

# Cataloguing the Fauna of Deep Time: Paleontological Collections in Brazil in the Beginning of the 20th Century

## *Cataloguer la faune du temps profond : les collections paléontologiques au Brésil, au début du 20e siècle*

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**Summary:** Since the beginning of the nineteenth century, the National Museum in Rio de Janeiro was the main institution that amassed paleontological collections, in Brazil. However, by the beginning of the twentieth century, two other strategic centers of research would also be significant places to consolidate paleontological sciences: the Paulista Museum, in the State of São Paulo, organized in 1894, and the Brazilian Geological and Mineralogical Survey in Rio de Janeiro, created in 1907. This paper argues that these paleontological collections and a vast network of interlocutors were fundamental, in the case of the Paulista Museum, to support the theories of director Hermann von Ihering (1850-1930) on land-bridges and on the History of the Atlantic Ocean. It would also consolidate Ihering's visionary proposal to transform the Paulista Museum into a South American Scientific Museum, which would challenge the supremacy of the Rio de Janeiro National Museum. At the Geological Survey, the geologists gathered paleontological collections and stratigraphic data to prove that it would be possible to find oil in the Brazilian territory, against general and international common beliefs. The goal of the Geological Survey was to centralize and coordinate paleontological scientific research in the institution, transforming a marginal research field in Geology into a consolidated research area. The publications of these institutions, as real modern catalogues, are fundamental to follow some aspects of their collections. The paper mentions just some examples of the work of cataloguing collections in these institutions to argue, in conclusion, that both examples shed some light into the importance and change of meanings attributed to paleontological sciences at the beginning of the twentieth century, also in Brazil. The collections supported the debates and economic activities – based on taxonomical studies in the Paulista Museum, and the absence of other resources in the Brazilian Geological and Mineralogical Survey – about the theories on the geological synthesis of the period.

**Résumé :** Depuis le début du XIX<sup>e</sup> siècle, le Musée National de Rio de Janeiro était la principale institution qui rassemblait des collections paléontologiques au Brésil. Cependant, au début du XX<sup>e</sup> siècle, deux autres centres de recherche stratégiques devinrent également utiles pour consolider les sciences paléontologiques : le Musée Paulista, dans la ville de São Paulo, organisé en 1894 et le Bureau des Recherches Géologique et Minières à Rio de Janeiro, créé en 1907. Cet article soutient que ces collections paléontologiques et un vaste réseau d'interlocuteurs étaient fondamentaux, dans le cas du Musée Paulista, pour soutenir les théories de son directeur Hermann von Ihering (1850-1930) sur les ponts continentaux et sur l'histoire de l'océan Atlantique. La proposition visionnaire d'Ihering était de transformer le Musée Paulista

en un musée scientifique sud-américain qui défierait la suprématie du Musée National de Rio de Janeiro. Au Bureau des Recherches Géologique et Minières, les géologues ont rassemblé des collections paléontologiques et des données stratigraphiques pour prouver qu'il serait possible de trouver du pétrole sur le territoire brésilien, à l'encontre de la croyance commune générale et internationale. L'objectif de Bureau des Recherches Géologique et Minières était de centraliser et de coordonner la recherche scientifique paléontologique dans l'institution, transformant ainsi un champ de recherche marginal en géologie en un domaine de recherche. Les publications de ces institutions, véritables catalogues modernes, sont fondamentales pour suivre certains aspects de leurs collections. Cet article cite seulement quelques exemples de travaux de catalogage de collections dans ces institutions pour affirmer, en conclusion, que les deux exemples mettent en lumière l'importance et le changement de signification attribués aux sciences paléontologiques au début du XX<sup>e</sup> siècle, également au Brésil. Les collections soutenaient les débats et les activités économiques - basés sur des études taxonomiques au Musée Paulista et l'absence d'autres ressources dans le Bureau de Recherches Géologiques et Minières -, sur des théories de la synthèse géologique de la période.

## Introduction

1. Referential and more general and descriptive historical approaches about the paleontological researches in Brazil were undertaken by well-known Brazilian paleontologists such as Josué Camargo Mendes (1945, 1981) and Setembrino Petri (2001).

