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FROM BURMEISTER TO AMEGHINO AND THE WORLDWIDE RECOGNITION OF THE VERTEBRATE PALEONTOLOGY FROM ARGENTINA

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Abstract. Francisco J. Muñiz was undoubtedly the first national Argentine paleontologist, preceding Florentino Ameghino with its pioneering descriptions of the fossil-bearing beds in Luján and their fossil mammals, including *"Muñi-felis*". In 1861, the German naturalist Hermann Burmeister (G. Burmeister, here after) arrived in Argentina to become the *Museo Público de Buenos Aires* Director. G. Burmeister renovated the institution and founded the *Anales del Museo*, one of the oldest Argentine scientific publications. In his last years, the *Museo de La Plata* was consolidated under the leadership of Francisco Pascasio Moreno, who was the creator and served as its Director from 1884 to 1906. Under the direction of Moreno, the museum attracted eminent researchers, including F. Ameghino and his brother Carlos. When the Ameghino brothers left the institution, figures such as Alcides Mercerat and Santiago Roth replaced them. Roth became a key rival to Carlos in exploring Patagonian deposits with vertebrate fossils. F. Ameghino brought global visibility and *reconnaissance* of the Argentine paleontology due to his numerous publications based on the collections largely made by his brother Carlos and his appointment as the Director of the *Museo Nacional de Buenos Aires* in 1902. After the death of Florentino, Carlos remained active at this museum, where a new generation of paleontologists emerged. Among them, Lucas Kraglievich stayed briefly in the *Museo de La Plata* after the death of Roth. Then the Spanish mastozoologist Ángel Cabrera assumed as the Head of Paleontology, marking a notable stage in the Paleontology of Argentina.

Key words. Vertebrates. Mammals. Fossils. Argentine Paleontology.

Resumen. DE BURMEISTER A AMEGHINO Y EL RECONOCIMIENTO MUNDIAL DE LA PALEONTOLOGÍA DE VERTEBRADOS DE ARGENTINA. Francisco J. Muñiz fue sin duda el primer paleontólogo nacional, precediendo a Florentino Ameghino con sus investigaciones pioneras en Luján, con la observación de los terrenos fosilíferos y la descripción de algunos mamíferos fósiles, incluyendo "*Muñi-felis*". En 1861, el naturalista alemán Germán Burmeister arribó a la Argentina para asumir como el director del *Museo Público de Buenos Aires.* G. Burmeister renovó la institución y fundó los *Anales del Museo*, una de las más antiguas publicaciones científicas argentinas. Durante sus últimos años, el *Museo de La Plata* se consolidó bajo el liderazgo de Francisco Pascasio Moreno, quien fue el creador y sirvió como su director desde 1884 a 1906. El *Museo de La Plata* atrajo a múltiples renombrados investigadores, incluyendo a F. Ameghino y su hermano Carlos. Alcides Mercerat y Santiago Roth reemplazaron a los hermanos Ameghino, con Roth transformándose en el rival clave de Carlos en la exploración de los yacimientos de vertebrados fósiles de Patagonia. F. Ameghino, con sus numerosas publicaciones sobre las colecciones hechas por su hermano Carlos, y su nombramiento como director del *Museo Nacional de Buenos Aires* en 1902, dió a la paleontología argentina una visibilidad y reconocimiento mundial. Después del fallecimiento de Florentino, Carlos permaneció activo en el *Museo Nacional de Buenos Aires*, donde una nueva generación de paleontólogos emergió, entre los cuales Lucas Kraglievich realmente se destacó. En La Plata, luego de fallecer Roth, el mastozoólogo español Ángel Cabrera asumió la jefatura de Paleontología, marcando una notable etapa en la paleontología argentina.

Palabras clave. Vertebrados. Mamíferos. Fósiles. Paleontología argentina.

Since the earliest times of the Spanish conquest (*i.e.*, XVI-XVII centuries), fossil bones and teeth of great size were frequently found and commonly considered to be the remains of giants. During the late XVIII century, ending the colonial era, the discovery of the complete skeleton of the *Megatherium* in Luján made a turning point in the interpretation of these findings. It was recognized as an extinct giant mammal but related to the living sloths, raising an extraordinary interest in Europe in the remains of the fossil mammals found in Argentina. Despite this and except for the creation of a *Museo Público* in Buenos Aires, which housed among many natural history objects a few fossils, during the Independence period and part of the middle XIX century, there was no development of paleontological

studies in the Argentine territory, making a difference to what happened in what is now Uruguay-formerly "*Banda Oriental*"-by Dámaso Antonio Larrañaga (1771–1848) (see Fernicola & Castiñeira Latorre, 2025).

Francisco J. Muñiz (1795–1871) was undoubtedly the first national Argentine paleontologist, preceding Florentino Ameghino (1853–1911) with its pioneering descriptions of the fossil-bearing beds in Luján and their fossil mammals, including "*Muñi-felis*". In 1861, the German naturalist Germán Burmeister (1807–1892; G. Burmesiter, here after) arrived in Argentina to become the Director of the *Museo Público de Buenos Aires*. G. Burmeister renovated the institution and founded the *Anales del Museo*, one of the oldest Argentine scientific publications. In his later years, the *Museo de La Plata* was consolidated under the leadership of Francisco Pascasio Moreno (1852–1919), who was the creator and served as its Director from 1884 to 1906. Under the direction of Moreno, the museum attracted eminent researchers, including F. Ameghino and his brother Carlos. When the Ameghino brothers left the institution, figures such as Alcides Mercerat (1869–1934) and Santiago (Kaspar Jacob) Roth (1850–1924) replaced them, with Roth becoming a key rival to Carlos in the exploration of the Patagonian deposits with vertebrate fossils. F. Ameghino, with his numerous publications based on the collections largely made by his brother Carlos and his appointment as the Director of the *Museo Nacional de Buenos Aires* in 1902, brought global visibility and *reconnaissance* of the Argentine paleontology. After the death of Florentino, Carlos remained active at the *Museo Nacional de Buenos Aires*, where a new generation of paleontologists emerged. Among them, Lucas Kraglievich (1886–1932) stayed briefly in La Plata after the death of S. Roth then the Spanish mastozoologist Ángel Cabrera Latorre (1879–1960) assumed as the Head of Paleontology, marking a notable stage in the Paleontology of Argentina.

FRANCISCO JAVIER MUÑIZ, THE FIRST ARGENTINE PALEONTOLOGIST

Francisco Javier Thomas de la Concepción Muñiz Frutos was an Argentine military medical doctor who, besides its contributions to medicine, deserves rightly the title of our first national paleontologist. Regarding his relevance, his first biographer was Domingo F. Sarmiento (1811–1888), in a volume (Sarmiento, 1885) prologued by Bartolomé Mitre (1821–1906) and F. Ameghino. Muñiz was Ameghino's immediate predecessor, as the latter recognized in his prologue, "*El se ocupó de las mismas que constituyen mis estudios predilectos, vivió quince años en donde Yo pasé mi niñez, y explotó los mismos yacimientos fosilíferos que Yo debía remover treinta años después y los recuerdos de sus hallazgos, vueltos populares en Luján, no contribuyeron poco a que me lanzara tras de él en las mismas investigaciones*" (He dealt with the same sciences that constitute my favorite studies, lived for 15 years where I spent my childhood, and exploited the same fossiliferous deposits that I had to remove thirty years later. and the memory of its discoveries, becoming popular in Luján, were not little to launch me after him into the same investigations) (Muñiz, 1953, p. 16).

Frequent discoveries of fossil bones in Buenos Aires city and its surroundings probably aroused the early interest of young Muñiz (Fig. 1.1). Assigned in 1825 to a troop cantonment at Chascomús, in Buenos Aires Province, in the lagoon ravines he found mammal fossils, such as a large armored xenarthran, mentioned by him as "*Dasypus giganteus*", probably a fossil dasypodid or perhaps a glyptodont. Years later, remains of a gigantic "*armadillo*" appeared in Uruguay, also named "*Dasypus giganteus*" by Vilardebó and Berro in 1838, in the Montevideo newspaper "El Universal" (Ottone, 2002). Curiously, in 1847, two friends of Muñiz annonimously claimed for him the paternity and priority of that species in the newspaper *La Gaceta Mercantil* (Palcos, 1943; Bond, 2001). So, despite limitations mainly related to the difficult political situation (long civil war between Unitarians and Federals), news on fossil discoveries circulated in the Río de La Plata society. Muñiz acted as a military surgeon in the war with Brazil, and back in Buenos Aires in 1828, married Ramona Bastarte Román (?–1868), settling at Luján, Buenos Aires Province, until 1848. On September 27, 1833, Charles Robert Darwin (1809–1882) passed rapidly through Luján on his journey to Santa Fé Province. He made a few geological observations but did not contact Muñiz since neither of them knew each other. In Luján, Muñiz began collecting in the banks and ravines of the Luján River and tributary streams, rich in Quaternary fossil mammals. In those years

appeared the book "Buenos Ayres and the Provinces of the Rio de La Plata…", written by Sir Woodbine Parish (1796–1882), a British diplomat in the Provinces of the Río de La Plata and sent by Great Britain to recognize the Independence of the Argentine Republic. Parish observed the geology of the "del Plata" area and its fossil mammals collecting some remains. In his book, Parish (1838) mentioned a new skeleton of *Megatherium* from "Luxán" (Luján) property of "Señor Muñiz", a doctor who extracted it with great care, being one of the first mentions of Muñiz as a cultist of paleontology. Also, Darwin (1846), citing the "British Packet of 1841", mentioned that "Dr. F. X. Muniz" collected in Luján many fossil mammals, probably "nine distinct species of mammifers" (Darwin, 1846, p. 106), showing that in those years, Muñiz possessed an important collection of fossil mammals.

