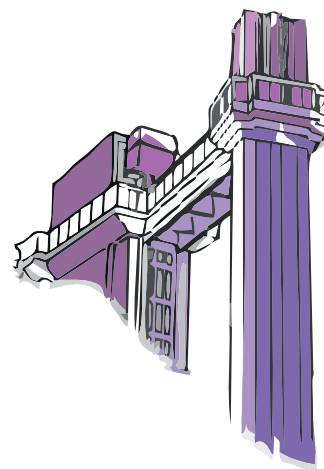


# Boletín de la Asociación Latinoamericana de Paleobotánica y Palinología

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*Palaeobotany and Palynology:  
towards new frontiers*

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**XIV International Palynological Congress  
X International Organisation of Palaeobotany Conference**



Asociación  
Latinoamericana  
de Paleobotánica  
y Palinología



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## The history of Brazilian paleobotany

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### **The Portuguese Royal Family in Brazil**

The transfer and establishment of the Portuguese Crown in Brazil (1808-1821) and the colony's elevation to the position of the *United Reign of Portugal, Brazil and Algarve* (1815-1822), paved the way for many *scientist-travelers* (naturalists, botanists, mineralogists) to explore the country. That notwithstanding, because of Brazil's inaccessibility attributable to the physical dangers of long sea voyages and the scientific community's lack of unanimity in appreciating the work of scientist-travelers, this task was usually performed by younger naturalists or naval officers or adventurers. Therefore, the naturalists who came to Brazil were those who braved the difficulties and undertook these hazardous journeys. For example, Auguste de Saint Hilaire, a French naturalist / botanist, visited Brazil during 1816 and 1822. He was highly impressed and fascinated by the tropical forests around Rio de Janeiro and narrated the beauty and diversity of species within them. He collected many Brazilian medicinal plants for his studies. To provide another example, in 1817, the *Scientific Mission of Natural History* or *Austrian Mission* funded visits by scientists in various specialties (zoologists Johann Baptist von Spix and Johann Natterer and botanists Carl Friedrich Philipp von Martius, Johann Sebastian Mikan and Johann Emmanuel Pohl), along with artists, a lithographer, a taxidermist and a photographer accompanying the Archduchess of Austria, Lady Maria Leopoldina, daughter of King Francis I, who had just married Prince Dom Pedro de Alcântara de Bragança e Bourbon through a power of attorney.

After their arrival in Rio de Janeiro, *Von Spix*, *Von Martius* and the painter *Ender* moved away from the Austrian group and travelled to the basin of the Paraíba do Sul. During 1817 to 1820, they covered thousands of kilometers across the country, visiting Ouro Preto and Diamantina in Minas Gerais Province, where they learned about diamond exploitation. Later, they went to the provinces of Bahia, Pernambuco, Piauí, Maranhão, Pará and Amazonas and crossed Caatinga vegetation in the Northeast of Brazil and the Amazon Forest, contracting several diseases. Nevertheless, they profited from their time by collecting and describing animals and plants. They discovered the giant meteorite of Bedengó in Bahia and the fossil fishes of the Santana Formation of Araripe Basin. The monumental *Flora Brasiliensis* (1840-1906), elaborated by *von Martius*, *August Wilhelm Eichler* and *Ignatz Urban*, was also the result of this travel. It was sponsored by three monarchs—the emperor of Brazil, the king of Bavaria and the emperor of Austria—with the support of 65 specialists from several countries. It is noteworthy that Lady Leopoldina's strength and determination, much more than could have been expected from either the archduchess of the Austria house or the princess of the Braganças house or from the empress of Brazil, stood out as a leader on projects to boost development of science, culture and other activities, strongly supporting the formation of the Brazilian society. Given that the "*Father of Paleobotany*", Adolphe Brongniart, published his first identifications of European and Indian fossil plants in 1822, the year when Brazil obtained its independence from Portugal, it is possible to assume with confidence that, during colonial times, no mention of fossil plants was made.

### **Independence from the Portuguese domain and the Empire of Brazil (1822- 1889)**

During the period of the Empire, as in the period of the *United Reign of Portugal, Brazil and Algarve*, naturalistic research in Brazil was led by *European Scientist-Travelers* (mainly British, French and German), with the incipient participation of Brazilian researchers. Until the opening of the Ouro Preto School of Mines in 1876, geological investigations were conducted almost exclusively by foreign scientists, some of whom settled in Brazil (Mendes and Petri, 1971).

It is worth explaining that there was only one period of Brazilian Empire (1822-1889), which is historically divided into the *First Reign* (1822-1831, Dom Pedro I), an interval of regencial government (1831-1840) and the *Second Reign* (1840-1889, Dom Pedro II).

#### **• First Brazilian Reign (1822-1831)**

##### *The European Naturalist-Explorers*

Friederich Sellow (a disciple of Carl Ludwig Willdenow, Georges-Cuvier, Jean-Baptiste Lamarck and Alexander Von Humboldt) left Berlin for Brazil in 1824 as part of the *Langsdorff Expedition* (a Russian

expedition organized and headed by *Baron Georg H. von Langsdorff*, a German naturalized Russian). Sponsored by the young Empire of Brazil, with sizeable credit and customs advantages, the expedition aimed to make scientific discoveries, conduct geographical research, gather statistics and study the trade of unknown products. From 1824 to 1829, *Sellow* traveled more than sixteen thousand kilometers throughout Brazil, from Minas Gerais to Rio Grande do Sul and Uruguay, making records of its nature and society and providing the most complete inventory of *Brazilian First Reign*. As a botanist, he was probably the first to examine Jacuí coal samples and to describe a fossiliferous sequence between São Gabriel and Caigatú (RS), with teeth and skulls of fish and *silicified dicots*. He sent paleontological samples to the National Museum of Rio de Janeiro. To the Berlin Natural History Museum he sent 12,000 plants, 5,000 birds, 110,000 insects and 2,000 geological samples. *Sellow* remained here until 1831 and died tragically by drowning in the River Doce (MG). Unfortunately, he had no time to describe what he had collected.

Charles Darwin (1809-1882) was certainly the most distinguished *Scientist-Traveler* who passed through Brazil during the First Reign. He left England in December 1831 to participate as a naturalist on the ship HMS “Beagle”. He arrived in Salvador (BA), in February 1832 and was astonished by his first sight of the tropical forest and fauna. Later, Darwin went to Rio de Janeiro, where he went on small tours, visiting Tijuca Forest, Botanical Garden, Gávea, Corcovado and the Imperial Museum (now the National Museum). He collected insects and observed and studied their behaviors around the city, sending dozens of insects to Professor Henslow for further studies. These materials provided information helpful to the posterior formulation of the *Theory of Evolution by Natural Selection*. Nevertheless, Darwin observed nothing in terms of paleobotany.

### **Brazilian naturalists during the First Reign (1822-1831)**

The first geological information of scientific value in Brazil was obtained by the *Andradas Brothers* (José Bonifácio and Martim Francisco de Andrada e Silva), who reported on Brazilian diamonds. Their research was published in 1792 by the *Société d’Histoire Naturelle Bulletin of Paris* (Mendes and Petri, 1971).

José Bonifácio de Andrada e Silva (1763-1838, Figure 1A), named the “Patriarch of Independence”, was a Brazilian geologist and a strongly influential political statesman during the First Reign (the Dom Pedro I government). He was a renowned scientist and was considered the first geologist from the American continent. However, he did not observe anything pertaining to paleobotany.

The Regencial Period (1831-1840) is an interval between the end of the *First Reign* of Dom Pedro I and the beginning of the *Second Reign* that occurred during the childhood of then-future Emperor Dom Pedro II.

