micraulaxus</i> Partridge	0	0	0	0	0	0	0	0	1	0	0	0	0
311	<i>Rugulatisporites neuquensis</i> Volkheimer	0	0	0	0	0	0	0	0	1	0	0	0	0
312	<i>Sapotacoidaepollenites</i> sp. Stover	0	0	0	0	0	0	0	0	0	0	1	1	0
313	<i>Schizocolpus</i> sp. Stover	0	0	0	0	0	0	0	0	0	0	1	1	0
314	<i>Senipites</i> sp. Srivastava	0	1	0	0	0	0	0	0	0	0	0	0	0
316	<i>Sphagnumsporites</i> sp. Cookson	0	0	0	0	0	0	0	0	0	0	1	0	0
318	<i>Spinizonocolpites hialinus</i> Zamaloa & Archangelsky	0	1	0	0	0	0	0	0	0	0	0	0	0
319	<i>Staphlosporonites</i> sp. Sheffy & Dilcher	0	0	0	0	0	0	0	0	0	0	1	0	0
320	<i>Stellidiopollis annulatus</i> Dettmann & Hedlund	0	0	0	0	0	0	0	1	1	0	0	0	0
321	<i>Stephanocolpites</i> sp. T. van der Hammen	0	0	0	0	0	0	0	0	1	0	0	0	0
327	<i>Stereisporites antiquasporites</i> (Wilson & Webster) Dettmann	0	1	0	1	0	0	0	1	0	0	0	0	0
328	<i>Stereisporites</i> sp. Norris	0	0	0	0	0	0	0	1	0	0	1	1	0
329	<i>Stoverisporites microverrucatus</i> Burger	0	0	0	0	0	0	0	0	1	0	0	0	0
330	<i>Striatriporites</i> sp. van Hoeken-Klinkenberg	0	0	0	0	0	0	0	0	1	0	0	0	0
332	<i>Teredolites</i> sp. Savrda	0	0	0	0	0	0	1	0	0	0	0	0	0
333	<i>Tetracolporites</i> sp. Couper	0	0	0	0	0	0	0	1	1	0	0	0	0
334	<i>Tetracolporites verrucosus</i> Stover	0	0	0	0	0	0	0	1	0	0	0	0	0
339	<i>Triatriopollenites lateflexus</i> Archangelsky	0	0	0	1	0	0	0	0	0	0	0	0	0
340	<i>Trichotomosulcites subgranulatus</i> Couper	0	0	0	0	0	0	0	1	0	0	0	0	0
341	<i>Tricolpites confessus</i> Stover ex Stover & Partridge	0	0	0	0	0	0	0	0	1	0	0	0	0
342	<i>Tricolpites reticulatus</i> Cookson	0	0	0	1	0	0	0	1	1	0	0	0	0
343	<i>Tricolpites simatus</i> Stover & Partridge	0	0	0	0	0	0	0	0	1	0	0	0	0
344	<i>Tricolpites</i> sp. T. van der Hammen	0	0	1	1	0	0	0	1	1	0	1	1	0
345	<i>Tricolpites striatus</i> Couper	0	0	0	0	0	0	0	1	0	0	0	0	0
346	<i>Tricolpites waiparaensis</i> Stover & Evans	0	0	0	0	0	0	0	0	1	0	0	0	0
347	<i>Tricolporites lilliei</i> (Couper) Stover & Evans	0	0	0	0	0	0	0	0	0	0	0	1	0
348	<i>Tricolporites pachyexinus</i> Couper	0	0	0	0	0	0	0	1	0	0	0	0	0
349	<i>Tricolporopollenites</i> sp. Doyle & Robbins	0	0	0	0	0	0	0	0	0	0	1	0	0
350	<i>Trilites parvallatus</i> Krutzsch	0	0	0	0	0	0	0	0	1	0	0	0	0
351	<i>Trilites</i> sp. Mildenhall	0	0	0	1	0	0	0	0	1	0	0	0	0
352	<i>Trilites</i> sp. cf. <i>fasolae</i> Archangelsky	0	0	0	1	0	0	0	0	0	0	0	0	0
353	<i>Trilites tuberculiformis</i> Cookson	0	0	0	0	0	0	0	0	1	0	0	0	0
354	<i>Triorites</i> sp. Erdtman	0	0	0	0	0	0	0	0	0	0	1	1	0
355	<i>Triporoletes simplex</i> (Cookson & Dettmann) Playford	0	0	0	0	0	0	0	0	1	0	0	0	0
356	<i>Triporopollenites sectilis</i> Stover	0	0	0	0	0	0	0	1	0	0	0	0	0
357	<i>Triporopollenites</i> sp. Pflug & Thomson	0	0	0	1	0	0	0	1	1	0	1	0	0