In June of 1841, Muñiz sent a great part of his collection to the Governor of the Buenos Aires Province, Juan Manuel Ortiz de Rosas (1793–1877), who was also in charge of the foreign affairs of the "Confederación Argentina" or Argentine Confederation, former name of the Argentine Republic, probably by request of the latter or a personal gift of Muñiz to him, although this is still not clear. In an apologetic note, Muñiz wrote that having no teachers or books, nor any to consult or discuss his doubts, he surely committed errors or mistakes, asking the indulgence of Governor Rosas as he was a "*sabio*" (sage) (Muñiz, 1953). Muñiz sent 11 drawers with remains of megatheres, glyptodonts, mastodons, toxodonts, macrauchenias, and other mammals, mentioning the carpal bones of an "ourangoutan" (Muñiz, 1953), all coming from Luján and surroundings. Based on those supposed "ourangoutan" bones, Ameghino (1889), in his "*Suplemento*" (Supplement), commented that Muñiz probably was one of the first discoverers of human fossil remains in Argentina. However, perhaps following the ideas of his epoch, he did not believe in fossil man, so he attributed this remains to another primate as an "orangutan". Ameghino mentioned manuscripts of Muñiz describing these bones, probably those given to him by José M. Muñiz, F. J. Muñiz son. This mention of a supposed fossil primate represents a curious fact for Argentine paleoanthropology.

The attached documents in the envoy described the

Figure 1. 1, Young Francisco Muñiz by Carlos Enrique Pellegrini (modified from Palcos, 1943); **2,** Vice Amiral Jean Henri Joseph Dupotet (Jean Dupotet, 2025).

beds where they were found, the conditions where they could have lived (warmer climates), and how they were fossilized. Also, there are some commentaries on the mammal findings, pointing out that in one limb of a glyptodont, he observed a set of small bones that seemed to have been "*embutidos en las carnes del animal…*" (embedded in the meat of the animal) (Muñiz, 1953, p. 9), being one of the first observations on the small dermal ossicles present in extinct xenarthrans serving as protection. Muñiz included detailed instructions for extracting the bones and assembling the tail of a glyptodont, demonstrating his knowledge and concern for the conservation of these pieces. The collection was presented by the government of Rosas to Vice Admiral Jean Henri Joseph Dupotet (1777–1852) (Fig. 1.2), head of the French squadron at the Río de la Plata, as a gift for the ending of the French blockade on the River Plate. In 1846, Dupotet took the fossils to France, with many of them deposited at the National Museum of Natural History in Paris (*Jardin des Plantes*), arousing considerable expectation as we see in Darwin's letter written in 1847 to Richard Owen (1804–1892) (Darwin, 1847; Podgorny, 2011d). Some of those fossils were later figured—although not described—by the French zoologist Henri Marie Ducrotay de Blainville (1777–1850) in his volume from 1864 on the osteography of the mammals (Fig. 2.1) (Blainville, 1839–1864), whereas others were studied by the French naturalist Francois Luis Paul Gervais (1816–1879), who in 1855 described one of the first South American fossil bear "*Ursus*" *bonariensis* (*Arctotherium bonariense*, Soibelzon,

2004), based on a mandibular *ramus* and postcranial bones. Dupotet took some fossils of the Muñiz collection to the museum of Dijon (France), including a complete carapace, tail, and partial skeleton of a glyptodont later described and named by Léonard Nodot (1802–1859), Director of the Dijon Museum, as *Schistopleuron typus* (currently *Glyptodon reticulatus*). Dupotet's shipment promoted a debate about whether it did not represent a dispossession of the national heritage or was rather beneficial since the fossils were studied by European naturalists of prestige who increased the knowledge of our extinct fauna instead of remaining in a local environment with the difficulties highlighted in Muñiz's note heading the shipment. In this note, Muñiz stated the political circumstances of our country during the civil war and Rosas government, when people and institutions were subjected to political ups and downs, hence the praise for Governor Rosas as the "*Restaurador de las Leyes*" (Restorer of the Laws) (see Palcos, 1943). But the facilities for the extraction of fossils, which were afterward shipped out of Argentina granted by Rosas to Woodbine Parish agents, such as the collection gifted to Dupotet, were not accompanied by a similar effort to bestow the *Museo Público de Buenos Aires* with the quite frequent findings of fossil mammals. Being one thing a consequence of the other, we can only speculate that if the initial impulse of the May Revolution in 1810 and the effort of some authorities such as Bernardino Rivadavia (1780–1845) had continued, Argentina would surely have had institutions with adequate repositories for the fossil collections and access to bibliography where the Argentine native scholars educated under the tutelage of European professors could compare their findings. However, this did not happen, and Muñiz found himself isolated, without any other naturalist with whom he could discuss the anatomical characteristics, often unique, present in the fossils he discovered. As an assertion of this, in his brief description of the remains delivered, Muñiz inferred, based on erroneous evidence, the presence of horns in one extinct giant sloth (his "*megalonyx*"), realizing this mistake only after posterior findings. So, in September 1841, he published "A spontaneous self-rectification" in the *La Gaceta Mercantil*, a newspaper with mixed information of commercial, political, and general interest news, since the Argentine Confederation lacked a proper scientific publication, and the *Museo Público de Buenos Aires* languished due to lack of resources and personnel.

On October 9, 1845, the newspaper marked a milestone in the history of Argentine paleontology, as in number 6603 of the *La Gaceta Mercantil*, Muñiz published the description of an almost complete fossil skeleton of a feline carnivore he found at Luján (Fig. 2.2), a "saber-toothed tiger", which he named "*Muñi-Felis-Bonaerensis*", a self-referential name not used in science, but which according to Palcos (1943) would have been imposed by his friends. Muñiz remarked in the description that this type of animal had not been made known by the "*recomendable* Mr. Darwin" (recommendable Mr. Darwin) (Muñiz, 1953, p. 20), probably referring to Owen's "Fossil Mammalia" published between 1838–1840, with a geological introduction by Darwin. In this pioneering

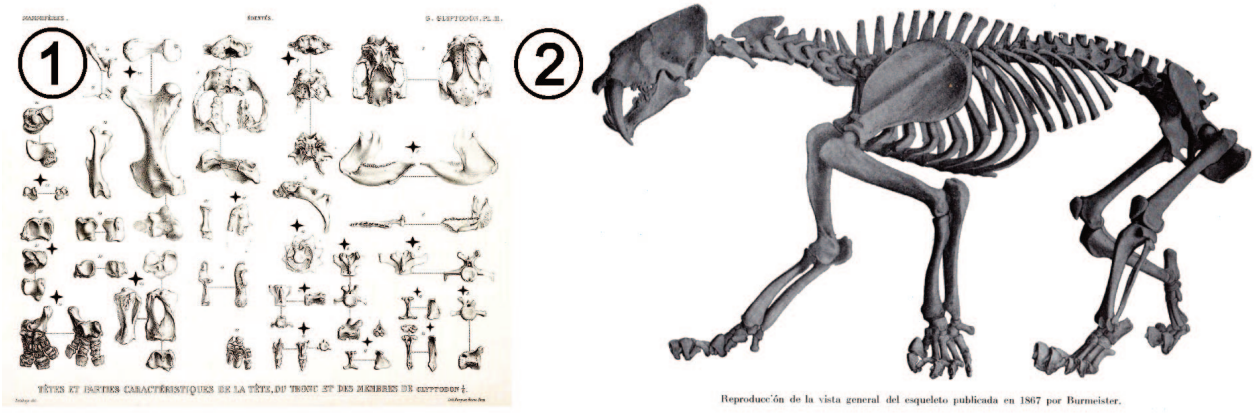

Figure 2. 1, *Glyptodon* (modified from plate 2, Blainville 1839–1864), stars indicate materials from the "Muñiz-Dupotet" collection; **2, *Muñi-felis***, from G. Burmeister (1868) but modified from Méndez Alzola (1941).

article for Argentine vertebrate paleontology, Muñiz gave a fairly detailed description (and a good table of measurements), using as reference the work "*del célebre* Mr. Cuvier" (of the famous Mr. Cuvier) (Muñiz, 1953, p. 39), referring to the book by the French naturalist Georges Cuvier (1769–1832), "*Recherches sur les ossemens fossils*..." of 1812, and others such as Félix de Azara (1742–1821).

Regarding the main anatomical features of this new felid, Muñiz commented on certain characteristics, such as the toothed edge of the canines, mentioning the similarities with a canine found in France of the extinct felid *Machaerodus*. Muñiz considered the skeleton could correspond to a female because the other calcaneum found, surely belonging to the same species, was much more robust. Muñiz also compared the adult skull of *Muñi-felis* to another skull of the same species belonging to a juvenile individual, pointing to its differences. He assumed the extinct felid as a great predator, and by analogy with the Yaguareté (*Panthera onca*), to be the natural enemy of the large extinct herbivores such as *Megatherium* and *Mastodon*, commenting that the "*Bonaerensis*" (*sic*) would be much larger and exceeding in fierce to other extinct felids such as the European cave lion "*Felis spelaea*".