In 1836, exactly 180 years ago, Franz Unger (1800-1870, Figure 1B), an Austrian botanist and paleontologist, first reported a Brazilian phytofossil, *Psaronius brasiliensis* Unger, a stem of an arborescent fern, in the work of Von Martius entitled *Historia Naturalis Plantarum*. At that time, Unger described the stem based only on a fragment of the surrounding layer of adventitious roots. In 1817 and 1820, this first phytofossil specimen was collected by Von Martius from the Pedra de Fogo Formation, Permian of the Parnaíba Basin, between Oeiras and Sao Goncalo do Amarante in Piauí. In 1872, during the Second Reign, Adolphe Brongniart (1801-1876) described the anatomical details of *Psaronius brasiliensis* based on other specimens collected either between 1817 and 1820 by C. F. Von Martius or in 1826 by F. Sellow and deposited in the Imperial Museum of Rio de Janeiro.

### **• The Second Brazilian Reign (1840-1889)**

The Second Reign was a time of great cultural progress and huge importance to Brazil with the growth and consolidation of the Brazilian nation both as an independent country and as an important member of the American nations. Profound changes were observed in the social situation, such as the gradual liberation of black slaves and the encouragement of immigration from Europe to supplement the Brazilian workforce.

In 1853, the exploitation of coal began in Rio Grande do Sul State with the opening of the Arroio dos Ratos mine (Mendes and Petri, 1971).

### **Studies of Brazilian Paleobotanical Material: Scientists from European Museums and North America in the Nineteenth Century**

From 1863 to 1864, Nathaniel Plant, an English naturalist, analyzed the coal reserves of Rio Grande do Sul, including its fossils. In Part III of Plant (1869), William Carruthers (1830-1922, Figure 1C) identified and described *the first phytofossils regarding Glossopteris Flora of Brazil* found in shales associated with the coals: *Flemingites pedroanus* Carruthers [specific epithet in honor of Dom Pedro II, Emperor of Brazil, now designated as *Brasilodendron pedroanum* (Carruthers) Chaloner, Leistikow, Hill, 1979]; *Odontopteris*

*plantiana* Carruthers [now *Botrychiopsis plantiana* (Carruthers) Archangelsky and Arrondo 1971]; and *Noeggerathia obovata* Carruthers [now *Gangamopteris obovata* (Carruthers) White, 1908]. This was a pioneering contribution to the inception of Brazilian Gondwanan paleobotany. Carruthers was a British naturalist specializing in geology and botany. In 1859, he was appointed assistant of the Department of Botany of the British Museum of Natural History. It is said that Carruthers combined his two passions (geology and botany) through the study of paleobotany, in which he specialized in *Lepidodendron* and *Calamites* genera, the Lycopodiaceae family and the anatomy of fossilized stems.

Among the *scientist-travelers* of the Second Reign, in addition to the Europeans, many North American researchers became interested in Brazilian paleontological studies.

Louis and Elizabeth Agassiz traveled to Brazil during 1865 and 1866. Agassiz dated as Cretaceous the fossil fish from Ceará State collected by George Gardner in 1841. Accompanying the Agassizes in 1865, Charles Frederic Hartt came to Brazil with an expedition that was to study freshwater fauna and the possibilities of an ice age in Northern Brazil. He returned to Brazil twice, once in 1867 and again in 1870, to do research on the geology of the Brazilian coast. Hartt was accompanied by researchers such as Orville Adelbert Derby and others.

During the second half of the nineteenth century, under the command of Dom Pedro II, Brazil made progress in the scientific field. During that period, the emperor's support of scientific events and publications vouched for any project carried out by Brazilian scientists. Since 1870, the National Museum of Rio de Janeiro and the Pará Museum of Natural History and Ethnography (now Museum Emílio Goeldi) have stood out as producing centers of ethnographical and natural sciences. Until that time, Brazilian scientific productions were still incipient, but grounded in Positivism and Darwinism, which, incorporated by the intellectual elites and Brazilian politicians, allowed Brazil to approach the *European Scientificism* context.

At the end of the Second Reign (1870-1889), some North American geologists and paleontologists were installed in Brazil by invitation of the Brazilian government (1874-1915); others received phytofossils in Europe.

In 1874, Charles Frederic Hartt (1840-1878, Figure 1D) was invited by the Brazilian Government to organize the *Imperial Geology Commission* with the goal of preparing a geological map of Brazil based on geological, mineralogical and paleontological (mainly paleobotanical) data, obtaining collections. He had among his assistants Orville A. Derby.

Orville Adelbert Derby (1851-1915, Figure 1E) was also a North American geologist, a naturalized Brazilian who dedicated his life entirely to Brazil's geology, earning the title of *Father of Brazilian Geology*. C. F. Hartt, Derby's professor of geology and geography at Cornell University, invited him to accompany him on a trip to Brazil in the summer of 1870. During the first trip of the Morgan Expedition, Derby was in the State of Pernambuco, collecting fossils from the Maria Farinha Formation. In the summer of 1871, on the second trip of the Expedition, Derby returned to Brazil to explore the valley of the Amazon River. At that time, he collected Carboniferous brachiopods in the limestone of the Itaituba Formation in the Tapajós River, which became the study object for his doctorate in 1874.

Invited by the provincial government, O. Derby organized the *Geographical and Geological Commission of São Paulo Province* from 1886 to 1904. It is currently designated the *Geological Institute* of the Department of Environment of the State of São Paulo.

In Piracicaba Region, State of São Paulo, Derby collected silicified stems of lycophytes from the Corumbataí Formation, Permian of the Paraná Basin. He sent them to Dr. B. Renault in Paris. Based on morphological study of the cortical surface and the anatomy of the inner portion of the stem, he erected the genus and species *Lycopodiopsis derbyi* Renault.

The taxonomy of the Permian gymnosperm woods of Paraná Basin began in the late nineteenth century with the description of *Dadoxylon pedroi*, identified by Zeiller in the coal layers of the Rio Bonito Formation exposed in the Valley of the Jaguarão in Rio Grande do Sul State.

René Zeiller (1847-1915, Figure 1F) considerably expanded knowledge of the Flora of Glossopteris in Southern Brazil and Africa and described new forms from the Lower Gondwanas of India. He examined a collection of phytofossiliferous samples from the Arroio dos Ratos mine belonging to Princess Isabel and explained that because of her generosity, some of those samples were donated to the École de Mines de Paris. In 1898, Zeiller re-examined the specimens described by B. Renault and recombined as *Lepidodendron derbyi* (Renault) Zeiller, which was endorsed by Arber (1905).

### ***The first Republic of the United States of Brazil (1890-1930)***

In Brazil, the method of large-scale producing generated by the *Industrial Revolution* began to significantly develop very late, that is, only in the late nineteenth and early twentieth centuries. It fell to the São Paulo coffee growers, with fortunes originating from coffee exports, to initiate investments in

the industrial sector. Therefore, it became necessary to intensify coal mining as a source of energy for that sector.

During the first three decades of the twentieth century, renowned European and American paleobotanists continued to describe Brazilian plant fossils sent to them by geologists who lived here.

H. Solms-Laubach (1842-1915, Figure 1G) was a German botanist who studied Permian fossil woods from the Parnaíba Basin, identifying them in 1904 as *Psaronius brasiliensis* (Unger) Brongniart. He also described petrifications of Permian ferns similar to the *Psaronius* from Corumbataí Formation in the northeast area of the Paraná Basin as *Tietea singularis* Solms-Laubach in 1913, differentiated by the absence of well-organized and defined meristeles in the central portion of the stem that are typical of *Psaronius*. These forms have recently been restudied by Tavares *et al.* (2011). Chahud and Petri (2015) have also recorded the species *T. singularis* in the formation immediately below Corumbataí, *i.e.*, in the Tatuí Formation (meaning the Rio Bonito + Palermo formations in the southern part of the basin).