2. These deposits of sedimentary rocks belonging to the Romualdo Member, a higher stratigraphic unit of the Santana Formation of the Araripe Basin, would originate from the Aptian-Albian (Lower Cretaceous). They are considered one of the most important paleontological deposits in Brazil (Kellner, 2002).

The history of Paleontology in Brazil does not have an impressive founding episode <sup>1</sup>. Since colonial times, gigantic fossil bones have been found in gold mining in the Province of Minas Gerais, or by chance in well digging for water in the dry lands of the Northeast of the country. Among the first records about the discovery and transfer to Portugal of great animal bones from Minas Gerais, one must mention the historical information between 1770 and 1771 by the naturalist Alexandre Rodrigues Ferreira, the well-known explorer of the Portuguese Amazon at the end of the eighteenth century. Ferreira discussed the origin of such bones in accordance with the catastrophism world-view of the time and questioned Buffon about the inexistence of huge animals in America (Ferreira, [1790] 1972). In the same line of thought, in his Memoirs about the fossil bones and the fossiliferous terrains of the province of Ceará in the northeast of the country, the naturalist João da Silva Feijó would also challenge Buffon' view.

In addition to mentioning big bones, Feijó's registers are among the first observations about the outstanding paleontological characteristics of the region. Addressing the "Rare Petrifications", he mentions that in the Cariri Mountains, several hundred miles from the sea, one could find "the most rare and curious petrifications of fish and many genera of am-

phibians, some measuring up to four hands span" [circa 88 cm] <sup>2</sup> (Lopes *et al.*, 2005). The works of George Gardner (1841) and Louis Agassiz (1841) publicized these fossiliferous deposits of Ceará both in Europe and the United States. The results were published in the same volume of the *Edinburgh New Philosophical Journal*, which includes the discoveries of Peter Lund in the caves of Lagoa Santa.

The works of the Dane Peter Wilhelm Lund (1801-1880) in the caves of Lagoa Santa, state of Minas Gerais (Holten and Sterll, 2011), made the megafauna of Brazilian territory more internationally known in the middle of the nineteenth century. The paleontological researches that Lund undertook until his death in 1880 are well known and Lund was able to identify circa 150 species of fossil mammals in the material gathered from some sixty caves, in the region of Lagoa Santa, state of Minas Gerais (Couto, 1950; Lopes, 2008; 2010a). He identified as the "Lagoa Santa human race" 20 human skulls, which he considered to be contemporary with Pleistocenic fossil mammals.

Undertaking a systematic register of gigantic bones found in the country and beginning to classify the collections of the Rio de Janeiro National Museum, Frederico Leopoldo César Burlamaque (1803-1866) published, in 1855, a paper entitled "*Notícia acerca dos animais de raças extintas, descobertos em vários pontos do Brasil*" [News about animals of extinct races, found in various places in Brazil], considered

the first study of Pleistocene fossils in Brazil. Burlamaque was the director of Rio de Janeiro National Museum from 1847 to 1862 and one of the main responsables for the consolidation of paleontological studies in the National Museum of Rio de Janeiro (Lopes, 2009; 2013).

The vast development of stratigraphic and paleontological research from 1830 onwards led to the establishment of basic units of stratigraphic successions in this period. These were based on the assumption of developing a comparable geological history of the earth around the globe and the setup of a logistics of cooperation networks (even if asymmetrical ones), of exchanges of objects and information that circulated data, beyond national borders, which would allow universal sequences to be determined. These sequences were based on studies of details of local specificities, which made it possible to negotiate the specifics of a region with a universal method of observation, communication and correlational registers. And the sequences would become even more controlled and standardized by the agreements established for the construction of geological maps, dictated by associations, geological surveys and international congresses that consolidated themselves throughout the nineteenth century (Rudwick, 1997; Podgorny *et al.*, 2008).

From the last decades of the nineteenth century onward, paleontological investigations were already a part of practices of scientific activities all over the world. With its consolidated practical significance for stratigraphy, its recognized importance for the exploration of mineral resources, paleontological research has ensured the increasing support of governments through geological surveys, as Martin Rudwick (1972) pointed out many years ago, and especially for coal and oil, including in Brazil.