In this contribution, Muñiz questioned the old idea of Buffon (Georges Louis Lecler de Buffon, 1707–1788) that there were no large American animals as in the Old World. It was becoming apparent that in the past, the American continent housed several gigantic-sized mammals that were now extinct, as Thomas Jefferson (1743–1826) had thought. Jefferson was a former critic of Buffon's opinion on the size of American mammals. However, based on erroneous evidence since Jefferson described his *Megalonyx* as a giant North American carnivore based on a big-sized ungual phalanx, later demonstrated to belong to an extinct giant ground sloth (Simpson, 1984; Bond, 2001). Finishing the *Muñi-felis* article, Muñiz apologized for any mistake made since he found himself "*aislado de toda relación que pudiera ilustrarme*" (isolated from any relationship that could enlighten me) (Muñiz, 1953, p. 43), something similar to what he wrote in the accompanying note of the collection sent to Rosas. Sometimes, Muñiz's isolation has been considered an imposture (Podgorny, 2011d, but see Feijó & Vizcaino, 1999), presenting himself as lacking references while classifying the fossils citing Cuvier and Owen; it is clear that Muñiz mentioned this literature because he owned or had access to it; what he meant by his isolation was that he lacked an interlocutor to discuss the many doubts that those findings generated. The skeleton of *Muñi-felis* was later referred to the genus *Smilodon* as *S. bonaerensis* (Muñiz, 1845), currently a synonym of *Smilodon populator* Lund, 1842 (Burmeister, 1868; Méndez Alzola, 1941; Forasiepi *et al*., 2007). Probably due to economic difficulties, the *Muñi-felis* skeleton was offered for sale, at least on one occasion to Darwin (Darwin, 1847; Muñiz, 1953; Podgorny, 2011d), but remained in Argentina and ended up being donated to the *Museo Público de Buenos Aires*. In 1845, Muñiz requested, through a letter to Governor Rosas, to be officially granted the privilege of being the only explorer of the fossiliferous deposits of the Luján River within a perimeter of one league (*ca*. 5 km) around the town. The reason for this request was that his discoveries had taught many people how to get to the fossils, and some having time and resources that he did not have, would anticipate him in new discoveries. However, the note was unanswered (Palcos, 1943).

The epistolary contact between Muñiz and Darwin is well known, as the latter was very interested in the strange cow mutation called "*vaca ñata*" on which Muñiz gave valuable information. In a letter dated 1847, Darwin told Muñiz that the saber-toothed tiger he discovered could represent the genus *Machaerodus*. Noticing Muñiz's apparent intentions to give away the saber-toothed remains, Darwin wrote to Owen that same year, attempting to achieve the magnificent acquisition of the *Machaerodus* specimen. Finally, in another letter of 1847, Darwin confirmed to Owen that Muñiz was still interested in offering the skeleton of the saber tooth among other remains such as *Megatherium*, believing Muñiz's fossil felid would look magnificent in a montage compared to the skeleton of a recent tiger. Darwin also asked Owen about the fate of Dupotet's fossils arrived in Paris. According to certain sources, after several negotiations, there was an intention to offer Muñiz 100 sterling pounds, a very profitable sum (nearly 12,793 current pounds or US$ 15,399), but the transaction did not take place, and the *Muñi-felis* skeleton stayed in Buenos Aires (Darwin, 1847; Barcat, 2009; Podgorny, 2011d) At the time,

Muñiz finished his Topographical notes, describing the sedimentary layers observed in the Pampean terrains of Buenos Aires Province, with the superficial layer of "*humus*", then whitish post-Pampean chalk, deposited in lowlands and small ravines or "*cañadas*", followed by the Fossiliferous Terrain formed by a yellowish marl bed, where the majority of the fossil skeletons were found (currently known as Lujanian beds, upper Pleistocene), followed by layers of pebbles or coarse sand and then, ferruginous marl (probably the red Pampean or Bonaerian). On the genesis of the fossiliferous terrain, Muñiz made original taphonomic observations (Muñiz, 1953). The positions of the skeletons found—many of them complete—indicated that those mammals died in swamps or ancient lagoons, in some cases exhibiting evidence of the efforts to escape from the swamp traps. Muñiz inferred a slow oscillation of the sea covered the fossiliferous sites with silt. Accounting for the marine beds observed in the Patagonian and the Mesopotamian areas, he deduced that the great Pampas basin had a very remote origin, speaking of cretaceous substances and planetary attractions as a possible cause for the crustal oscillations and sea advances. Even if not fully correct, this shows that Muñiz was a keen observer of the geology and paleontology of the Pampean beds.

As mentioned, two friends of Muñiz claimed for him the priority on the naming and discovery of the "*Dasypus giganteus*" in a note to "La Gaceta Mercantil" (1847). They presented themselves as two federals, friends of justice, in an ominous confession of political faith, clearly showing the troublesome situation, not precisely favorable for discussing fossil species (Palcos, 1943).

In 1848, Muñiz settled in Buenos Aires, and after Rosas was overthrown (1852), Muñiz served the Buenos Aires Province with active participation in civil war battles (*i.e.*, Cepeda battle, 1859, where he nearly lost his life attending a wounded soldier), as a military doctor (he retired as with colonel), in politics as a senator, and from 1855 to 1862, as the Dean of the Faculty of Medicine. As a consequence of a cultural revival, the "*Asociación de Amigos de la Historia Natural del Plata*" (Friends of Natural History of the Plata Association) was created in 1854 to help the *Museo Público de Buenos Aires* (Public Museum of Buenos Aires), with Muñiz as one of its founding partners. In 1857, he donated several fossils to the museum, including part of the lower jaw of the same fossil bear given to Rosas, a complete skull of *Toxodon*, parts of the skull of a fossil horse (*Hippidion*), and a curious petrified tree that adorned the front of his house in Luján.

Urged by economic necessities, in 1860, Muñiz sold a series of fossil remains, including a *Smilodon* skull, to Stockholm, receiving various honors (Knight Cross of the Order of Wasa) from King Charles XV (1826–1872) of Sweden. In 1866, he approached the newly founded "S*ociedad Paleontológica de Buenos Aires*" (Paleontological Society of Buenos Aires). During the Paraguayan war (1865–1870), despite his age, Muñiz served as chief surgeon in the army, retiring as professor and doctor in 1869. Unfortunately, during the yellow fever epidemic of 1871, on April 8, he died while caring for a patient of said epidemic, thus disappearing who deserves, with justice, the title of the first national Argentine paleontologist. Although standing as an isolated figure and beyond the limitations and problems he faced, Muñiz deservedly was a correspondent with Darwin, biographed by Sarmiento, respected by G. Burmeister, and revindicated by F. Ameghino as his predecessor in the knowledge of the geology and paleontology of the Luján area. As a result, Muñiz stands out as a pioneering figure for the Argentine mammalian paleontology, an enlightened person in an epoch obscured by the political circumstances.

Since 1852, once Rosas fell, the new authorities of the "*Confederación Argentina*" (Argentine Confederation) and Buenos Aires showed a renewed interest in the study and exhibitions focused on the natural sciences, but politics would once again influence the fate of the institutions dedicated to the natural sciences. After Rosas was overthrown, General Justo José de Urquiza (1801–1870), stood as the political leader and provisional Director of the Argentine Confederation. However, on September 11, 1852, Buenos Aires rose against Urquiza, separating from the other provinces and the Confederation.

In May of 1854, the pharmacist Santiago Torres (?–?) replaced Antonio Demarchi (1822–1879) as the Director of the *Museo Público de Buenos Aires* (Public Museum of Buenos Aires), staying in charge until 1861. Probably by the suggestion of S. Torres, the government endorsed the

constitution of an association to help the museum, which is still at the convent of Santo Domingo in Buenos Aires. Thus, on May 6, 1854, the association "*Amigos de la Historia Natural del Plata*" was created to increase and protect the museum. A few founding members were related to paleontology; one was Muñiz, another was Manuel Ricardo Trelles (1821–1893), the main promoter of the association (Asua, 2012) and who was very interested in various topics, and Friar Manuel Torres (1750–1817?/1819?). Close ties with the University of Buenos Aires, whose Rector José Barros Pazos (1808–1877) was a member of the association, contributed favorably to the *Museo Público de Buenos Aires* as it was removed between 1854 and 1857 from the convent of Santo Domingo to an old building in the former Jesuitic block, where the University of Buenos Aires had been operating since 1821. The block is known as the "*Manzana de las Luces*" ("Enlightened block") (Asua, 2012), a name traditionally given to the temple of San Ignacio and surroundings, referring to the site where the "enlightened" people interested in culture and sciences met since colonial days (Camacho, 1971), and where many cultural institutions concentrated, as clearly expressed in the newspaper "El Argos de Buenos Ayres" (September 1, 1821).

POLITICAL AFFAIRS AND THE COMING OF BURMEISTER

Separated in 1853 from the Argentine Confederation, Buenos Aires Province returned to it triumphally after the battle of Pavón in 1861. In consequence, in 1862, Paraná was replaced by Buenos Aires as the capital of the Confederation, where the powerful and conflictive political relationship between provincial and national governments unexpectedly interfered with the natural history museums. Undoubtedly, the arrival of G. Burmeister to Argentina marked a decisive turn for the Argentine vertebrate paleontology. Despite criticisms received, especially for the somewhat severe treatment of his contemporaries, he transformed the *Museo Público de Buenos Aires* from almost a cabinet of curiosities into a museum of natural sciences, also editing the first Argentine scientific publications on the subject. It is difficult to synthesize the extraordinary scientist who came to Argentina in the figure of G. Burmeister. We will say that Karl (Germán) Hermann Konrad Burmeister was born on January 15, 1807, in Stralsund, the capital city of Western Pomerania, a German territory traditionally under Prussian influence. An excellent scholar, G. Burmeister studied at Halle University (Saxony) and graduated in 1829 from the Faculty of Medicine and Philosophy. Primarily interested in entomology, he wrote a thesis on a natural system classification for insects, and in 1837, he was appointed professor of zoology at Halle University. He married Marie Elise Sommer in 1836 and had two sons, Heinrich and Hermann. The latter would become a companion to his father on some trips, living in South America between 1857 and 1888 before returning to Europe, whereas Heinrich remained with his mother (Birabén, 1968; Ulrich, 1972; Mantegari, 2003). The scientific production of G. Burmeister in its German period is extraordinary and diverse. Superb entomologist, he published a Manual of Entomology in five volumes (1832–1855), which became an international reference book among specialists and was translated into English (Ulrich, 1972). In 1843, he published the first edition of his notable book, "History of the Creation. A representation of the development of the Earth and its inhabitants. For the educated of all classes" attaining enormous success with eight editions in german (1843–1872), and several translations. Besides the general public, this work enjoyed great esteem among great scientists such as Alexander von Humboldt (1769–1859). In 1848, G. Burmeister briefly ventured into politics, participating in the revolutionary movement of 1848 and becoming Deputy for Liegnitz, Silesia, Prussia (now Legnica, Silesia, Poland). Not agreeing with certain political practices and not betraying the ideals of his voters, he resigned from the seat in 1850. Faced with new setbacks, marital problems, and confrontation with the Prussian educational authorities. Through Alexander von Humboldt, G. Burmeister obtained a leave of absence from the university and a royal subsidy to visit Brazil. He had long wanted to visit Latin America to study its fauna and consider the possibility of settling there. On September 12, 1850, G. Burmeister headed to South America, visiting several locations in Brazil. In 1851, he suffered an accident at Lagoa Santa, famous for its caves with fossil mammals, and explored by naturalists such as the Danish Peter Wilhelm Lund (1801–1880), who was considered the father of Brazilian paleontology. On his farm, G. Burmeister was