In 1905, E. A. Newell Arber made a careful and analytical summary of what had become known so far about Glossopteris flora in his *Catalogue of the Fossil Plants*. In this important work, Arber referred to Brazilian fossils deposited in the British Museum and other European museums, quoting from the works of Unger (1836) and Solms-Laubach (1904) (see Arber, 1905 and references therein mentioned below) on *Psaronius brasiliensis*; fossils described by Carruthers (1869) and its restudy by Zeiller (1895). He referred also to Plant (1870) studies registering *Lepidodendron* in association with *Glossopteris* in Candiota and Jaguarão coals in Rio Grande do Sul. He cited Hartt's (1870) records on *Asterophyllites (Calamocladus)* in the south of Bahia and the work of Liais (1872) on the occurrence of *Sphenopteris* and calamitaleans in Candiota and Jaguarão coals. He recorded Derby's (1888) observation that trunks of *Dadoxylon*-type conifers and the stems and leaves of *Lepidodendron* and *Psaronius* fragments occurred in the province of São Paulo. He emphasized that Renault (1890) had described a new species of lycophyte stem as *Lycopodiopsis derbyi* of Piracicaba (SP) associated with fern trunk (*Psaronius*) and *Cordaites* leaves. Arber also reported his agreement with Zeiller (1898) that the genus *Lycopodiopsis* Renault would be a true *Lepidodendron* and highlighted that Hettner (1891) had recorded the presence of Glossopteris flora in the coal area of Jacuí river called Arroio dos Ratos, located in Rio Grande do Sul. He also observed that Zeiller (1895) examined Hettner's specimens in the Berlin Museum and among them identified *Gangamopteris cyclopteroides* var. *attenuata*. Arber also stressed that Zeiller was the first to recognize that Brazil had a remarkable combination of elements of the Glossopteris flora [*Gangamopteris cyclopteroides* Feistm. and *Neuropteridium validum* (Carr.) Feistm.] with common Euramerian plants in the Upper Carboniferous such as *Lepidophloios laricinus* Sternberg.

Charles David White, or simply David White (1862-1935, Figure 1H), was a North American geologist. After briefly mentioning the *Flora of the Brazilian Coal Measures* (Science, 1905), White produced the first comprehensive monograph on the Permian plants from Southern Brazil, which is one of the most important and complete descriptions of fossils of the Glossopteris flora from the coal layers of Brazil (Santa Catarina and Rio Grande do Sul), as described in Part III of (the not least important) Israel Charles White's *Final Report for the Coal-Stone Research Committee of Brazil* (1980), in which the famous *White Column* of the stratigraphic sequence of the Paraná Basin has been described.

G. Lundqvist (1919) recorded a new *Glossopteris* taphoflora from the Permian of Rio Grande do Sul and Paraná states. In that work, he accepted White's proposal (1908) to consider *G. cyclopteroides* Feistmantel as synonymous with *G. obovata* (Carr.) White. He also described the fructification *Arberia brasiliensis* Lundqvist.

### **The Brazilian naturalists-scientists of the first three decades of the twentieth century (1907-1929)**

This is the first phase of development of Brazilian geopaleontological activities in the twentieth century.

Under the leadership of Orville Derby, the Geological and Mineralogical Service of Brazil (SGMB, Portuguese acronym) was established in 1907. Its primary purpose was to advance Brazil's interests (*i.e.*, the interests of its government and industry) in the pursuit of the country's mineral resources and coal. The first group of paleontologists arose in this context, interrupting the delivery of fossils for study abroad.

In 1910, Derby's disciple Matias Gonçalves de Oliveira Roxo (1885-1954, the first Brazilian paleontologist) began his research in SGMB. Roxo 1938 (apud Dolianiti 1972) published the first Brazilian textbook on paleophytology (Paleofitologia). The young people attracted to the paleontological sciences included Elias Dolianiti (1911-1985), who became the first Brazilian paleobotanist and began his research around 1945 (discussed below).

Edward Wilber Berry (1875-1945, Figure 1I) was an American botanist whose research focused on paleobotany. From 1911 to 1930, Berry produced important works on the American Mesozoic and Cenozoic paleofloras. However, he also conducted important taxonomic studies identifying Cenozoic fossil

leaves from Central and South America (from the Caribbean to Patagonia), providing paleoclimatic and paleophytogeographic interpretations.

Berry's publications, especially by The Johns Hopkins University, continue to provide the foundation for many Paleogene and Neogene paleobotanical studies. Berry published on various Tertiary phytossiliferous occurrences in Brazil: in 1924, he co-authored a work with Charles Arthur Hollick on the flora of Bahia Pliocene (Alagoinhas and Marau); in 1933, he published a work on petrified wood (*Jacaranda tertiaria* Berry) of Bahia Pliocene; in 1935, he published a work on Brazil's Tertiary plants in general; and in 1937, he published a work on Acre Pliocene leaves (Cruzeiro do Sul municipality).

Carlotta Joaquina Maury (1874-1938, Figure 1J) was an American paleontologist who was an expert in invertebrate paleozoology. She began working for the Geological and Mineralogical Survey of Brazil in 1918. In 1930, her paper "*O Cretáceo da Parahyba do Norte*" of the *Geological and Mineralogical Service of Brazil, Monograph 8*, described two coconut fruits of the Gramame Formation (Maastrichtian) from João Pessoa (state of Paraíba). Those fruits were named *Palmocarpon luisi* (in honor of President Washington Luis). According to Maury, they came from a *Palmae flora*, which covered the Northeastern coastal region during that time, similar to *Palmocarpon cretacea*, Maastrichtian of the Netherlands. In 1936, in her work entitled "*O Cretáceo de Sergipe*" in the Riachuelo Formation, Maury recorded the presence of *Lithothamnium*. Maury (1937) simultaneously with Berry (1937) worked on the identification of the Acre Pliocene leaves (Cruzeiro do Sul municipality). Those identifications were *evaluated* by Duarte (1970), who proposed *synonyms* for the identified species.

### **The second and third Republic of the United States of Brazil**

#### *Brazilian paleobotany during the Vargas Dictatorship - Vargas Age (1930-1945)*

During the *Vargas Age* (1930-1945), or *New State*, the *National Department of Mineral Production* (DNPM, Portuguese acronym) was formed and the SGMB was changed to the *Division of Geology and Mineralogy* (DGM). The division was included in the newly formed DNPM. The *Section of Paleontology* was placed within the division to house the collections formed by the SGMB. In addition, the *Conselho Nacional de Petróleo* (CNP) and the *Companhia Siderurgica Nacional* (CSN), the largest steel industry in Latin America, were formed. The plant is located in the city of Volta Redonda (RJ), its blast furnaces consuming a huge quantity of coal of the Santa Catarina mines and promoting its most intense study.

During World War II (1939-1945), a co-operation agreement between the DNPM and the *U.S. Geological Survey* was signed and lasted approximately 20 years. At that time, several North-American paleontologists and geologists came to Brazil, among them *Charles Brian Read*.

Charles Brian Read (1907-1979) was a brilliant North American geologist and paleobotanist. His paleobotanical studies included morphology and plant anatomy, floristics and biostratigraphy. In the late 1930s and early 1940s, Read studied and published on the Devonian to Permian floras of South America in Peru, Argentina and Brazil (especially the Paraná Basin) with the macrofloral successions. Read's primary work on Brazilian phytossils was presented in 1941 as Monograph 12 DNPM / DGM entitled *Plantas fósseis do Neo-Paleozoico do Paraná e Santa Catarina, Brasil*.