By the beginning of the twentieth century, the National Museum in Rio de Janeiro continued its paleontological work, however two other strategic centers of research would also become significant places to consolidate paleontological sciences: the Paulista Museum, in the State of São Paulo and the Brazilian Geological and Mineralogical Survey in Rio de Janeiro. Orville Derby, who had already left the Rio de Janeiro National Museum to direct the Geographical and Geological Commission of São Paulo (1886-1907), would continue his paleontological activities as the first director of the Geological and Mineralogical Survey in Rio de Janeiro (1907-

1915), where he would forge the tradition of paleontological works to search for coal and oil. And Hermann von Ihering, former National Museum's travelling naturalist for more than a decade, became the director of the Paulista Museum, in the city of São Paulo, in 1894, thanks to the support of Orville Derby, then at the Geographical and Geological Commission (Lopes and Figueirôa, 2003).

### Cataloguing collections should be as or more important than public displays in the Paulista Museum

Hermann Friedrich Albrecht von Ihering was a renowned member of the international scientific community, a specialist on biogeography, zoology, paleontology, anthropology. In Germany, he had studied at Giessen and received a degree in medicine in Berlin and Göttingen, under the influence of Rudolph Leuckart. Ihering's PhD in zoology about the ontogeny of *Cyclas* (freshwater mollusks), at the University of Göttingen, was published in Leipzig in 1876. He went to Brazil in 1880, where he developed his professional career (Lopes and Podgorny, 2014). For him, his museum would never be a local or provincial one. On the contrary, Ihering's work had acquired a continental dimension and thanks to his conception about specialization of science, his dream and his plan for the Paulista Museum was the construction of a Scientific Museum specialized in the Zoology and Paleozoology of South America, to challenge the supremacy of the generalist Rio de Janeiro National Museum.

Ihering published more than 300 papers in German, English, Portuguese, French and Spanish – mainly in German and Argentinean journals and in the Paulista Museum Journal, which he created. In many of these articles, Ihering described new species of marine and continental shells from South America, from the Brazilian Northeast to the sedimentary areas of Patagonia, Argentina (Lopes and Podgorny, 2014). Argentinean shells were systematically sent to him by his friend Florentino Ameghino, the specialist on South American fossil mammals (Podgorny, in press). Ihering and Ameghino exchanged more than 300 letters. Samples, mentions or requests of shells, were continual in all those letters. Throughout his scientific career, Ihering described and classified more than three hundred new fossil mollusks from

the Tertiary to the Pleistocene, including genera, subgenera, species and subspecies (Parodiz, 1996). He insisted that the Paulista Museum should be a scientific institution where research activities and cataloguing collections should be as or more important than public displays. Ihering gathered and catalogued some 17,000 fossil and modern mollusks, which were carefully stored in 480 drawers in the Museum. In these collections and several others that the Museum amassed, he based his contributions on the land-bridges theories. Ethnology was another of Ihering's main works at the Paulista Museum, and when he left the direction of the Museum in 1916, and went back to Germany – the institution held circa 80,000 Natural History and Ethnology specimens.

In order to receive publications needed for his work, Ihering exchanged the *Revista do Museu Paulista* [Paulista Museum Journal] with more than 400 scientific institutions from all over the world. He not only kept an extensive exchange network with European and North American researchers and institutions, but he also received collections from and built close ties with researchers from Uruguay, Chile, Argentina, South Africa, Australia, New Zealand. He also encouraged and supported a network of dealers and amateurs in Brazil to supply his Museum. The documents show that the Paulista Museum was among the Brazilian museums, the institution that acquired the most extensive collections from local and international commercial dealers (Grola and Barbuy, 2016). As Paula Findlen (1996) already pointed out some years ago, catalogues are among the most significant objects of a collection. The Paulista Museum Journal was truly a modern catalogue (Lopes, 2010). In order to exemplify Ihering's movement to catalogue collections in his networks, let's refer to some examples.