treated for a fracture in his right leg, an injury that bothered him for the rest of his life. After 19 months in Brazil, he returned to Europe. In 1856, he traveled again to visit the Plata basin at the suggestion of von Humboldt.

On his way to South America, G. Burmeister passed through Paris, where he met the Argentine Juan Bautista Alberdi (1810–1884), a former "*emigré*" as an enemy of Rosas but who was at that time Minister of the Argentine Confederation before the French Empire of Napoleon III (1808–1873).

Knowing the scientific importance of G. Burmeister and the benefits his trip would bring to the knowledge of these regions, Alberdi gave G. Burmeister on September 22, 1856, a recommendation letter for General Urquiza, then president of the Confederation, expressing that G. Burmeister was on a special mission sponsored by the King of Prussia, Frederick William IV (1795–1861), to study Mendoza Province and that his visit would help to know the richness "*de que somos por ahora poseedores inconscientes*" (we are currently unconscious possessors) (Birabén, 1968, p. 15). G. Burmeister left Southampton, England, on October 9, 1856, arriving in Rio de Janeiro (Brazil), where he stayed with the German doctor and naturalist Robert C. B. Avé-Lallemant (1812–1884). He later continued his trip to Uruguay in December 1856, where he made some paleontological collections. On January 31, 1857, he arrived for the first time in Buenos Aires city, being very impressed by its edifices, such as the new landing dock and the almost finished new Custom House. While visiting the *Museo Público of Buenos Aires*, G. Burmeister commented that it was still underdeveloped. However, with a vigorous push and the "treasures" (fossils) buried in the surroundings of Buenos Aires, it would reach a high rank amongst the museums, an almost premonitory statement (Birabén, 1968). Regarding the wealth of the fossil mammals found there when talking with the French naturalist Auguste Bravard (1803–1861), G. Burmeister mentioned his intention to seek fossil vertebrates in the "*toscas*" (Ensenadan, Pleistocene) of the Río de la Plata, in Buenos Aires city and its surroundings. Bravard considered that the expeditions in these "*toscales*" were challenging after the experiences of his French colleague and collector Francoise Seguin (1812–1878). Despite the warnings, G. Burmeister went on a collection trip to the "*toscales*", but only gathered a few remains (Burmeister, 1876). Fortunately, the "*toscales*" fossil wealth had not been exhausted, and many vertebrates could be collected before they almost disappeared due to modern urbanization (Soibelzon *et al.*, 2008). G. Burmeister went to Rosario (Santa Fe Province) and Paraná (Entre Ríos Province), receiving documentation to travel through the Confederation. G. Burmeister was well-impressed by Paraná, the Argentine capital at that time, with a notable commercial and intellectual movement. In Paraná was the *Museo del Paraná*, a scientific museum expectedly rival of the *Museo Público of Buenos Aires*, with Bravard as the Director. Due to his intransigent manners, G. Burmeister faced some problems, so the Consul of Prussia and friend, Freiherr Friedrich Hermann Herbert von Gülich (1820–1903), wrote to Juan María Gutiérrez (1809–1878), then Minister, to help the German scholar and attributing G. Burmeister's harsh conduct and brusque character to personal troubles (Mantegari, 2003). After visiting Mendoza Province and other areas, G. Burmeister returned to Paraná, where he attended a military parade for the celebrations of May 25, 1858, and was so well-impressed with it and the gala ball that he felt for a moment in a solemn ball in Berlin or the court of one of the small German principalities (Borello, 1973). When in Paraná and Santa Fé, G. Burmeister made observations on the geology of the Paraná cliffs and the Pampean in the Salado area. Then G. Burmeister attempted to become the rural owner of a farm near Paraná (from September 1858 to June 1859) with his son Hermann, after which he sold the property and sent his collections to Hamburg, Germany. G. Burmeister destiny was not to be a farmer but to stay, fortunately for us, a scientist. Then, he visited Córdoba, Tucumán, and other northwestern provinces, feeling very comfortable (Birabén, 1968) and taking notes on natural history, ethnography, and archaeology. As the brilliant draftsman he was, he made many sketches, including those of the old city of Mendoza before it was completely destroyed by an earthquake on March 20, 1861 (with Bravard as one of its victims), so the views G. Burmeister took have a notable documentary value.

Crossing the Andean Cordillera in a voyage that can be described as a heroic deed, G. Burmeister arrived in Chile,

then Perú, Panamá, and finally to Europe, reaching there on May 12, 1860 (Birabén, 1968). This trip resulted in Burmeister's book "*Reise durch die La Plata-Staaten*…" ("Journey through the states of La Plata…"), edited in two volumes in Halle (Germany) in 1861, with observations on the places visited, the people, costumes, ethnographical and archaeological notes, including his sketches and those made by his adjutant Anton Goering (1836–1905). A magnificent work, G. Burmeister's "journey" book alone would credit him as more than a remarkable chronicler for Argentina. As a professor in Halle, he immediately collided with the new ordinances for medical students that reduced the number of assistants to G. Burmeister classes, so on March 1861, he resigned his position as a professor and divorced his wife, returning to South America. He expressed his feelings of comfort in Argentina in the second volume preface of the "Journey to the States of del Plata", where he also stated he was going to dedicate himself to scientific research in the Plata region for the rest of his life (Mantegari, 2003). G. Burmeister was aware of the offers made to Bravard to be in charge of the Museum of Buenos Aires, precluded by his unexpected death. So, G. Burmeister wrote to the consul Freiherr von Gülich as an intermediate in his offer to be Director of the Museum of Buenos Aires to the then Governor of Buenos Aires, Mitre, and his minister, Sarmiento. As one of the most renowned European naturalists, G. Burmeister's outstanding production between 1829 and his coming to Argentina in 1861 comprises at least four books on Natural History, including the renowned "Natural History of Creation", four books on general zoology, 12 on geography and geology articles and books including "Journey to the States of del Plata", three on Climatology, 23 works on Mastozoology (including the magnificent monography on *Tarsius*), Ornithology, Herpetology and Carcinology, 40 entomological papers, and the "Treatise on Entomology". On paleontology, 12 works on varied groups, such as the one on Trilobites from 1843, became a classic translated into English in 1846. He also wrote on fossil cetaceans, amphibians ("stegocephalians" or "labyrinthodonts"), and reptiles, especially one on a fossil marine gavial-like crocodile, that he compared with living and fossil ones, recommending that before describing new species, paleontologists should take account on the individual variations (Ulrich, 1972). A skillful anatomist, he was well-acquainted that morphological variations observed in fossils could indicate age or sexual variations and not necessarily characters that justified the naming of new species. He was an excellent designer, and many of his works were illustrated by him. It is important to remark that G. Burmeister was not a creationist; his book "History of Creation", has no connection with the biblical one, and references of G. Burmeister to the *Diluvium* or "flood", were due to the old geological term for Quaternary sediments and the extinct fauna, and not by acceptance of a biblical inundation. With regards to the evolution topics, Burmeister believed that biological diversity originated in steps of increasing complexity and the progression, including man, had reached its culmination, an idea probably related to the transformation changes or metamorphosis developed by the Natural Philosophy of Johann Wolfgang von Goethe (1749–1832). G. Burmeister was not, at least publicly, a "Lamarckist" or "Darwinist" because he did not agree with the explanations proposed by these authors for the transformations that occurred in this increasing complexity or evolution through time. In G. Burmeister words: "*ich glaube nicht an die Umbildung der Species. Welche manchr Naturforscher lehren*" (I do not believe in the transformation of species taught by some naturalists) (Ulrich, 1972, p. 2). So, by 1861, with at least 119 titles published (Birabén, 1968; Ulrich, 1972), we got an idea of who the extraordinary naturalist coming to Argentina was and after his arrival, he signed his works and was known to the people in Argentina as G. Burmeister.