Carl Rudolf Florin (1894-1965, Figure 1K) was a prestigious Swedish botanist and paleobotanist during the first half of the twentieth century. His studies covered observations on floras worldwide since the middle Paleozoic. One of Florin's best-known papers is "*The distribution of Conifer and Taxad genera in Time and Space*". His works and evolutionary interpretations were based on the *Teloma Theory of Zimmerman*. In 1940, Florin described *Paranocladus dusenyi* and *P (?) fallax* based on specimens from the area of Figueira or Cambuí (PR), today recognized as the Triunfo Member of the Rio Bonito Formation, Cisuralian (Asselian/Sakmarian) of the Paraná Basin.

During the Vargas Age, some Brazilian researchers devoted to the study of living angiosperm logs anatomy conducted investigations of Paleozoic and Cretaceous woods.

Dr. Fernando Romano Milanez was an anatomist of living logs and director of the Botanical Garden of Rio de Janeiro. He oriented paleobotanist Diana Mussa in her first work within the specialty. In 1935, he described a petrification of Cretaceous angiosperm from Piauí designating *Lecythioxylon brasiliense*. In 1950, in collaboration with *Elias Dolianiti*, he conducted a study on a new Lower Permian gymnospermic trunk.

Dr. Calvino Manieri, an anatomist of living woods and director of the Wood Section of the Institute for Technological Research of São Paulo State during 1944 and 1946, greatly contributed to the study of the anatomy of Paleozoic *Dadoxylons*.

Euzébio Paulo de Oliveira (1883- 1939, Figure 1L) was an engineer of the Commission of Coal Mines of Brazil in 1907. In 1935, Euzébio de Oliveira and Luiz Flores Moraes Rego noted the presence of typically Euro-American plants (*Sphenopteris*) in the Pennsylvanian of Paraíba Basin, i.e., in the northwestern region

of the Gondwanan Continent. In 1936, he described *Dadoxylon derbyi* Oliveira. In turn, Moraes Rego (1935) (*apud* Dolianiti 1972) has suggested a possible correlation among the sediments of the Poti, Piauí and Pedra de Fogo formations (Parnaíba Basin) and the formations of the Tubarão and Passa Dois groups (Paraná Basin) based on the presence of *Psaronius* in the northeast and *Pecopteris* and *Tietea* in the south.

#### **Fourth Republic of the United States of Brazil (1946-1964)**

With the fall of dictator Getúlio Vargas in 1945 began a new period of Brazilian republican history known as the *Fourth Republic of the United States of Brazil* (1946-1964).

Brazil's rapid industrialization during the presidency of Juscelino Kubitschek (1956-1960) led to national demand for geology experts in both public institutions and private enterprises. Thus, in 1957 the Geologists Formation Program (CAGE) was initiated within the Ministry of Education and Culture.

The first group of Brazil-trained geologists (1957-1960) resulted from the opening of four geology programs: the Universidade Federal de Pernambuco (UFPE); the Ouro Preto School of Mines; the Universidade de São Paulo (USP) and the Universidade Federal do Rio Grande do Sul (UFRGS). All these programs were initiated by Brazil's federal government.

In 1944, Elias Dolianiti (1911-1985, Figure 1M), a DNPM naturalist, traveled to the coal region of Santa Catarina, collecting approximately 3,000 fossil specimens of *Glossopteris* flora. He became a great specialist of that flora in Brazil, registering several species from the Rio Grande do Sul to Paraná, especially those collected in the State of Santa Catarina between 1946 and 1956. He also studied fossil plants from the Fonseca Tertiary Basin, Minas Gerais, from 1946 to 1950 and reviewed the flora of Teresina (Parnaíba Basin) in 1954.

In 1955, Dolianiti identified fossil fruits from the Maria Farinha Formation, Paleocene of the Pernambuco Basin as *Nipa pernambucensis*, collected between Olinda and Paulista. They are considered a small-sized palm with big fruit, coming from the Eastern Hemisphere.

In response to a request from the National Research Council (CNPq), Dolianiti accompanied Prof. Richard Kräusel (1890-1966) from the University of Frankfurt, Germany, in his field work to the Paraná Basin, resulting in an excellent work on gymnosperm woods of the Brazilian Paleozoic (Kräusel and Dolianiti, 1958) and Early Devonian fossils of the Picos Formation in the Parnaíba Basin (Kräusel and Dolianiti, 1957, *apud* Dolianiti 1972).

In the 1960s and 1970s, Dolianiti gave continuity to his research on the Brazilian Paleozoic and Mesozoic floras. He led scholars and actively participated in fieldwork. In the 1980s, Dolianiti began to investigate the flora of Cerquilha (São Paulo State) with José Henrique Millan.

In 1972, during the International Symposium on Carboniferous and Permian Systems in South America, Dolianiti expounded on the presence of two Carboniferous and Permian floristic regions in Brazil that previously had been observed by several authors, one in the northern area of the country (Parnaíba Basin), which was floristically Euro-American, and another, which was Gondwanan, in the southern area (Paraná Basin).

*Elias Dolianiti* had a profound knowledge of Brazilian paleobotany and despite the difficulties of doing research during the time published more than 30 scientific papers on fossil plants of Brazil's sedimentary basins. All those papers are known and appreciated by experts. The certainty, clarity and accuracy demonstrated in Dolianiti's works brought him deserved national and international recognition as an authority on Gondwanan flora. In our view, he undoubtedly deserves the title of *Father of Brazilian Paleobotany*.

Reinhard Maack (1892-1969, Figure 1N) was a German geologist who moved to Brazil in 1926 and spent most of his life in the State of Paraná. Maack published numerous works on southern geology and scientifically trained many young people in Paraná. He was a student of the Permian lycophytes of Paraná Basin. Following his studies on the geology of Southern Africa, Maack moved to Brazil, making significant correlations between the Kaokoveld region in Namibia and Gondwanan strata of Southern Brazil, greatly contributing to the knowledge of the *Theory of Continental Drift* and the *Gondwana supercontinent*. In 1949, Maack became a naturalized *Brazilian*.

Octavio Barbosa (1907-1997, Figure 1O) was a geologist. Starting in the beginning of the 1930s, he worked in the old SGMB. Barbosa published more than 200 papers on geology and mineral prospecting. From 1952 to 1958, he published works on paleobotany, defining the age of the Gondwana floras of Paraná Basin and observing the *Parataxopitys americana* Barbosa, a fossil wood of the Irati Formation (Kungurian of Paraná Basin). He was the first researcher to detect the taphoflora of Monte Mor, State of São Paulo, registering it as a Pennsylvanian flora prior to the *Glossopteris* flora.

Friedrich Wilhelm Sommer (1907-1994), an Austrian naturalized Brazilian, worked at DGM/ DNPM, in Rio de Janeiro. Despite being more inclined toward micropaleontology, Sommer made some incursions



into the field of paleobotany. His most outstanding works include studies on algal fossils of Spongiophytales, Tasmaniales and Protosalvinales of the Parnaíba and Paraná Basins and studies on Pennsylvanian and Permian megaspores of the Paraná Basin.

Lelia Duarte [1930? -2013] was an extremely productive paleobotanist dedicated to research on Brazilian Mesozoic and Cenozoic fossil plants. She worked in the Paleontology Section of the DGM/DNPM from 1956 to 1984(?). She conducted numerous field studies and participated intensely in scientific events. During her time at the DGM/DNPM, she collected and deposited important phytofossil specimens in the DGM/DNPM collection of paleobotany. From 1985, Duarte worked at the Universidade do Estado do Rio de Janeiro. Her contribution to Brazilian paleobotany was wide and involved phytofossils from different Brazilian sedimentary basins.