The Journal, according to Ihering 'was not a popular education journal but the archives of results of the Brazilian scientific explorations' (Lopes, 2010). The annual reports detailed, over many pages, the objects received by the Museum, as well as the name of the specialists to whom the objects were sent to be classified and for publication in a future paper in the Museum Journal: for example, crustaceans were sent to Arnold E. Ortman (1863-1927), in Princeton, shells that Ihering received from Argentina also were sent to Gustav Steinmann (1856-1929) in Freiburg and to

Alexandre Édouard M. Cossman (1850-1924) in Paris and land snails were dispatched to the Swiss Henri Hans Suter (1841-1918) in New Zealand. Bones were sent to Florentino Ameghino, and once a part of a jaw found in limestone caves of the South of the State of São Paulo (Iporanga, Monjolinho), that was sold to the Paulista Museum by the German born Ricardo Krone (1861-1917). Krone was an engineer and a dealer of natural history objects to several museums. (Grola, 2012). In his article about the detailed description of the caves of the region, Krone supposed that the bones belonged to some kind of *ground sloth* – *Nothrotherium*, typical of South America. The first remains of a young animal of this genus had been found by Peter Lund in the middle of the nineteenth century, in the caves of Lagoa Santa, Minas Gerais. In his letters to Ihering, Krone mentioned in his expectations that his works in the caves might compare with Lund's explorations (Krone, 1898; Grola, 2012), perhaps to increase the price of his specimens.

These few bones, broken to small pieces, remained stored for some ten years, at first at the private bookshop owned by Florentino Ameghino, and later at the Buenos Aires Museum. The bones would reappear in the pages of the Museum Paulista Journal, *Revista do Museu Paulista*, as the sole paper amongst Ameghino's huge production, published in that journal (Ameghino, 1907).

The most important object in that collection was an incomplete skull, with part of the jaw of an adult animal, which Ameghino identified as *Nothrotherium*, confirming Krone's identification. Ameghino then built, based on Lund's researches and on the main scientific authorities on the subject, Gervais, Reinhardt, Burmeister, Scott, and, of course, Ameghino himself, what was supposed to be the phylogenetic links that correlated the *Megalonyx* and *Nothrotherium* to the other Gravigrades (in Ameghino's acception), as evidence of the absence of intermediate forms, yet to be discovered.

But the importance of the jaw and some other bones was due not only to the corroboration by Ameghino about the relationships of the cave fauna of Brazil with that from the "Pampean Formation" in Argentina, but also because such collections provided "precise and decisive data" (Ameghino, 1907: 61). For Ameghino, since the *Nothrotherium* descended from a genus

characteristic of the higher Pampean formation in Argentina, this would prove that the fauna from Brazilian caves as well as those from Europe and North America were from the Quaternary, much more recent than the upper part of the Argentinean Pampean Formation. Such temporal sequences would undergo many changes in Ameghino's works, but they were fundamental data for his suppositions about the antiquity of the mammals in Argentine territories (Lopes, 2010).

To Arthur Smith Woodward (1864-1944), the well-known paleontologist at the British Museum, were sent only once photos of fossil fishes found in the course of exploration for oil and gas in bituminous shales in São Paulo, considered as a Gondwana area. Woodward compared the photos with other samples from the same region that Ihering had sent to the Senckenberg Museum, in Frankfurt. From Frankfurt, F. Kinkelin had sent some of these fossils to the British Museum for identification. The British Museum already possessed another important collection gathered by John Gordon in Rio de Janeiro. Such collections allowed Smith Woodward to identify the fossils in the photos as probably Tertiary fishes (Smith-Woodward, 1898).

Three almost complete vertebrae, a fragment of a vertebra, a four-phalanx finger and one isolated ungual phalanx became the most significant objects at the Paulista Museum. They were collected, in 1902 by Jango Fischer in a place known as *Sanga da Alemoa* in Santa Maria, Rio Grande do Sul state, in the South of Brazil, nowadays considered as one of the most important paleontological loci in the state of Rio Grande do Sul (*Paleorrota* Geopark). Jango was Dr. Fischer's nickname. Dr. João Guilherme Fischer (1876-1952) was an amateur naturalist and collector, with a degree in Agronomy and Pharmacy. He followed a long diplomatic career in Brazil, Chile and Paris, until 1944. Ihering quickly sent the bones to the British Museum. Smith Woodward published, at first, a note of just ten lines<sup>3</sup>, most certainly to ensure his priority in mentioning the new fossil.