G. Burmeister arrives to Argentina

G. Burmeister's offer to be in charge of the *Museo Público de Buenos Aires* (Public Museum of Buenos Aires) was well received by Sarmiento, who invited him to travel as soon as possible. Sarmiento, as well as other Argentine politicians like Urquiza, was interested in investigating the natural resources of Argentina, especially those related to geology and mineral resources, and the future economic impact on the development of the Confederation. G. Burmeister arrived in Buenos Aires on September 1, 1861, a few days before the battle of Pavón (September 17), the event of decisive significance as the "defeat" of the national troops

by the Buenos Aires ones. This generated a profound political crisis and the resignation of the then President of the Confederation, Santiago Derqui (1809–1867), with Mitre, Governor of Buenos Aires, as his successor, and from 1862, formal President of the Argentine Confederation, and the definitive national unification with Buenos Aires as prevailing power. Consequently, Paraná lost importance as the former capital of the Confederation and also its National Museum, as the political power moved to Buenos Aires, where the old Public Museum was. After some dilations, Sarmiento urged Mitre to make the nomination of the German naturalist effective, so he could begin his studies at the museum in Buenos Aires, curiously stating, "in order to undertake precious studies that give rise to some rare fossils" (Mantegari, 2003). On February 21, 1862, G. Burmeister replaced S. Torres as the General Director of the *Museo Público de Buenos Aires* at the "*Manzana de la Luces*" (in Perú street), where he stayed from 1862 to 1892. By then, at 54 years old, G. Burmeister was a mature but energetic man, developing an intense activity over the 30 years he stayed in Argentina, having a great production, especially on Quaternary fossil mammals of the *"pampas"* (Fig. 3.1–2). As the Director of the *Museo Público de Buenos Aires*, G. Burmeister (who signed many articles under his Spanish name Germán) transformed the by-then not-very relevant and decayed provincial museum into an organized and growing institution, becoming the *Museo Nacional*. Despite being in Argentina, G. Burmeister did not cut ties with his homeland, publishing many articles through Halle University. In his personal life, G. Burmeister added an important tie to Argentina by marrying a Tucumán lady, Petrona Luisa Tejeda Reynaga (1843–1907) and by having another four sons, of which Carlos Germán Venancio Burmeister (1867–?; C. Burmeister, here after) and Federico Alberto Andrés Burmeister (1874–1965, F. Burmeister, here after) aided him as auxiliaries or traveling naturalists at the Buenos Aires and the La Plata museums. As he previously did in Germany and Argentina, G. Burmeister worked in many fields. However, he made his most notable contributions on vertebrate paleontology and the Pampean fossil mammals, making him a reference in the field.

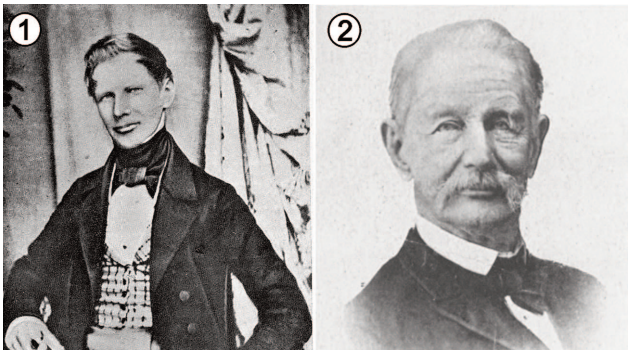

Figure 3. 1, Young G. Burmeister; **2,** Old G. Burmeister (both pictures were taken and modified from Birabén, 1968).

Although almost exclusively attending the *Museo Público de Buenos Aires*, from 1870–1871, G. Burmeister was appointed to Córdoba Province by Sarmiento, then Argentina's President and his Minister Nicolás Avellaneda (1837–1885) as Commissioner for the organization of a Faculty of Sciences in the Universidad Nacional de Córdoba (National University of Córdoba), and also in 1873, appointed again as Scientific Director of the *Academia Nacional de Ciencias* in Córdoba Province (National Academy of Sciences), but this time staying in Buenos Aires Province. For these tasks, G. Burmeister convoked a large group of German professors, who ended up being considered very important to the scientific development in Argentina. However, he would leave Córdoba in 1875 due to diverse disagreements with his colleagues (Mantegari, 2003). G. Burmeister promoted the creation of a "*Boletín de la Academia de Ciencias*" (Bulletin of the Academy of Sciences in Córdoba), which became an important scientific journal for Argentina. After this interval in Córdoba, G. Burmeister devoted himself entirely as the Director of the *Museo Público de Buenos Aires*. He was very fond of the institution, expressly writing that he loved it (Burmeister, 1870–1874).

Officially respected and supported by many, G. Burmeister was also sometimes criticized by young foreign and Argentine scientists (*i.e.*, Doering, F. Ameghino, Holmberg, and sometimes Moreno), who were upset by his intransigence and often not very pedagogical attitudes. Even at his age and suffering physical difficulties, in 1884, he went to Entre Ríos and Corrientes to examine fossils at the Paraná River cliffs (see Mantegari, 2003), some of them shown to him by Professor Pedro Scalabrini (1848–1916) of the *Escuela Normal de Paraná* (Burmeister, 1885). Honored on the 50th anniversary of his doctorate by many

personalities in Buenos Aires, G. Burmeister also had many *reconnaissance* such as the Cross of the Order of the Crown by the King of Prussia Wilhelm I (1797–1888) and the Order of the Rose by the Brazilian Emperor Dom Pedro II (1825–1891) (Birabén, 1968; Casinos, 2012). The Order of the Rose was conceded by donating to the Museum of Rio de Janeiro (Brazil) of the skeleton of an extinct giant ground sloth *Scelidotherium*, from the Quaternary of Argentina. At 79 years old, in 1886, G. Burmeister went to Rio de Janeiro and supervised the skeleton mounting, which was viewed and admired by Dom Pedro II (see Lopes, 2000; Mantegari, 2003). Also, in 1890, at 83 years old, G. Burmeister went to Italy, returning from Genoa in August 1890 (Burmeister, 1883-1891), which speaks of the indomitable energy of this man. Independent and making himself many things at the museum, this sometimes caused him dangerous troubles (see Birabén, 1968), as on June 6, 1870, when he surprised an infidel employee stealing at the museum and was seriously beaten by it; also on February 8, 1892, while trying to shut a window he fell from a stair and wounded severely, thus forcing his retirement from the museum and ultimately causing his death on May 2 of the same year at his house in Buenos Aires (Belgrano and Cevallos streets).

Before his demise, G. Burmeister suggested Carlos Berg (1843–1902), then at the *Museo de Montevideo* (Uruguay), be appointed as the Director of the *Museo Nacional*. Honored by the principal authorities, such as the then-President Carlos Pellegrini (1846–1906), G. Burmeister's passing concluded a historical stage of what can be considered the beginning of Argentine vertebrate paleontology.

G. BURMEISTER AND HIS LEGACY

The Museum

G. Burmeister took over a museum that was a mix of natural science objects (minerals, animals, plants, and fossils) and historical ones (numismatic, medal collections, mummies) (Burmeister, 1864–1869), transforming the *Museo Público de Buenos Aires* into a real natural history establishment. He managed all the natural history objects in the museum. G. Burmeister was aware of the importance of the Pampean fossil mammals and its significance for the museum, given the scientific value and the interest it generated to visitors and general public, as stated in the preface ("Proemio", Burmeister, 1864–1869) of the first volume of the *Anales del Museo Público de Buenos Aires*, "*El suelo de la Provincia de Buenos Aires es conocido largo tiempo ha en el mundo científico como uno de los depósitos más ricos de huesos fósiles en la superficie de la tierra*" (The soil of the Province of Buenos Aires is long time known in the scientific world as one of the richest deposits of fossil bones on the surface of the earth) (Burmeister, 1864–1869, p. 3). Many of these fossils were taken to museums in Europe, but others of great scientific value were preserved in the *Museo Público de Buenos Aires*, an establishment "*casi desconocido tanto en Europa como en América por falta de comunicaciones públicas sobre sus riquezas depositadas*" (almost unknown both in Europe and in America due to the lack of public communications about its deposited wealth) (Burmeister, 1864–1869, p 3). For G. Burmeister, the fossil richness of the territory had to be protected, kept at the museum, and developed into an official scientific publication to make the scientific research at the *Museo Público de Buenos Aires* known, both for scientists and the general public of Europe and other places of the Americas. A defender of the autonomy of the museum, G. Burmeister maintained a sometimes conflictive relation with Gutiérrez, Rector of the University of Buenos Aires during 1861–1878, who considered the museum under his jurisdiction, by a decree, December 5, 1862, of the Governor of Buenos Aires, Mariano Saavedra (1810–1883), subordinating the by then provincial museum to the university, G. Burmeister considered that he depended directly on the Higher Government and not the Rector of the university. Finally, Gutiérrez warned G. Burmeister that the museum was part of the university but gave him freedom in making decisions and autonomy for the museum. In complex situations, G. Burmeister also had almost unconditional support from Sarmiento, a powerful and influential political figure with a high esteem for the scientific capacity of the Prussian sage. To make a true natural history museum, G. Burmeister took special care in the exhibition of the materials, preparing shelves, cabinets, and pedestals according to models he brought from Halle, with the economic support of the provincial government (Burmeister, 1864–1869). After its arrival, he was devoted to the mounting and restoration of the carapace and skeleton of a *Glyptodon* stored in the collection, finishing it