From 1956 to 1961, Duarte studied Melastomataceae, Styracaceae, Annonaceae leaves and a Bombacaceae flower in the Tertiary Fonseca Basin. In 1985a, she erected two new species of ferns from this basin: *Anemia debiis* Duarte and *Asplenium ferruginii* Duarte.

In 1965, Duarte began her studies on the Early Cretaceous floras of Araripe Basin and in 1985b, presented as its components *Brachyphyllum obesum* Heer, *B. castilhoi* Duarte, *Podozamites lanceolatus* (L & H) Sch, *Nymphaeites choffati* (Sap) Teixeira and *Choffatia francheti* Sap. In 1993, her studies were concentrated on Araucariaceae of the Santana Formation, mainly the Crato Member. Simultaneously, she presented the floristic elements from the Areado Formation of the São Francisco River Basin (1985c).

Collaborating with Adelia Maria Salviano Japiassú, Duarte conducted an extensive and complete survey of the plant record throughout Brazil (as known through 1971) from the Triassic to the Holocene.

Lelia Duarte defended her doctoral thesis at the Universidade de São Paulo (1972) on the Miocene Amazon flora of the Pirabas Formation occurring in the state of Pará. She concluded that it is a tropical flora composed exclusively of angiosperms with high diversity of species, composed of 20 species belonging to 19 genera and 18 families, among which only one species belongs to monocots. The rest are distributed among the Archchlamidaceae with 15 families and 16 genera and Sympetalae, with two species in two genera of two distinct families.

An important contribution to the knowledge of the Cenozoic flora of southeastern Brazil, was made by Duarte and Rezende-Pimentel (1985), who described the flora of the Peripheral Depression of São Paulo, in Vargem Grande do Sul, where they identified leaf fossils of Celastraceae, Myrtaceae, Melastomataceae and Symplocaceae.

In the 1980s, Duarte and Mandarin-de-Lacerda also conducted important studies of the Paleogene flora of Taubaté Basin.

Duarte, along with her collaborators, also contributed significantly to the Quaternary paleobotany of Umbuzeiro (State of Paraíba) and Morro do Chapéu (State of Bahia).

Diana Mussa (1932-2007, Figure 1P) had a deep knowledge of plant anatomy, biostratigraphy and geology, devoting herself to Brazil's largest study of Permian macrofloras in the fossil woods of the Paraná Basin. Her doctoral thesis entitled "*Lignitofloras Permianas da Bacia do Paraná, Brasil (Estados de São Paulo e Santa Catarina)*" was defended at USP (1982).

In the early 1980s, Diana Mussa worked as a researcher at the DNPM and was recruited by the National Museum (MN/UFRJ) in 1983. She conducted research, advised students and taught various subjects both in the Department of Geology and Paleontology of the National Museum (DGP-MN / UFRJ) and in the Institute of Geosciences (IGEO / UFRJ). In 1993, following a public contest, she was appointed as Associate Professor of Paleobotany at the National Museum / UFRJ.

Mussa's scientific production, which included approximately 50 high-level papers, involves mainly Paleozoic, Mesozoic and Cenozoic woods studies; however, it also includes phytofossiliferous impressions from the Devonian to the Cretaceous. Based on paleoanatomy, she made ontogenetic interpretations, paleoclimatic, taphonomic and phylogenetic lineages of fossil plants.

Mussa worked with phytofossils from almost all of Brazil's continental sedimentary basins: Acre, Parnaíba, Lima Campos, Potiguar, Sergipe-Alagoas, Jatoba, and Itaboraí, with special attention to Gondwanan phytofossils of the Paraná Basin. She described approximately 30 genera of fossil plants. She left an important collection, with more than one thousand slides of fossil woods. She trained many graduate students. With a beautiful career, despite the fact that she was published only in Portuguese, Mussa is internationally recognized as Brazil's most important paleoxtologist and the world authority on Devonian floras.

Richard Kräusel (1890-1966), from the University of Frankfurt – Germany, produced not only the previously mentioned works in partnership with Dolianiti but also an important monograph on revision of the petrified genus *Lycopodiopsis* and other Permian lycophytes of the Paraná Basin, reviewing all previous information and adding observations based on new material (Kräusel, 1961).

Sergio Mezzalira (1920-2009, Figure 1Q), working at DGM/DNPM in Rio de Janeiro from 1942 to 1946, produced scientific field works in the State of São Paulo, locating for the first time an occurrence of Corumbataí Formation fossil plants in Rio Claro. He moved to the Geographical and Geological Institute (now the Geological Institute, IG) of São Paulo in 1946 and started cataloging the fossil collection. Although Mezzalira was an expert on the bivalves and crustaceans of the Passa Dois and Bauru groups, he also often studied Permian, Mesozoic and Cenozoic phytofossils. From 1953 to 1960, he developed a mapping project on the contact between the Corumbataí and Irati formations in the areas of São Carlos, Rio Claro, Piracicaba, Araras and Casa Branca, locating and collecting many fossils. He recorded new occurrences of lycophytes in Piracicaba, glossopterids in Tatuí and the fructification *Plumsteadiella* in the Tubarão Group. He described Cenozoic phytofossils from the Rio Claro Formation in Vargem Grande do Sul (SP), erecting a new fossil species of Melastomataceae, *Tibouchina izildaisabelae* Mezzalira.

### **Fifth Republic: Military dictatorship (1964-1985)**

During the *Military Dictatorship*, more precisely in the period from 1968 to 1972, several post-graduate courses began to emerge in Brazil's geology schools, encouraged by CAPES. These courses included strengthened expertise in paleontology (mainly in the UFRGS, USP and UFRJ), including paleobotany. Foreign researchers such as Sergio Archangelsky from Argentina, Denise Pons from France and John Rigby from Australia were specially invited to encourage the study of paleobotany among graduate students of Rio Grande do Sul and São Paulo.

Many Brazilian paleobotanists of "generation 1968-1980" were trained in important paleobotanical centers abroad. Carlos A. Bortoluzzi trained between 1972 and 1973, Mary Bernardes-de-Oliveira performed a *sandwich stage* (between master and doctorate) in 1973-1974, and Margot Guerra-Sommer trained between 1980 and 1981. All three of these paleobotanists did this training at the *Laboratoire de Paléobotanique M. Le Prof. Édouard Boureau, Université Paris VI, France*. Oscar Rösler was trained between 1975 and 1976 at the *University of London, England, by Prof. William Gilbert Chaloner*.

The graduate students specializing in paleobotany in Rio Grande do Sul at that time (1968-1980) included the following:

Dr. Carlos Alfredo Bortoluzzi, who primarily studied the coal deposits of Santa Catarina and the Dicroidium flora of the Triassic Santa Maria Formation, Rio Grande do Sul.

Dr. Miriam Cazzulo-Klepzig (Figure 1R), who works at UFRGS studying Permian taphoflora from the Itararé Group to the Rio do Rasto Formation (Passa Dois Group) as a palynologist. She also studies macrofloras from a taxonomic, paleoclimatic, paleoecological and faciological point of view, and has published more than 40 works since 1979.

Dr. Margot Guerra-Sommer (Figure 1S), has been a professor at UFRGS since 1974. She structured the paleobotanist sector and implemented paleobotanical research in the IGEO/UFRGS post-graduate program. As a paleobotanist, Guerra-Sommer performs dendrological and paleoclimatic determinations of Paleozoic and Mesozoic taphofloristic associations of supersequences Gondwana I and Gondwana II of the Paraná Basin and the Lower Cretaceous of the Araripe Basin. She analyzes them from a taxonomic, taphonomic, paleoecological, paleoclimatic, relative and absolute (radiometry) dating point of view. In addition, she studies paleophytoatmospheric indicators of cuticular structure type of the Glossopteris flora and of *charcoal* and palynofacies studies and organochemistry of Quaternary sediments for paleoenvironmental, paleoclimatic and paleoecological interpretations. She has been endeavoring to train new paleobotanists.