In 1907, the bone fragments returned in a more complete form, transformed into images and texts in the *Revista do Museu Paulista*, with a fac-simile translation to Portuguese. Smith Woodward identified the bones as those of a primitive short-necked dinosaur. The close similarity between the cervical vertebrae found in Brazil with those from the Karoo Formation

of South Africa (Gondwanaland) increased their importance. The shape and characteristics of the cervical vertebrae found in Brazil, in comparison with those deposited in the British Museum, were considered as 'so closely similar to those of a corresponding vertebra from the Karoo Formation of South Africa ascribed to the Dinosaurian *Euskelosaurus*', by Harry G. Seeley (1839-1909) in 1894. The *Euskelosaurus* original vertebra belonged to the British Museum. Smith Woodward concluded that the new Brazilian fossils were allied to *Euskelosaurus* (Smith Woodward, 1907: 54). If the determination was correct, the rocks in which the bones were found would be Triassic and they would be the first land-reptile found in South America belonging to the Gondwana fauna. The bones became the *Scaphonix fischeri* in honor of Doctor Fischer (Smith Woodward, 1907: 54). Until today, it is one of the founding papers on the rhynchosaur group in South America.

Faunal connections that correlated the territories of America and other continents go beyond these examples. Precisely to enable such connections by means of land-bridges, the *Revista do Museu Paulista* systematically underlined the importance of the collection of fossil and modern mollusks. In his book *Archhelenis* and *Archinotis*, published in Leipzig in 1907 and many of his papers, Ihering supported the idea of land-bridges, considering that "America exists as a single continent only since after the Pliocene, and South America, before that was in close connection to the West of Africa and to the South with an Antarctic continent", (Ihering, 1907: 337). Ihering had proposed the name of *Archinotis* to identify the land mass linking South America and Antarctica and called *Archhelenis* the land mass uniting Brazil and Africa.

Ihering was dismissed from the Paulista Museum in the period of the First World War, precisely in 1916, in the middle of political and scientific controversies, including accusations about Ihering's misappropriation of the Museum collections. Prior to returning as an invited professor of Paleontology to the University of Giessen, in Germany, he stayed for a short-term visit (three months) in the well-known Naples Zoological Station, in 1921, to review the literature on the anatomy of mollusks, which he needed in order to finalize his last book on *Die Geschichte des Atlantischen Ozeans [The*

3. "On some Dinosaurian bones from South Brazil", by Smith Woodward, was presented at the Meeting of the British Association for the Advancement of Science, in Southport, in 1903 and published next year. An abstract notice of this paper was published in the *Report of British Association for the Advancement of Science*, 1904: 663.

history of the Atlantic Ocean], published in Jena in 1927 (Ihering, 1927). In this book, Ihering argued about the existence of land-bridges to establish the paleogeographical reconstruction of the relationships among South America, Africa and Australia. He upheld arguments to suppose that the Atlantic Ocean had not yet existed in the Cretaceous and Eocene periods.

It is important to remember that until the first decades of the twentieth century, the stability of the continental areas and the nature of the relations between these areas were among the fundamental questions to be solved in paleogeography and historical biogeography. Ihering strongly disagreed about the conceptions put forward by Wallace (1823-1913) regarding the permanence of the great oceanic basins (Lopes and Podgorny, 2009; 2014). Up to now, Ihering's studies are quoted also because he investigated the role of freshwater animals – while leaving aside the migrant fauna capable of crossing over major barriers – to address issues of historical biogeography (Choudhury and Pérez-Ponce de León, 2005).

Later in Ihering's career, like many other defenders of the land-bridge theories, he also disagreed with continental drift theories proposed by Frank Taylor (1860-1938) and Alfred Wegener (1880-1930) (Ihering, 1931). The fossil bones and shells that Ihering catalogued in the Paulista Museum enabled him to take an active part in those great geological debates that marked the beginning of the twentieth century. These debates remained at the basis of the research of those interested in more pragmatic results of the paleontological sciences, such as the search for oil in Brazil.

**'In the end we have to find the terrestrial links of Africa and Brazil by land-bridges'**  
(Oliveira, 1940: 18)

By the first decade of the twentieth century, the interests in paleontology had changed significantly. In a recent work, Martin Rudwick discussed the context of paleontology in the 1920s in the United States and in Britain. He mentions that although '*paleontological research continued along traditionally stratigraphical and taxonomic lines, the foundation of the Journal of Paleontology*' was an indicator of the context of these changes that turned into oil prospection: "*The Journal of Paleontology was*

*founded in 1927, not by Paleontological Society but by the Society of Economic Paleontologists and Mineralogists, and primarily for the publication of papers on fossils 'helping the understanding of American stratigraphy', particularly microfossils most useful to the oil industry*" (Rudwick, 2018:141).