with success and recognizing the efforts made by the technician of the museum (Burmeister, 1883–1891). He incorporated many important and invaluable natural science objects, especially those related to vertebrate paleontology. Bravard's collection had valuable specimens such as the skull and mandible of *Macrauchenia patachonica* from Arrecifes (Buenos Aires Province), the skull of the gigantic bear *Arctotherium latidens* from Ensenadan beds near the city of Buenos Aires, and fossils from Tertiary beds of Paraná, amongst other pieces. The museum acquired other fossil mammals, such as magnificent specimens of glyptodonts and giant sloths such as a *Mylodon*, and also received donations, including a magnificent fossil dolphin skull of *Saurodelphis argentinus* from the Miocene of Entre Ríos Province. In addition, G. Burmeister acquired for the museum a complete specimen of the fossil equid *Hippidion* found near Luján by the Breton brothers and the extraordinary skeleton of the "*Muñi-felis bonaerensis*", the saber-toothed tiger described by Muñiz, currently named *Smilodon populator*, which was donated to the museum by the North American railroad entrepreneur William Wheelwright (1798–1873) (Palcos, 1943). G. Burmeister managed to double the budget of the institution, which allowed him to increase the number of employees, integrating the staff for a brief time (1866–1868) with the famous Italian taxidermists Antonio Pozzi (1822–1898) and his son Santiago (1849–1929) (Lascano González, 1980; Mantegari, 2003; Farro, 2009; Miñana & Martinelli, 2022). Being G. Burmeister a figure worth of consideration, the provincial Senator José Hernández (1834–1886), the author of the Argentine national poem "*El Gaucho Martín Fierro*" (The Gaucho Martín Fierro), intervened personally obtaining a new employee for the museum, arguing that the paleontological richness of the province had to be protected from those who take the fossils to Europe obtaining a great profit, and citing as examples the collection of fossils made in Mercedes by Ameghino that had been sold for 100,000 francs, and the important collection that "Santiago Rut" (Santiago Roth) sold to Copenhagen (Denmark). Hernández remarked that the sage G. Burmeister was a first-category scholar of universal importance and the *Museo Público de Buenos Aires* paleontological wealth was (and here Hernández probably exaggerated on purpose) one of the firsts in the world (Bond, 2019). Above all this, G. Burmeister demanded salary increases not only for himself but for his employees and kept asking for more space, sometimes at the expense of the edifice of the Universidad de Buenos Aires at the "Manzana de las Luces" (see Mantegari, 2003). Undoubtedly, the efforts of G. Burmeister made the Museum of Buenos Aires a well-known Argentine scientific institution among both local and foreign visitors and scientists, as in 1872, the young Belgian naturalist Édouard van Beneden (1846–1910), son of the zoologist and paleontologist Pierre J. van Beneden (1809–1894), visited the museum and spoke highly of the fossils exhibited as precious materials, recognizing that the progress of the museum was mainly due to the activities of G. Burmeister, but with an important support from the provincial government of Buenos Aires (Governor Mariano Acosta, 1825–1893). Van Beneden considered that the paleontological collections of Pleistocene fossil mammals exhibited at the Museum of Buenos Aires were *on par* with many European museums. Such an exhibition was possible because of the continued incorporation of Quaternary fossil mammals, those from the Tertiary of Paraná, others from Monte Hermoso (Buenos Aires Province), and only a few collected in Patagonia, since the *Museo Público de Buenos Aires* did not have the same resources as the La Plata Museum, when under Moreno directive systematic collecting campaigns in Patagonia began (see Mantegari, 2003). Some fossils from Patagonia were brought by his son C. Burmeister and others by the explorer Ramón Lista (1856–1897), whom G. Burmeister guided.

Protection of the fossils: pioneering efforts of G. Burmeister

The fossil richness of the Pampas region awoke—since the beginnings of the XIX *siècle*—a fossil fever where many collectors extracted and sold unique specimens to European museums, obtaining juicy profits (Podgorny, 2011a, 2011b, 2013; Toledo, 2021b). This impoverished the national paleontological heritage, further disadvantaging the local museums. Clearly aware of this, G. Burmeister decided to apply to the governmental authorities of Buenos Aires Province, accomplishing the issue of a decree dated April 14, 1863, and signed by Governor Saavedra and its Minister

Acosta, prohibiting the extraction of fossils without the government's permission. The decree also established that those materials extracted without permission would be confiscated and deposited in the *Museo Público de Buenos Aires*, where the fossils extracted with permission should onwards be stored. Although not totally effective, this decree is clearly the immediate antecedent of the subsequent national laws of paleontological protection 9080 (1913) and 25743 (2003), making G. Burmeister one of the pioneers in Argentina of paleontological protection.

The Paleontological Society of Buenos Aires, a magnificent, short-lived intent

Besides official support, the old "*Asociación Amigos de la Historia Natural*" (Friends of Natural History Association) did not satisfy G. Burmeister as an effective aid to produce the Argentine scientific publications needed. So, in 1863, G. Burmeister, in rather discourteous terms, requested the resignation of S. Torres, former Director, professor of natural history, and promoter of the association, and dissolved it. Despite its apparent ineffectiveness, the dissolved association left substantial money as a legacy (see Mantegari, 2003). In 1866, the new *Sociedad Paleontológica de Buenos Aires* (Paleontological Society of Buenos Aires) was created, becoming the first paleontological association in Latin America. This new Society began with the best auspices, its members being politicians, professors, merchants, *etc*., and inextricably linked to the official sphere since its President Gutiérrez was Rector of the then provincial Universidad de Buenos Aires, the Scientific Director was G. Burmeister. Among its partners, the Society had many influential citizens, such as Marcos Paz (1811–1868), Argentine Vice President, who exercised the presidential function as President B. Mitre was at the military command in the war against Paraguay; Guillermo Rawson (1821–1890), Minister of the Interior; Eduardo Costa (1823–1897), Minister of Justice and Public Instruction; Pastor Obligado (1818–1870) and Saavedra (politicians and former Governors of Buenos Aires); and many other personalities, including the Italian Pellegrino Strobel (1821–1895), one of the first geology professors at the *Universidad de Buenos Aires*. A few scientific associations, especially paleontological ones, could probably show members so closely related to political power as the Paleontological Society of Buenos Aires.

In its statute, the first article established that *La Sociedad Paleontológica de Buenos Aires se forma por libre unión de los Socios fundadores y con aprobacion previa del Superior Gobierno* (The Paleontological Society of Buenos Aires is formed by the free union of the founding members and under the prior approval of the Superior Government) (Burmeister, 1864–1869), done this on August 8, 1866, and making it clear that the Society was within the legal frameworks. The *Sociedad Paleontológica de Buenos Aires* had as its main purpose to study and to make the fossils of the "State" of Buenos Aires known, further promoting the *Museo Público de Buenos Aires* scientific progress. Meetings and sessions of the *La Sociedad Paleontológica de Buenos Aires*, from July 11, 1866, to March 11, 1868, were published together with the statute in volume 1 of the "*Anales del Museo Público de Buenos Aires*", between 1866 and 1868 (Burmeister, 1864–1869). The sessions recorded the progress of the museum, entry of new materials, acquisition of books and publications, deals with related societies, money movements, admission of new members, *etc*. Additionally, the scientific discussions were published, almost all with G. Burmeister as a principal lecturer on various issues, such as fossil cetaceans, fossil shell beds, glyptodonts, toxodonts, the origin of man, some living mammals, and insects. In other sessions, Professor Strobel exposed the importance of the current geographical distribution of terrestrial mollusks for geology and paleontology, and Gutiérrez spoke on the early discoveries of mammals in the Plata region. Even in its last year (1868), the association incorporated new members, such as General Brigadier Mitre, President; Dardo Rocha (1838–1921), future Governor of Buenos Aires; Avellaneda, Minister and future President; and the Italian professor Giovanni Ramorino (1840–1876), second geology professor at Universidad de Buenos Aires and fundamental in the early years of F. Ameghino.

The society continuously appealed to the provincial government of Buenos Aires for support and monetary contributions from the associates. Despite the efforts, the *Sociedad Paleontológica de Buenos Aires* had a short life, so the society sessions were no longer recorded by the second volume of the Annals. G. Burmeister informed that different

circumstances prevented the meetings of the *Sociedad Paleontológica de Buenos Aires*, so the progress of the museum would be informed through a published bulletin along with the *Anales del Museo Público de Buenos Aires* (Burmeister, 1870–1874).

Although it is difficult to assess the causes of the closure of the association (Auza, 1997), we must remember it was deliberating in the middle of critical circumstances, as internal revolts (for example, those led by the brothers Saá and F. Varela (1821–1870) against Mitre's government), one of the most terrible international wars in which Argentina has participated, the Paraguayan War (1865–1870), in which one of the society's member, Rocha, was seriously wounded), and a severe cholera epidemic that caused many victims, one of them Vicepresident Paz. Also, some members, like Strobel, who returned to Europe, left the society. Whichever the causes, the last entry of the Paleontological Society was on March 11, 1868, in the second volume of the *Anales* (1870–1874) as a new bulletin (Auza, 1997; Asua, 2012). Although short-lived, the *Sociedad Paleontológica de Buenos Aires* was a pioneer institution among the paleontological associations of Argentina and Latin America.