Dr. Tania Lindner Dutra (Figure 1T) began her paleobotanical studies in 1974 and wrote a brilliant doctoral thesis on the Cretaceous-Tertiary floras of Antarctica (1997). As a lecturer at the University of Vale dos Sinos in Rio Grande do Sul, Dr. Dutra is practically the only Brazilian paleobotanist to develop studies on the Mesozoic and Cenozoic floras of the Antarctic Peninsula and their paleoecological, paleogeographic and biostratigraphic implications. She studies the Araucaria Forest of meridional Brazil, Southern South America and Australia, correlating it with the Paleogene floras of Antarctica. She also develops studies on Mesozoic floras of Southern Brazil. She has trained other paleobotanists.

Dr. José Henrique Millan represents the paleobotanists of the "*generation from 1968 to 1980*", in Universidade Federal do Rio de Janeiro (UFRJ). He received his doctorate from the USP (1970) with a thesis on the Pennsylvanian pre-Glossopteris flora of the Itararé Group, Paraná Basin, in Monte Mor (São Paulo State). Millan's thesis is a very comprehensive study of the components of that taphoflora that records the first occurrence of conifers and *Ginkgophyllum* in the Paraná Basin. Dr. Millan worked at the National Museum of Rio de Janeiro. In addition to becoming an expert of Gondwanan platyspermic seeds of Paraná Basin, he studied the Pennsylvanian taphofloristic occurrences in Itapeva and the Early Cisuralian in Cerquilho (São Paulo State), both of the Itararé Group. He can be considered the great student of the interglacial Itararé

Group floras in the state of São Paulo, although he has also studied the flora of the Rio Bonito Formation in Santa Catarina.

In the Geosciences Institute of the Universidade de São Paulo there were two Paleobotanists of the “*generation from 1968 to 1980*”: Oscar Rösler and Mary Elizabeth Cerruti Bernardes-de-Oliveira.

Dr. Oscar Rösler (Figure 1U) is a paleobotanist from the State of Paraná. His thesis at USP (1972) was on the Early Permian flora of the Triunfo Member, in the lower portion of the Rio Bonito Formation in São João de Triunfo and Cambuí, in the State of Paraná. His thesis describes three new species of sphenophytes—*Sphenophyllum brasiliensis*, *Annularia occidentalis* and *A. readi*—associated with fern remains, glossopterids, lycophyta, etc. He created many collections of Carboniferous and Permian phytofossils throughout the Paraná Basin, which were deposited in the Scientific Collection of IGc / USP and located many new fossil outcrops.

Dr. Rösler became an important student of paleofloristic Lower Gondwana succession of the Paraná Basin and in 1978 proposed a paleofloristic succession scheme for the Gondwana I sequence (Itararé, Guatá and Passa Dois groups). He has authored more than 50 papers on the floras of the Tubarão and Passa Dois groups. He has supervised several master’s degrees and doctorates in paleobotany at USP.

In 1978, with Dr. M.R. de Lima and Dr. M.E. Bernardes-de-Oliveira, Rösler started meetings of paleobotanists and palynologists (RPPs) at IGc / USP. These meetings or events have come to constitute a stimulus and integration tool for paleobotany students from all over the country and subsequently, beyond the limits of USP, gave rise to the Brazilian paleobotany symposia.

As Dr. O. Rösler foresaw in 1980, in an evaluation of the 2nd RPP: “*The symposium was successful and will certainly stimulate the realization of future events of this kind, because it has been shown that they stimulate scientific production in this area, and they constitute unique opportunities for discussing specific topics of direct interest to our paleobotanical community.*”

Dr. Mary E. C. Bernardes-de-Oliveira’s (Figure 1V) doctoral thesis at USP (1977) was on Glossopteris flora of the Late Cisuralian Siderópolis Member, upper portion of the Rio Bonito Formation, in the State of Santa Catarina. As a professor at IGc / USP since 1968, she operates in paleobotanical research, with many publications in the late Paleozoic Tubarão Group, Paraná Basin - Glossopteris flora. In the Early Cretaceous Crato flora of the Araripe Basin, along with North American (David Dilcher) and European (Barbara Mohr, L. Kunzmann, C. Coiffard, Denise Pons, etc) researchers, Bernardes-de-Oliveira has developed studies on ferns, gymnosperms, basal angiosperms and magnoliids (e.g., new genera and species: *Ruffordia goeppertii*, *Welwitschiostrobus murili*, *Duartenia araripensis*, *Pseudofrenelopsis capillata*, *Hexagyne philippiana*, *Schenkeriphyllum glanduliferum*, *Friedsellowia gracifolia*, *Jaguariba wiersemana*, *Spixiarum kipea*, *Cariria orbiculiconiformis*, *Pluricarpellatia peltata*, *Novaolindia dubia*, *Endressinia brasiliensis*, among others). In the Paleogene and Neogene basins, she has developed studies on the paleobotany of the Continental Rift of Southeast Brazil basins: Taubaté and São Paulo (*Bauhinia* aff. *B. divaricata*, *Leandra* sp., among others); the Aiuruoca Basin (*Nectandra*, *Annona*, *Caesalpinia veraechinataformis*, *Machaerium aiuruoquense*, *Machaerium paleogenum*, among others) and the Peripheral Depression of São Paulo State-Rio Claro Formation (e.g., *Ocotea fittipaldii*, *Typha meli*, *Aspidosperma duartei*, among others). Her publications are co-authored with her students and several Brazilian, South American, European, Indian and North American researchers.

### **Sixth Republic (1985 to the present)**

During the Sixth Republic (1985 to the present), - “*Generation 1968-1980*” has attracted a new generation of Brazilian paleobotanists. This new “*Generation 1990-2016*” began to emerge in the 1990s and has been forming and developing to the present with great boldness, innovation and training. In addition to working with prints, this generation works with petrifications and cuticles, phytofossils and charcoals. The new “*Generation 1990-2016*” works not only with revisions of taxonomy in impressions but also with paleoanatomy, phytostratigraphy, paleoecology, phytofacies, taphonomy, paleoclimate, paleophytogeography (using new study techniques), etc.

### **“Generation 1990-2016” in meridional Brazil**

Dr. Roberto Iannuzzi (Figure 1W), who is a professor at IGeo-UFRGS, develops paleobotanical studies with paleophytogeographic, phytostratigraphic and paleoecological interpretations of both Carboniferous Rhacopteris flora and Permian Glossopteris flora. He began his paleobotanical studies with Dr. O. Rösler, analyzing Mississippian floras of Bolivia and Argentina in the form of impressions. Later, he also studied Permian floral impressions of the Terezina and Rio do Rasto formations in Santa Catarina and Paraná. He examined the *Dicroidium* Triassic flora of Rio Grande do Sul and its biostratigraphic implications with Dr. Guerra-Sommer. After studying some Permian filicophytes, sphenophytes and ginkgophytes of the

Paraná Basin, he began to analyze, especially with Dr. O. Rösler, South American paleophytogeography and biostratigraphy to observe the floristic migration and translatitudinal displacement of the continent during the late Paleozoic.

With his team and other collaborating researchers, Iannuzzi conducted herbivory analyses and an insect-plant interaction in Glossopteris leaves in the Paraná basin and the Bolivian Altiplano. He was the first to record the presence of herbivory in *Botrychiopsis* leaves in Western Gondwana. Without abandoning his studies on the Mississippian, he extended those studies to the Permian plants (*Asterotheca*, *Pecopteris* and *Glossopteris*) and drew (together with palynologist Dr. Paulo Alves de Souza) an overview of the floristic succession of Permian of the Paraná Basin in 2005.