The Brazilian Geological Survey's paleontological researches also highlight the same economic concern towards paleontological studies. In the absence of other resources, paleontology acquired an importance in the tasks of the Geological Survey in the search for oil in Brazil.

These paleontological researches also point out the persistence of the discussion about the land-bridges theories. The land-bridges theories supported especially by Hermann von Ihering in Brazil, were taken into consideration until the 1940s, in the works of technicians of the Brazilian Geological Survey as well as in other Brazilian institutions, such as the Rio de Janeiro National Museum.

In cultural practices that differ from those of Herman von Ihering, who did not have a work team at the Paulista Museum and had his personal network of collectors and dealers, in the Geological Survey, a team of technicians was organized and encouraged to publish. Collections continued to be shipped abroad to be classified by many foreign experts, now mainly North Americans. North American geologists were also hired at the Geological Survey by Orville Derby and his followers, such as Euzébio Paulo de Oliveira (1883-1939) who worked at the Geological Survey since its foundation in 1907 and occupied the post of interim and *de facto* director of that institution from 1922 until 1933.

The documents, the monographs and articles published by several co-workers allow us to identify that the first registers, the collections and the field notes were checked, made available to other technicians and taken into account in later researches and publications. As suggested by Marianne Klemun, *in the form of collective knowledge, they gained the status of being accepted* (Klemun, 2014: 282) and validated in the name of the institution.

At the beginning of the twentieth century, Brazil was considered a region without oil (Peyerl, 2017, Lopes 2019). The technicians of the Geological Survey discussed the status of knowledge on the previous geological studies,

based on their own experiences in the field, and followed the geological studies of Orville Derby.

The main problems of the Geological Survey, at that time, were the precariousness of the equipment, the lack of training of technicians to operate the machines and, of course, financial resources. However, the Geological Survey delimited the most promising sedimentary areas for the existence of oil in the country in three oil provinces: Amazon; Atlantic (coastal area from the northeast to the region of Campos, RJ) the main area, and the South of Brazil – especially São Paulo and Paraná states (Oliveira, 1920). Since the beginning of these more systematic activities (from 1919 until 1930), there were only 51 drillings in the country (Dias and Quaglino, 1993). Therefore, it is quite obvious that the geologists considered the paleontological samples collected in the course of field work and the geological structures identified as the main – or almost single – resources for the search for oil.

Drilling was the sole means available to obtain confirmation about the existence of oil on a commercial scale. On the other hand, detailed geological mapping of areas previously identified as a priority was the sole assurance to direct the precise coordination of the drillings. As Euzébio de Oliveira stated: *“only paleontological studies of a formation can then lead us to the knowledge of its nature, in order to conclude whether or not we are in the presence of oil-bearing rocks”* (Oliveira, 1937: 26).

To give some examples, the South of Brazil was one of the regions that received close attention in the search for oil. The south of the country was the region that was surveyed the most, from a geological point of view, since the nineteenth century, thanks to previous works of the provincial São Paulo Geological Commission (Oliveira and Figueirôa, 2019) and by the Coal Commission at the beginning of the twentieth century.

The Geological Survey's first Monograph published investigations carried out in the South of Brazil, especially on the state of Paraná Devonian fossils. The well-known North American paleontologist John Mason Clarke (1857-1925), catalogued the shells found in the course of field work by the technicians of the Geological Survey and also expressed his considerations on the existence of Gondwanaland at that

time. He criticized Wegener's theory but with no conclusive opinion (Clarke, 1913). Euzébio de Oliveira would also criticize the concept of continental drift in his publications dealing with the geology of the State of Paraná.

The 1920s experienced quite an exceptional scientific and technical burst of activities in the states of São Paulo and Paraná. In Permian and Triassic areas, identified as Gondwanan lands, although the Geological Survey was unable to identify any oil field, it did prove the existence of natural gas, a major economic resource that until then had not been discovered in Brazil. As the years passed, and oil was not found in the South of Brazil, the Geological Survey would be harshly criticized for having concentrated its search on these regions of the country.