358	<i>Trisaccites microsaccatus</i> Couper	0	1	1	0	1	0	0	1	0	0	0	0	0
359	<i>Tuberculatosporites parvus</i> Archangelsky	0	0	0	0	0	0	0	0	1	0	0	0	0
360	<i>Tubulifloridites lilliei</i> Couper	0	0	0	0	0	0	0	1	1	0	0	0	0
361	<i>Undulatisporites</i> sp. Pflug	0	0	0	0	0	0	0	0	0	0	1	0	0

N° taxa	PALINOMORPHS	A	B	C	D	E	F	G	H	I	J	K	L	M
362	<i>Verrucosisporites</i> sp. Dybová & Jachowicz	0	1	1	1	0	0	0	0	0	0	1	1	0
363	<i>Vitreisporites pallidus</i> Reissinger	0	0	0	0	0	0	0	0	1	0	0	0	0

N° taxa	LEAF IMPRINTS	A	B	C	D	E	F	G	H	I	J	K	L	M
1	<i>Acropyle antarctica</i> Florin	0	0	0	0	0	1	0	0	0	0	0	0	0
11	<i>Araliaephyllum</i> sp. Fontaine	0	0	0	0	0	1	0	0	0	0	0	0	1
18	<i>Athrotaxis</i> sp. Don	0	0	1	0	0	0	0	0	0	0	0	0	0
29	<i>Blechnum</i> sp. Linneo	0	0	0	0	0	0	0	0	0	0	1	1	0
39	<i>Carpolithes</i> sp. Brongniart	0	0	1	0	0	0	0	0	0	0	0	0	0
40	<i>Cassia</i> sp. Linnaeus	0	0	0	0	0	0	0	0	0	1	1	0	0
49	<i>Cinnamomum</i> sp. Schaeff.	0	0	1	0	0	1	0	0	0	0	0	0	0
50	<i>Cissites parrifolius</i> Cockerell	0	0	1	0	0	0	0	0	0	0	0	0	0
51	<i>Cladophlebis patagonica</i> (Frenguelli) Herbst	0	0	1	0	0	0	0	0	0	0	0	0	0
52	<i>Cladophlebis</i> sp. Brongniart	0	0	1	0	0	1	0	0	0	0	1	1	1
68	<i>Culcita</i> sp. Presl	0	0	0	0	0	0	0	0	0	1	1	0	0
69	<i>Cupania patagonica</i> Berry	0	0	1	0	0	0	0	0	0	0	0	0	0
96	<i>Dicksonia</i> sp. L'Héritier	0	0	0	0	0	0	0	0	0	0	1	1	0
97	<i>Dicotylophyllum elegans</i> Li	0	0	0	0	0	0	0	0	0	1	1	0	1
98	<i>Dicotylophyllum</i> sp. Bandulska	0	0	0	0	0	0	0	0	0	1	1	0	1
102	<i>Dryopteris seymouriensis</i> Dusen	0	0	0	0	0	0	0	0	0	0	0	0	1
103	<i>Dryopteris</i> sp. Adanson	0	0	0	0	0	0	0	0	0	0	1	1	1
108	<i>Elaeocarpus</i> sp. Linnaeus	0	0	0	0	0	0	0	0	0	0	0	0	1
109	<i>Ephedra notensis</i> Linnaeus	0	0	0	0	0	0	0	1	0	0	0	0	0
111	<i>Equisetites</i> sp. Sternberg	0	0	1	0	0	0	0	0	0	0	0	0	0
117	<i>Ficophyllum palustris</i> Cantrill	0	0	0	0	0	0	0	0	0	1	1	0	0
118	<i>Ficophyllum skuaensis</i> Dutra	0	0	0	0	0	0	0	0	0	1	0	0	0
131	<i>Garnbierina rudata</i> Stover	0	0	0	0	0	0	0	1	0	0	0	0	0
133	<i>Gleichenia</i> sp. Smith	0	0	0	0	0	1	0	0	0	0	1	1	0
151	<i>Hymenophyllum priscum</i> Menéndez	0	0	0	0	0	1	0	0	0	0	0	0	0
166	<i>Knightia andreae</i> Dusen	0	0	0	0	0	0	0	0	0	0	0	0	1
176	<i>Laurophyllum hickenii</i> Mendéndez	0	0	1	0	0	0	0	0	0	0	0	0	0
177	<i>Laurophyllum proteaefolium</i> Berry ex Menendez	0	0	1	0	0	1	0	0	0	0	0	0	0
178	<i>Laurophyllum</i> sp. Kartzi Berry	0	0	1	0	0	1	0	0	0	0	0	0	0
190	<i>Lophozonia</i> sp. Turczaninow	0	0	0	0	0	0	0	0	1	0	0	0	0
194	<i>Lygodium</i> sp. Swartz	0	0	0	0	0	1	0	0	0	0	0	0	0
195	<i>Magnoliidaephyllum birkenmajeri</i> Zastawniak	0	0	0	0	0	0	0	0	0	0	0	0	1
199	<i>Menispermites</i> sp. Lesquereux	0	0	1	0	0	1	0	0	0	0	0	0	0
201	<i>Mespilodaphne longifolia</i> Meisn	0	0	0	0	0	0	0	0	0	0	0	0	1