Along with detailed taxonomic studies of glossopterids, sphenophytes, platyspermic seeds and pecopterids of the Late Paleozoic of Rio Grande do Sul, together with his students, Iannuzzi has performed taxonomic revaluations of the genera *Gangamopteris* and *Rubidgea*, *Cordaicarpus*, fructifications of Pteridosperms and described new species of *Phyllothea*. In addition, he has re-evaluated the Poti flora (late Viséan) and reinterpreted *Kegelidium lamegoi* Dolianiti of Parnaíba Basin. With Dr. Mercedes Di Pasquo and others, he developed new palynological information about the Poti Formation. He has also studied the Quaternary flora of Catalan (GO). At that time, Iannuzzi was also devoted to the study of the Cisuralian postglacial paleofloristic succession of Rio Grande do Sul. He has observed the genus *Paulophyton* in the Carboniferous of Paracas, Peru. With his team, Iannuzzi is studying the taxonomy, biostratigraphy and phytogeography of the Devonian paleoflora of the Paraná Basin.

Dr. André Jasper (Figure 1X) is a professor at UNIVATES in the State of Rio Grande do Sul. In paleobotany, he operates in the areas of plant paleo-wildfires through the analysis and microscopic study of charcoals, Gondwana paleofloras and paleoecology.

Dr. Jasper began his paleobotanical studies in 1999 with the arborescent cormophitic lycophytes of the Rio Bonito Formation. He also studied the *Botrychiopsis* and their biostratigraphic implications in the Paraná Basin. He has been devoted to studies on the evidence of Permian and Triassic paleo-wildfires and their relations with levels of atmospheric oxygen, observing the paleoecology of coal-related layers in Paraná Basin. He looks for paleobotanical evidence of paleo-wildfires in Permian and other geological periods not only in Brazil but also in other Gondwanan countries. The Permian woods of Tocantins State and charcoals from various stratigraphic levels (Permian, Campanian, Barremian) of the Paraná, Parnaíba, Roraima basins and other Gondwanan countries such as India and Africa are studied with many collaborators and students. Along with co-authors, he registered the presence of *Lycopodites* in the Lower Permian of the Paraná Basin.

Dr. Jasper is the Brazilian coordinator for the Second International Scientific Cooperation Project Brazil-India of CNPq.

Dr. Isabela Degani-Schmidt (Figure 1Y) is dedicated to the study of the epidermal cuticles of fossil leaves, wood anatomy, charcoal structures and dispersed organic matter through observation with optical, scanning electron and fluorescence microscopies for the paleoenvironmental paleoecological and paleoclimatic interpretation of Permian bogs. She develops works, co-authored with Dr. Guerra-Sommer and others, on Ginkgophyte logs of the Rio Grande do Sul Triassic; the effects of volcanic ash on the Permian peatland; changes in the number of stomata in the Permian leaf epidermis of glossopterids of the Paraná Basin and its paleoclimatic and paleoecological relations; Albian/Cenomanian conifer logs of the Parnaíba Basin and Cisuralian *Agathoxylon*-type wood of the Paraná Basin; radiometric dating of Permian tonsteins in Southern Brazil; and correlations of solenoid complex woods level of the Irati Formation (Brazil) and the Upper Barakar (India).

It is noteworthy that the paleobotany school of Rio Grande do Sul, which began under the strong leadership of Dr. Margot Guerra-Sommer, increased by Drs. Tania Dutra, Roberto Iannuzzi and Andre Jasper, has stimulated the emergence of a strong group that is generating or spreading researchers to other parts of the country, including Dr. Robson Tadeu Bolzon of the University Federal do Paraná, Dr. Etienne Fabbrin Pires of the Universidade Federal do Tocantins, Dr. Juliane Marques de Souza of the Universidade Federal de Roraima, Dr. Carlos E. Vieira of the Universidade do Vale dos Sinos, and Dr. Nelsa Cardoso of the Pontifícia Universidade Católica do Rio Grande do Sul. Other researchers include Dr. Daiana Boardman, Dr. Graciela Tybusch, Dr. G.A. Roesler, etc., of the Universidade Federal do Rio Grande do Sul.

### **The new “generation 1990-2016” in Rio de Janeiro**

Dr. Sheila Merlotti, one of the paleoxylologists still active in the area, grew up under the guidance of Dr. Diana Mussa.

Dr. Sheila Merlotti's doctoral thesis is from UFRJ (1994) and is entitled “*Lignitaflores do município de Pouso Redondo, SC, Formação Rio Bonito, Supergrupo Tubarão, Bacia do Paraná, Brasil: considerações*”

*taxonômicas, filogenéticas, tafonômicas, paleoecológicas e bioestratigráficas*". Since that time, Dr. Merlotti has developed works on Permian gymnospermic logs of Rio Bonito Formation and Parnaíba Basin. She is an associate professor at the Universidade Federal de Santa Catarina.

The paleobotany of Rio de Janeiro almost became cruelly ostracized after the death and / or retirement of its brilliant researchers. A new impetus for the specialty has arisen from the hiring of Dr. Luciana Witovisk Gussella by the MN/UFRJ.

Dr. Luciana Witovisk Gussella (Figure 1Z) has a Ph.D. in Geosciences from UFRJ (2012) and is analyzing preserved logs for permineralization and carbonification and analyzing Antarctic Cretaceous leaves. She works in the field of paleobotany, especially Cretaceous logs from the Larsen Basin, James Ross Island, in Antarctica. She is currently professor of paleobotany in the Department of Geology and Paleontology of the National Museum - UFRJ. She is also directing undergraduate research in Taubaté Basin (São Paulo) and the Sub-Basin Center Tucano (Bahia).

### **The new “generation 1990-2016”, trained at the Universidade de São Paulo**

Under the guidance of Dr. Oscar Rösler, important Brazilian paleobotanists have trained at the Universidade de São Paulo and now work (or once worked) at other Brazilian universities. They include the following:

Dr. Fernando Cilento Fittipaldi (1951-2013, Figure 1XX), who under the guidance of Dr. Rösler began his master's studies of the cuticular characterization of *Glossopteris communis* Feistm., from Rio Bonito Formation, Paraná Basin. He introduced cuticular studies to Brazilian paleobotany with techniques for epidermal cuticle recovery.

Later, while preparing his doctorate, Fittipaldi devoted himself to the study of plant fossils of the Itaquaquetuba Formation (São Paulo Cenozoic Basin), analyzing foliar or reproductive structures compressions of *Luehea divaricatiformis*, *Schizolobium inaequilaterum*, *Myrcia* cf. *rostrataformis*, *Psidium paulense*, *Byrsonima bullata*, *Serjania itaquaquetubensis* and *Serjania lancifolia*. In addition, he proposed eight new species of angiosperms (*Ocotea pulchelliformis*, *Piptadenia tertiaria*, *Cassia rosleri*, *Sophora giuliettiae*, *Machaerium piranii*, *Bertolonia coimbrai*, *Tocoyena riccominii* e *Echinodorus rossiae*), a new fern species (*Lindsaea pradoi*) and a new bryophyte species (*Isotachis simonesi*).