The Carboniferous fauna of the Amazon valley had been investigated by Derby since the nineteenth century (Derby, 1877; 1894). Mason Clarke had already classified what was named the “Amazonian fossil wealth” of the successive geological periods (Clarke, 1899). The geologists from the Geological Survey would renew such studies and undertake new field work as they believed in the possibility of finding oil in Amazonia. The geologists did not find oil in the Amazon region until the end of the 1930s, but were able to gather a significant collection of data about this vast region and their works constituted the most systematic investigation about the Tertiary sea that occupied the Amazon region at that time, which after the rise of the Andes had ceased to communicate with the Pacific and contributed to the complex geological history of the region (Roxo, 1924).

In one of his reports “What the Geological Service accomplished in the Amazon”, [*O que realizou o Serviço Geológico na Amazonia*], Euzébio de Oliveira systematized, in 1929, the geological knowledge already produced about the region, since de nineteenth century. He underlined the then unpublished studies by Carlota Joaquina Maury on a rare variety of graptolites (from Silurian beds identified as Trombetas by Derby and José Correia de Freitas in 1876) – to reconstruct the geological evolution of the region and reaffirm his conviction about the need to carry out the search for oil in that huge area, given the scarcity of geological studies (Oliveira, 1929).

Glycon de Paiva, a well-known Brazilian geologist, considered the writings of Euzébio de

Oliveira about the regions identified as the Low Amazon (South of the Amazon and the state of Acre) ‘as one of the best written pages of Brazilian geology’ (Paiva, 1940: XI).

In the search conducted in the Northeast, in the coastal areas of the state of Bahia, where commercial oil fields were discovered only in 1939, the pioneer investigations in the first decades of the twentieth century concentrated in areas of the Barreiras Formation. In these areas, deposits of bituminous rocks and monazite sands had been known since the nineteenth century and Paulino Franco de Carvalho, a technician of the Geological Survey, had collected fossil samples in these areas, which were known to be highly fossiliferous (Oliveira, 1924c).

Other studies conducted by the Geological Survey in the southeast of Brazil concentrated in areas of the municipality of Campos, in the state of Rio de Janeiro. This region is close to the off-shore areas which are nowadays held as the best bet for commercial oil exploration in Brazil. Promising fossiliferous areas in Campos consist of flat oceanic shores, with a very shallow ocean. The pilot drillings at the depth of 30 meters revealed *Ostrea* marine mollusks in sediments around the city of Campos, presenting evidence that in previous eras, in all probability, the region was a marine environment. The proposal for oil prospecting in the Campos area was thus based on the results of preliminary surveys, fossil evidence and data gathered by the Brazilian Navy about signs of coastal mountain ranges submerged in the sea. Such subaquatic areas, where vast amounts of organic matter from marine animals could accumulate, might represent areas favorable for oil formation, according to Roxo (1924a: 58) (Lopes, 2019).

It is interesting to note that the geology of Campos, in the northern coastal plains of the state of Rio de Janeiro, was associated to the geology of the Tampico area, a well-known important place for oil in Mexico, by Horace Williams, a north American geologist who worked under contract with the Brazilian Geological Survey. Williams supposed that the Cretaceous and Tertiary formations dived under the continental shelf along the coastline. His research was one of the first to undertake a general overview about the geology of the Brazilian eastern coastal plains in the segment from the state of Rio de Janeiro up to the state of Pernambuco, in the northeast, [circa 2,000 km], in which he

correlated the sedimentary stratigraphy of Rio de Janeiro with the formations of Bahia (also classified as Tertiary and Cretaceous) (Lopes, 2019).

Carlota Joaquina de Paiva Pereira Maury (1874-1938) collaborated for twenty years – from 1918 to 1938 - with the Geological Survey, in field work and by cataloguing fossils mostly in the Atlantic region. In a letter to Luciano Jacques de Moraes, a geologist from the Geological Survey, dated 16 August, 1929, Carlota Maury presented herself as ‘an old friend of the Geological Survey’. Carlota Maury was a North American paleontologist, one of the first women to work in research for oil companies (Arnold 2009; 2010). Making references to several articles by Hermann von Ihering and based on collections held at the Geological Survey, Carlota Maury considered that ‘*the true affinities of the South American and Antillean Tertiary faunas were with the North American Tertiary species and not with those of the Old World*’. And Carlota Maury dismissed the need of Ihering’s *Archhelenis* continent to explain the difference between the molluscan faunas of northern and southern South America. Such differences could have been caused by oceanic currents, temperature or others factors. And this would be ‘*in accordance with the laws of growth of the continents and the relative stability of the great oceanic basins*’. For her, there was a consensus of opinions among American geologists against the existence of continental land-bridges, certainly in regard to Tertiary geological times (Maury, 1924: 15).