204	<i>Microcachrys</i> sp. Hooker	0	0	0	0	0	0	0	1	0	0	0	0	0

N° taxa	LEAF IMPRINTS	A	B	C	D	E	F	G	H	I	J	K	L	M
205	<i>Monimiophyllum antarcticum</i> Zastawniak	0	0	0	0	0	0	0	0	0	1	1	0	1
206	<i>Monimiophyllum</i> sp. Zastawniak	0	0	0	0	0	0	0	0	0	1	1	0	1
211	<i>Myrcia chubutensis</i> Berry	0	0	1	0	0	0	0	0	0	0	0	0	0
212	<i>Myrciophyllum santacruzensis</i> (Berry) Zastawniak	0	0	1	0	0	0	0	0	0	0	0	0	1
215	<i>Myrtoidea patagonica</i> Passalia et al.	0	0	1	0	0	0	0	0	0	0	0	0	0
216	<i>Nelumbo</i> sp. Adanson	0	0	1	0	0	0	0	0	0	0	0	0	0
232	<i>Nothofagus cretacea</i> Zastawniak	0	0	0	0	0	0	0	0	0	0	1	1	1
233	<i>Nothofagus glaucifolia</i> Dutra	0	0	0	0	0	0	0	0	0	0	0	0	1
234	<i>Nothofagus</i> sp. Tshudy & Van Loenen	0	0	0	0	0	1	0	1	1	1	1	1	1
235	<i>Nothofagus</i> sp. aff. <i>lendenfeldii</i> (Ettingshausen) Oliver	0	0	0	0	0	0	0	0	0	0	0	0	1
236	<i>Nothofagus</i> sp. aff. <i>ulmifolia</i> (Ettingshausen) Oliver	0	0	0	0	0	0	0	0	0	0	0	0	1
237	<i>Nothofagus zastawniakiae</i> Dutra	0	0	0	0	0	0	0	0	0	0	0	0	1
240	<i>Osmunda</i> sp. Linnaeus	0	0	0	0	0	0	0	0	0	1	1	0	0
243	<i>Pecopteris</i> sp. Sternberg	0	0	0	0	0	0	0	0	0	0	0	0	1
248	<i>Pentaneurum dusenii</i> (Zastawniak) Li	0	0	0	0	0	0	0	0	0	0	0	0	1
257	<i>Phyllocladus aspleniifolius</i> (Labillardière) J. D. Hooker	0	0	0	0	0	0	0	0	0	1	1	0	0
258	<i>Phyllocladus</i> sp. Mirbel	0	0	1	0	0	0	0	0	0	1	1	1	0
259	<i>Phyllopteroides leavis</i> Cantrill & Webb	0	0	1	0	0	0	0	0	0	0	0	0	0
272	<i>Podocarpus fildesensis</i> Zhou	0	0	0	0	0	0	0	0	0	0	1	0	0
273	<i>Podocarpus inopinatus</i> Florin	0	0	1	0	0	1	0	0	0	0	0	0	0
274	<i>Podocarpus</i> sp. Persoon	0	0	0	0	0	1	0	1	0	1	1	1	1
291	<i>Pseudoaraucaria valentini</i> Lamberti	0	0	0	0	0	1	0	0	0	0	0	0	0
292	<i>Pseudopanax</i> sp. Vargas	0	0	1	0	0	0	0	0	0	0	0	0	0
294	<i>Quadruplanus brossus</i> (Stover) Stover & Partridge	0	0	0	0	0	0	0	1	0	0	0	0	0
315	<i>Sloanea</i> sp. Linnaeus	0	0	0	0	0	0	0	0	0	0	0	0	1
317	<i>Sphenopteris</i> sp. (Brongniart) Sternberg	0	0	1	0	0	0	0	0	0	0	1	0	0
322	<i>Sterculia acuminataloba</i> Berry	0	0	1	0	0	0	0	0	0	0	0	0	0
323	<i>Sterculia cretaceum</i> (Velenovsky) Berry	0	0	0	0	0	1	0	0	0	0	0	0	0
324	<i>Sterculia sehuensis</i> Berry	0	0	1	0	0	1	0	0	0	0	0	0	0
325	<i>Sterculia washburnii</i> Berry	0	0	0	0	0	0	0	0	0	1	1	0	1
326	<i>Sterculiaephyllum australis</i> Dutra	0	0	1	0	0	0	0	0	0	1	1	0	1
331	<i>Taeniopteris</i> sp. Brongniart	0	0	1	0	0	1	0	0	0	0	0	0	0
335	<i>Thorhallenia</i> sp. Passalia	0	0	1	0	0	0	0	0	0	0	0	0	0
336	<i>Thyrsopteris antiqua</i> Menendez	0	0	0	0	1	1	0	0	0	0	0	0	0
337	<i>Thyrsopteris elegans</i> Kunze	0	0	0	0	0	0	0	0	0	1	1	0	0
338	<i>Thyrsopteris</i> sp. Wilson	0	0	0	0	1	1	0	0	1	1	1	0	0