Dr. Rosemarie Rohn Davies (Figure 1YY) is a professor at the Universidade Estadual Paulista (UNESP), in Rio Claro (SP). She works brilliantly in paleobotany, especially in the Permian of the Paraná and Parnaíba basins. Under the guidance of Dr. Rösler in 1994, she contributed greatly to the knowledge of the late Permian *Glossopteris* Flora of the Rio do Rasto and Teresina formations in the State of Paraná and Northern Santa Catarina, describing sphenophytes, pteridophylles and glossopterids. She also studied the pre-*Glossopteris* flora of the Itararé Group in Salto de Itu (SP) and proto-glossopterids (mainly sphenophytes) from Capivari and Cerquilha (SP). Recently, she has been dedicated to the study of the petrified logs *Tietea* and *Psaronius* of the Corumbataí Formation and Calamitaceae, Maratiales, along with the gymnosperms of the Parnaíba Basin. Among the paleobotanists guided by Dr. Rohn Davies, Dr. Tatiane Tavares Marinho Vieira, now at the Universidade Federal do Tocantins, and Dr. Rodrigo Neregato stand out.

Dr. Fresia Riccardi-Branco (Figure 1ZZ) is a lecturer at the Universidade Estadual de Campinas (Unicamp). In 1998 she studied for her doctorate the Gondwanan Taphoflora of the Triunfo Member of the Rio Bonito Formation (Asselian/Sakmarian) in the municipality of Figueira, State of Paraná, continuing with studies on the Late Paleozoic of the floras of Triunfo Member, lower portion of the Rio Bonito Formation, in the region of Cambuí, PR under the guidance of Dr. Rösler.

She conducts research in phytotaphonomy, Phanerozoic floras of South America and new methods of paleontological analysis.

In partnership with Dr. Bernardes-de-Oliveira, Dr. Riccardi-Branco studied the paleofloristic composition and succession in Itararé Group, of the State of São Paulo.

She conducts studies of the bryophytes and lycophytes of Corumbataí and Teresina formations, in the State of São Paulo, develops multidisciplinary studies in Quaternary paleoenvironmental reconstruction in Brazil, and develops paleofloristic studies in Araripe Basin. She also studied the Paleogene floras of Fonseca and Gandarela and has observed the characteristics of plant remains accumulations in the sub-basin of the Rio Preto and their distribution model in the area of Itanhaém, SP. She conducts paleophytogeographic and lignitaphofloristic studies in the Paraná and Parnaíba basins. She also develops a Quaternary paleoenvironmental analysis of the Cerrado / Atlantic Forest ecotone in the municipality of Mogi Guaçu (SP). She has also used data from multiple sources for paleobotanical analysis in the Carboniferous-Permian area of the Paraná Basin. Important paleobotanists guided by Dr. Riccardi-Branco include Dr. Jean Carlo Mari Fanton, Dr. Rafael de Souza Faria and Dr. Isabel Cortez Christiano de Souza.



**Figure 1.** Brazilian Paleobotanists, from early times to now. A- José Bonifácio de Andrada e Silva; B- Franz Unger; C- William Carruthers; D- Charles Frederic Hartt; E- Orville Adelbert Derby F- René Zeiller; G- H. Solms-Laubach; H- Charles David White; I- Edward Wilber Berry; J- Carlotta Joaquina Maury; K- Carl Rudolf Florin; L- Euzébio Paulo de Oliveira; M- Elias Dolianiti; N- Reinhard Maack; O- Otavio Barbosa; P- Diana Mussa; Q- Sergio Mezzalira; R- Miriam Cazzulo-Klepzig; S- Margot Guerra-Sommer; T- Tânia Lindner Dutra; U- Oscar Rösler; V- Mary E. C. Bernardes-de-Oliveira; W- Roberto Iannuzzi; X- André Jasper; Y- Isabela Degani-Schmidt; Z- Luciana Witovisk Gussella; XX- Fernando Cilento Fittipaldi; YY- Rosemarie Rohn Davies; ZZ- Fresia Riccardi-Branco.

The new “generation 1990-2016” formed at the Universidade de São Paulo under the guidance of Dr. Mary E. C. Bernardes-de-Oliveira includes the following scholars who work (or who have worked) at other Brazilian universities or other institutions: M.Sc. Sandra Eiko Mune (2005), who has published works mainly on the interglacial Pennsylvanian taphoflora of Monte Mor; M.Sc. Maria Aparecida dos Santos (2007), who has published works on Jaguariúna taphoflora; Dr. Paula Andrea Sucerquia Rendon (2007, 2013), who has published works on conifers (Cheirolepidiaceae) of Early Cretaceous Crato flora and works at the Universidade Federal de Pernambuco; M.Sc. Maria Cristina de Castro Fernandes (2011), who has published on platyspermic seeds of the upper part of the Itararé Group of Paraná Basin and Fabaceae of Aiuruoca Basin; M.Sc. Carlos Humberto Biagolini (2012) and M.Sc. Alexandra G. Caramês (2012), who have reported on new taxonomic elements of taphoflora of Itaquaquecetuba Formation (São Paulo Basin); M.Sc. Elaine Priscila Gomes Estevam Biemann (2012), who has published on Welwitschiaceae of the Crato Formation and works at the Universidade Nove de Julho (UNINOVE); M.Sc. Fabiola Fabricio Braz (2012), who has published on Nymphaeaceae leaves and their insect damage; M.Sc. Amanda Hoelzel Mendes (2014), who has published on Gangamopterids from the Itararé Group in Cerquilha (SP) and M. Sc. Karoline Gonçalves Pereira (2014), who is preparing to publish on the Paleogene Myrtaceae of the Entrecórregos Formation. All these scholars’ research articles have been co-authored with Dr. Bernardes-de-Oliveira and her collaborators.

Nevertheless, it is noteworthy that the IGc/ USP, the birthplace of many Brazilian paleobotanists and a stimulation and meeting center for Brazilian paleobotanists and palynologists that has hosted eight paleobotanists and palynologists national meetings (RPPs), is in need of new blood, *i.e.*, new recruits who specialize in paleobotany. Its huge paleobotanical material collection for study includes Neopaleozoic phytofossil collections of the Paraná Basin and Mesozoic phytofossil collections from the Araripe Basin and the Cenozoic basins in Southeastern Brazil, including Aiuruoca, Taubaté, São Paulo and Peripheral Depression of São Paulo. All this material awaits study by researchers.

We need to remember that at the Universidade Federal de Pernambuco and the Universidade Regional do Cariri, new groups of paleobotanists are being trained under the leadership of Drs. Alcina Barreto, Paula Sucerquia and Flaviana Jorge de Lima, whose primary focus of study is the Mesozoic floras of the northeastern parts of Brazil.

### **Final considerations**

As seen from the foregoing account, the Brazilian paleobotany was and is, for the most part, conducted by geologists dedicated to this science or developed within geological institutions. Consequently, it has resulted in a paleobotanical approach for geological purposes: paleoclimatic, paleophytogeographic, phytostatigraphic interpretations or dating. Brazilian biologists turning to paleobotany through the influence or requirement of the “geological environment” are developing a paleobotany with a geological vision or purpose. Therefore, *our paleobotany needs more researchers from the biological area* or who are more concerned with phylogeny, evolution, biochemistry, etc.

It is necessary to remember that because of Brazil’s huge land mass, the almost complete and abundant record over geologic time from the Silurian to the Holocene in large continental basins, and its proportionally small number of experts in this area, a great deal of paleobotanical material remains to be studied.

Overall, Brazilian paleobotanical studies, although significant, require more precise taxonomic identification of taphofloristic occurrences (whether known or unknown) and analysis of phytofossiliferous material under all types of preservation: impressions, petrified wood, compressions or charcoal, and epidermal cuticles of leaves.

This material should be analyzed through methods including simple observations in stereo-optical microscopy and the use of infrared light, scanning electron microscopy and transmitted light and tomography microscopy to extract the maximum information. It requires in-depth taphonomic and biostratigraphic studies with paleoecological and paleophytogeographic interpretations. However, phylogenetic and evolutionary interpretations are also required so that the long and complete story of Brazil’s rich plant diversity, which so enthralled the first naturalists who were here, can be better known, completed and explained.

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