Until the end of the 1930s, in the works that grew over the years at the Geological Survey and other Brazilian institutions, arguments kept surfacing in favor or against the existence of land-bridges, or the Gondwana continent itself, and against the Wegener theory, about which there was a great diversity of arguments in paleontological publications. As an instance, Alberto Betim Paes Leme (1883-1938), former Geological Survey mining engineer and afterwards the director of Rio de Janeiro National Museum (1935-1938) was also one of the strongest Brazilian voices against continental drift theories (Figueirôa, 2012). Betim Paes Leme is considered as one of the persons responsible for the renewal of geological, paleontological and mineralogical studies at the Rio de Janeiro National Museum, after Derby left, since his hiring in 1911.



In his papers, widely anchored in the collections stored at the National Museum, Betim Paes Leme, criticized Wegner, but without being conclusive, arguing in favor of old continental bridges and isostatic movements that could be responsible for their sinking. The existence of continental rocks in Brazilian oceanic islands such as Trindade and Fernando Noronha was another argument in favor of land-bridge theories (Leme, 1930; 1943).

For Euzébio de Oliveira, the Geological Survey director, based on the technical studies that had already been undertaken in Brazil, from the relative age of fossiliferous areas in Sergipe, in the Northeast of the country, *'the basis for the existence of the Gondwana continent, of the links of vast portions of lands between Africa and Brazil did not stand. The collections of catalogued shells suggest the existence of a Triassic sea in this zone.'* The presence of terrestrial formations also in Abrolhos, a set of small islands with coral reefs on the coast of the State of Bahia, indicated a large extension of the coast line. It was another argument that suggested to Euzébio de Oliveira that *"it was possible that in the end we have to search for terrestrial links of Africa and Brazil by continental bridges"* (Oliveira, 1940: 18).

These short mentions were aimed at stressing, at first, the persistence of discussing the land-bridges theories in Brazil supported by evidence from the fossil collections and geological mapping that were carried out in our territory. And also, to underpin a different point of view from the traditional bibliography on oil in Brazil, that states that the strategic planning for oil in the country began only at the end of the 1930s, following the oil commercial production.

The paleontological and stratigraphic works of the Geological Survey in different regions of Brazil, since the beginning of the twentieth century, were fundamental to establish the long-term planning of the geological oil research in the Brazilian territory, even if the results would not appear in the short term (Lopes, 2019). They depended on the scientific, cultural and technical resources at hand in those given contexts.

### Final Considerations

Both examples, Paulista Museum and Geological Survey, shed some light on the importance

and change of meanings attributed to the works of amassing and cataloguing paleontological collections at the beginning of the twentieth century in Brazil, and on the persistence of the land-bridge theories, defended by Ihering and other followers in Brazil.

After Ihering was dismissed from the Paulista Museum in 1916, the Museum was transformed into the São Paulo Historical and Provincial Museum that no longer challenged the scientific supremacy of the Rio de Janeiro National Museum. Part of Ihering's malacological and paleontological collections is housed in the *Museo Argentino de Ciencias Naturales*, in Buenos Aires, Argentina. Ihering had applied for a job there and sold some collections, which he considered his personal property.

The majority of those collections catalogued by Ihering are today at the University of São Paulo Museum of Zoology – MZUSP – and Museum of Archaeology and Ethnology – MAE-USP.

With the fire at the Rio de Janeiro National Museum in 2018 and the loss of so many collections, thanks to initial efforts by Ihering and collaborators, the University of São Paulo Archaeology and Ethnology Museum – MAE-USP – keeps and preserves today probably one of the main indigenous heritage repositories in the country.

The collections of paleontological samples amassed by the Geological Survey technicians became the core of today's Earth Sciences Museum, in Rio de Janeiro (Pinto, 2009). With the loss of some of the National Museum's paleontological collections, the Geological Survey Museum thus holds one of the most significant paleontological collections in Brazil.

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