The Museum publications, the *Anales del Museo Público de Buenos Aires*

Since its arrival, G. Burmeister published different papers in foreign and national journals from 1864 to 1891, many on fossil mammals from the *Museo Público de Buenos Aires* collection. In foreign journals, for example, he preliminary described the magnificent skeleton of the saber-tooth *Smilodon* ("*Muñi-felis*") of Muñiz (Burmeister, 1868), then known as *Machaerodus*. Also, he wrote on glyptodonts in a local pharmacological journal, the "*Revista Farmacéutica de la Sociedad de Farmacia Nacional Argentina*", (1863–1864), reputedly the most ancient Argentine scientific publication since 1858 (see Babini, 1986). This article was also published in an English journal (Birabén, 1968). G. Burmeister also published about fossil ground sloths (Mylodontidae) in a popular periodical review, the "*Almanaque Agrícola, Industrial y Literario de la República Argentina y de Buenos Aires*" (1864–1865) (Mones, 2021), which dealt with different subjects, as agriculture or medicine new. So, it is clear that, for G. Burmeister, there was an urgent need for a proper scientific publication exclusive for the *Museo Público de Buenos Aires*. Finally, with official support and private contributions, G. Burmeister created the *Anales del Museo Público de Buenos Aires*, marking a milestone for scientific publications in Argentina, being the first one devoted to the natural sciences, zoology, and paleontology. The title of the first volume (1864–1869) was "*Anales del Museo Público de Buenos Aires, para dar a conocer los objetos de Historia Natural nuevos o pocos conocidos conservados en este establecimiento*" (Annals of the Public Museum of Buenos Aires to present the new or little-known natural history objects preserved in this establishment) (Burmeister, 1864–1869), with G. Burmeister as Director of the establishment. G. Burmeister, in the introduction or "*Proemio*" (October 20, 1864) mentioned that the government of Buenos Aires was a supporter and protector of the edition of the *Anales del Museo Público de Buenos Aires*, also stating that prominent members of the *Asociación Amigos de la Historia Natural del Plata* (Association Friends of the Natural History of Plata) promised to make every effort to ensure the publication and continuity of the volumes (but as we mentioned before, this did not happen). For G. Burmeister, the *Anales del Museo Público de Buenso Aires* were intended to position the museum alongside its international peers, being not only useful for the institution but also for the nation, recommending them to the youth of the country so that they could favor and protect this publication with their votes. Additionally, G. Burmeister thanked Gutiérrez, Rector of the University, for his assistance in publishing this work (Burmeister, 1864–1869). Ending the first volume of the *Anales del Museo Público de Buenos Aires,* the statute and sessions of the *Sociedad Paleontológica de Buenos Aires* were presented. The first volume consisted of a series of articles, all authored by G. Burmeister, written in Spanish (as were the other two following volumes). The first article outlined the history and collections of the museum, followed by one on contemporary paleontology, with interesting insights into biostratigraphy and the succession of life through the geological periods, being this the first work of its kind in Argentina. The rest of the volume included articles on living birds, cetaceans, and fossil mammals. The articles devoted

to the "*Pampean* fossil fauna" were of high quality, with descriptions that reflected G. Burmeister's anatomical knowledge. He described the main features observed in the skeletal remains and rightly suggested that some differences preserved in fossil species, considered of systematic value, might simply be individual variations. G. Burmeister began by describing the skull and partial skeleton of the *Macrauchenia* from the Bravard collection, acquired by the museum, using Bravard's original plates from his intended description of this ungulate, which he had planned to name *Opistorhinus* (due to the posterior position of the nares, a feature also noted and described by G. Burmeister). In the following article, G. Burmeister described the notoungulate genus *Toxodon* and its species with great detail and illustrated it with excellent drawings made by G. Burmeister himself, including the magnificent skull donated by Muñiz. Additionally, there is an article on the anatomy of glyptodonts as well as a general overview of fossil mammals known in Argentina, mainly from the Quaternary or Diluvial beds, along with others from the continental beds of the "*Tertiaire Patagonien*", accompanied by a solid geological synthesis. This first volume is a masterful work and, with its excellent plates, auspiciously inaugurated the scientific contributions to the Argentine paleomammalogy, published by the *Museo Público de Buenos Aires* in Argentina.

The second volume of the *Anales del Museo Público de Buenos Aires* (1870–1874) is an extraordinary, detailed monography (*"Monografía de los Glyptodontes en el Museo Público de Buenos Aires"*) devoted to the glyptodont family Glyptodontidae. In the preface, G. Burmeister explained the four-year delay in publishing the *Anales del Museo Público de Buenos Aires* attributing the delay to diverse causes such as the printing of the scientific plates, his advanced age, and his multiple tasks (*e.g.*, curator, sculptor, and designer). Despite these obstacles, the result is magnificent, with highly detailed descriptions absolutely of all the known genera of Glyptodontidae (*Panochthus*, *Hoplophorus*, *Glyptodon*, and *Doedicurus*), demonstrating his expertise as an anatomist. The detailed osteological descriptions of the skull and postcranial elements were also accompanied by cross-sections of the teeth, analyzing different dentine types, the hyoid apparatus (correcting previous errors published in the first volume), general features of the brain, presumed theoretical nerve projections from the optic area, muscular, and nervous insertions (Fig. 4.1), detailed descriptions of the carapace scutes and other dermal scutes from different parts of the animal, among other things. As in the first volume, but with more detail, the drawings and plates were mainly made by G. Burmeister (Fig. 4.2); these are magnificent and have been reproduced many times in other works. Some plates were made by the Swiss painter Adolf Methfessel (1835–1909) under G. Burmeister's direction. This work also included a photograph illustrating a caudal tube of *Panochthus*, a pioneering use of photography in Argentine science (Burmeister, 1870–1874; Toledo, 2022). The monograph of the glyptodonts exemplifies why the *Anales del Museo Público de Buenos Aires* deserve a special place in the history of Argentine mammalian paleontology. Even F. Ameghino, often critical of G. Burmeister, wrote that it was a monumental contribution to the Argentine paleontology (Ameghino, 1889). G. Burmeister also documented the origins of the specimens and often complained about the public damaging valuable pieces by taking pieces, especially scutes, as "*souvenirs*". He emphasized the great work required to reconstruct these animals, especially the carapace, and the effort made by the curator of the museum, Luis Fontana (1846–1920), who spent a year working on this task, something that was

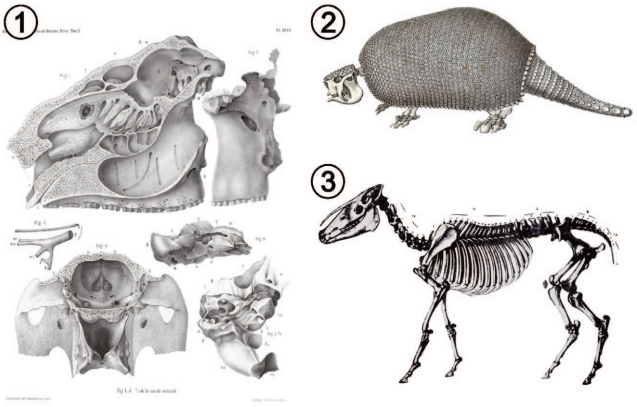

Figure 4. 1, ***Glyptodon*** skull showing internal structures and reconstructed nerve projection of the optic region (modified from plate 28, Burmeister, 1870–1874); **2,** ***Glyptodon clavipes*** skeleton and carapace (modified from plate 36, Burmeister, 1870–1874); **3,** ***Hippidion bonariense*** skeleton, taken from Burmeister (1875) but modified from Palcos (1943).

unappreciated by the visitors (Burmeister, 1870–1874). Ending the volume in a section called *Boletín del Museo Público de Buenos Aires*, G. Burmeister reported on the difficulties affecting the meetings of the *Sociedad Paleontologíca de Buenos Aires* and listed the novelties and acquisitions from 1868 to 1871, incorporated with the aid of the government, including the Bravard collection.

The third and last volume was published between 1883 and 1892 as *Anales del Museo Nacional de Buenos Aires* (Annals of the National Museum of Buenos Aires) (formerly Public Museum). The volume included the works of G. Burmeister on actual cnidaria, *Physalia* (Portuguese caravel) with a fine plate, and other studies on entomology, followed by the reproduction of the Monography of Bravard on the Tertiary terrains of Paraná and a series of articles on the fossil mammals of the Tertiary of Paraná by G. Burmeister himself. This volume had two other articles written by C. Burmeister, his son, detailing his trips to Monte Hermoso and Patagonia as a natural history traveler and collector for the *Museo Nacional de Buenos Aires*. The first fascicle was published as the *Anales del Museo Público de Buenos Aires.* The shift to a museo nacional *status* occurred in September 1884, as clearly stated at the end of the second fascicle. The last fascicle was published shortly before the death of G. Burmeister. In it, G. Burmeister commented on the species Bravard mentioned while also describing new mammals (*e.g.*, rodents, litopterns, and toxodonts) and reptiles. Some of these materials were based on specimens of the *Museo Nacional*, others collected by Enrique de Carles (1861–1934), who was by then working as a collector for G. Burmeister's museum, and additional specimens shown to G. Burmeister by Professor Scalabrini in Paraná. G. Burmeister also described forms from Patagonia, collected by Lista and his son (like *Colpodon* from Chubut), and provided detailed descriptions of Patagonian Tertiary mammals of the *Museo de La Plata* (as the toxodontid *Adinotherium*). This last volume showed the changing times, where the generation of the old German sage director is being replaced by the young generation in the Argentine paleontology. In 1892, it was evident that the *Museo de La Plata*, directed by Moreno, was competing with the museum directed by G. Burmeister, benefiting from greater resources. At La Plata, G. Burmeister had access to the fossil mammals collected in the Miocene of Santa Cruz Province, as stated by G. Burmeister, whose attitude with Moreno went from cordial to critical. In one article in the *Anales del Museo Público de Buenos Aires*, he critiqued some new species published in the "*Revista del Museo de La Plata*" by Moreno and the Swiss naturalist Mercerat (Ameghino's successor after he resigned from the *Museo de La Plata*). G. Burmeister remarked that Moreno's significant resources could have been better used. When examining an article by Mercerat on Miocene Santacrucian toxodontids, G. Burmeister stated that a bad example corrupts good customs, suggesting that Mercerat followed F. Ameghino as a poor example.

Finally, the old dispute with F. Ameghino returned with all its intensity in some articles of this last volume, with G. Burmeister criticizing many of the works of F. Ameghino, sometimes justifying this idea by pointing out that many of the anatomical references used by F. Ameghino were wrong. Furthermore, G. Burmeister evaluated several of the publications by F. Ameghino such as the "*Contribución al conocimiento de los mamíferos fósiles de la Argentina*" (Ameghino, 1889), published by the *Academia Nacional de Ciencias* in Córdoba Province, an institution that had embittered G. Burmeister in the past. G. Burmeister criticized the text and especially the figures that he found particularly substandard. Then, he examined the new journal published by F. Ameghino, the "*Revista Argentina de Historia Natural*" (1891), in which F. Ameghino critiqued G. Burmeister's work and introduced many new species. However, the critics of G.Burmeister against the new taxa proposed by F. Ameghino were sometimes unjustified; this time, G. Burmeister disqualified F. Ameghino's work with a tremendous and harsh phrase: "*cometiendo nuevos errores y haciendo nuevas especies, creciendo los dos en el suelo pútrido de sus obras,como los hongos en la basura, que es el verdadero terreno del nacimiento de éstos*" (making new mistakes and creating new species, both growing in the putrid soil of their works, like mushrooms in the garbage, which is the true terrain of their birth) (Burmeister, 1883–1891, p. 471). Finally, the almost sure origin of the feud of their conflict appeared on the scene: the fossil human (Toledo, 2022). G. Burmeister remained skeptical of the human fossil findings, such as the one by the Spanish collector de Carles at the San

Borombon River (Buenos Aires Province), which was widely known then. G. Burmeister was similarly dubious about the fossil human from the Frías rivulet found by F. Ameghino because he considered all the fossil human findings claimed by F. Ameghino as exagerated as the supposed 12 fossil human skeletons at Córdoba Province (Ameghino,1885). Among his many complaints, G. Burmeister commented that he came to this country to apply his scientific skills for its benefit and could not ignore how "my science", the paleontology, was, in his opinion, so poorly treated by F. Ameghino. By the ending of this *Anales del Museo Público de Buenos Aires,* G. Burmeister dedicated one of his last scientific writings to a final, caustic remark about F. Ameghino: "*Como un aviso al público, agrego que no contestaré jamás á quejas y nuevas invectivas del señor Ameghino, tratándole como individuo que no existe, dejando en olvido sus obras y su persona*" (As a warning to the public, I add that I will never respond to complaints and new invectives from Mr. Ameghino, treating him as an individual who does not exist, leaving his works and his person in oblivion), finishing in latin "*Dixi et salvavi animam meam*" (I said, and I have saved my soul) (Burmeister, 1883–1891, p. 487). This phrase was the final stroke on this long and famous quarrel between these two extraordinary figures of the Argentine mammalian paleontology.

De Carles, who found the Sanborombon human skeleton and worked some time as a traveling naturalist for the *Museo Nacional de Buenos Aires*, eventually left this post to become an independent collector, selling his magnificent collection of fossil mammals from the Quaternary and Pliocene of Argentina to the rich Spanish businessman, José Rodrigo Botet (1842–1915). Botet subsequently donated it to the Museum of Valencia (Spain), where the San Borombon skeleton is housed, among many other mammalian fossils (Simpson, 1984; Casinos, 2012).

Two important works by G. Burmeister were published between the second (1870–1874) and third volumes (1883–1891) of the *Anales del Museo Público de Buenos Aires.* The first, "*Caballos Fósiles de la Pampa Argentina*" (Fossil Horses from the Argentine Pampa) (Burmeister, 1875), was sponsored by Buenos Aires for the Universal Exposition of Philadelphia in 1876. This work was presented with a "Supplement" (1889) in Paris. This was a splendid contribution devoted to fossil horses of Argentina and illustrated with beautiful plates describing some magnificent specimens, such as the complete *Hippidion* skeleton bought by the museum (Fig. 4.3), and included an outstanding mastodont skull made by Methfessel in such supplement. This contribution received several important distinctions (Mantegari, 2003). The second work, released in 1881, was an ambitious project entitled "*Description physique de la Republique Argentine*" (1876–1879) (Physical description of the República Argentina), which was published in several volumes, with the final one being an *Atlas* with masterful plates. This book was written in French, probably to reach a broader audience. This contribution proposed a comprehensive knowledge of Argentina's territory, geology, and fauna. One volume was focused on vertebrates, describing the Argentine mammals, their nature, origin, and development. G. Burmeister described living mammals and many extinct forms, such as *Toxodon*, *Nesodon*, *Typotherium*, *Macrauchenia*, mylodontids, megatheriums, and glyptodonts. He also described new species like the "*Anchitherium australe*", a proterotheriid litoptern, brought by Lista from Patagonia, and also the skull of *Astrapotherium patagonicum*, which he named without the authorization of Moreno, who had brought it from Patagonia, provoking new frictions between Moreno and the old professor. The second volume, among other things, reviewed what was then known of the geology of Argentina, based on D'Orbigny, Darwin, Bravard, and G. Burmeister's observations. The geological succession known by then was very simple for Tertiary and Quaternary deposits. G. Burmeister distinguished first the "*Formation tertiaire inférieure dite guaranienne*" (lower tertiary Formation named Guaranian), then the "*Formation tertiaire supérieure dite patagonienne*" (upper tertiary Formation named Patagonian), with marine fossils, especially invertebrates, and some terrestrial vertebrates. For G. Burmeister, the deposits of Paraná were deposited near the coast. The terrestrial mammals then recorded for the "*Patagonienne*" ("Patagonian") were a mixed assemblage of taxa as those from Paraná like the "*Anoplotherium americanum*" (currently a litoptern), and others coming from Patagonia as the toxodontid *Nesodon imbricatus*, supposedly coeval, but nowadays acknowledged to pertaining to different ages. Then comes the "*Formation diluvienne, dite quaternaire ou*

postpliocene" (Diluvian Formation for the Quaternary or post-Pliocene), in other words the "*Pampean*" formation. In a very detailed synthesis, G. Burmeister described the fossil deposits and the mode of their deposition and concluded that these fossiliferous beds were the result of a long temporal series of alluvial deposits made by rivers and streams, occasionally accompanied by sand deposits that could also cover the remains of extinct mammals. He rejected Bravard's idea that the Pampean deposits were dunes that originated from the action of the wind. However, G. Burmeister accepted the taphonomic observations made by Bravard concerning the presence of marks attributable to insect larvae, similar to those seen in actual remains lying on the surface and exposed to the elements rather than submerged, as Darwin suggested. Above the *Pampean* beds were the more recent "*Formation moderne des alluvions*" (Modern Formation of alluvium). The "*Description physique de la Republique Argentine*" represents a magnificent influential contribution in the fields of geology and paleontology and was supported by the national government in order to be presented at the Universal Expositions of Paris in 1878 and 1889 (Asúa, 1989).

G. Burmeister and the Argentine paleontology

G. Burmeister's figure has sometimes been overshadowed or diminished, mainly by his conflict with F. Ameghino and alleged adherence to "creationism", the latter claim false. For example, the great paleontologist George Gaylord Simpson (1902–1984), who knew well our mammalian paleontology, in his book on the history of paleontology in South America, briefly mentions G. Burmeister by his quarrel with Ameghino, describing him as a "Teuton of the old school… a rigid biblical creationist" opposed to the Darwinism of F. Ameghino (Simpson, 1984, p. 77). For Simpson, G. Burmeister's primary contribution was associated with Muñiz's materials and the assemblage of the collections of the Pampean fossil mammals for the *Museo Nacional de Buenos Aires* (Simpson, 1984). However, G. Burmeister's contributions were more than these, not only in reference to his work within the collections but also to the protection of the provincial fossils. He created the *Anales del Museo Público de Buenos Aires,* which was the first proper natural science publication in Argentina (Babini, 1986), and he produced a wealth of scientific studies and provided masterful anatomical descriptions *(e.g.*, neurological or nervous innervations), displaying a level of expertise unmatched by other Argentine paleontologists of the late XIX Century. His efforts contributed significantly to the international renown of the *Museo Nacional de Buenos Aires* even within his lifetime, positioning him as a foundational figure in Argentine paleontology and helping to establish it as a respected scientific field beyond national borders.

Geology and the "*Conquista del Desierto*" (Conquest of the Desert)

The brothers Oscar (1844–1917) and Adolf Doering (1848–1925) or Döring, from the *Academia de Ciencias de Córdoba*, despite quarreling with G. Burmeister in the "Córdoba episode", remained affiliated with the academy. Later, they became friends with F. Ameghino, sharing their rivalry with G. Burmeister (see Márquez Miranda, 1951; Podgorny, 2011d). Adolf Doering participated as a naturalist in the Río Negro military expedition (1879), commanded by the young general Julio Argentino Roca (1834–1914), during the presidency of Avellaneda. This expedition, popularly known as the "*Conquista del Desierto*", began the national government's definite occupation of the Argentine territory. The expedition produced several scientific reports, such as the geological study by A. Doering (1880) that covered the surveyed areas. In his extensive introductory discussion of the Cenozoic, A. Doering expressed that the Argentine formations and their correlations, based on a comparative paleontological study, were incomplete compared with those of the United States of America and Europe. Doering discussed past movements of land and sea, the extension of the sea, and the criteria concerning the recognition of the stages of Cenozoic periods in Europe, among other things. In discussing marine fossils and their implications for past sedimentation and coastal distance, A. Doering recognized G. Burmeister's accurate observation that the fossils from the Paraná marine "Patagonian" indicated estuarine and near-coastal deposits. Then, he discussed the recognized Cenozoic Argentine formations, detailing the main fossils known for each formation and stage, expanding G. Burmeister's geological framework and introducing a new classification for the Cenozoic (Fig. 5), his Neotropical

Cenozoic Formations System for the Austral-Atlantic region. This included: (I) the "Eogene" formations (with almost all extinct genera), with the Guaranitic Formation (Eocene or Upper Cretaceous), and the Guaranitic and Pehuenche stages (the latter with the unusual fossil mammal "*Mesotherium*"); and the Patagonic Formation (Oligocene) with the Mesopotamian (terrestrial mammals) and the Patagonian (marine with *Ostrea patagonica*) stages, and (II) the Neogene formations, with the Araucanian Formation (Miocene), including the Araucanian (with *Nesodon* and "*Anchitherium*") and the Puelche stages. Above these, the Pampean Formation (Pliocene and "Pre-Glacial"), with the Lower Pampean, Eolitic, and Lacustrine Pampean stages, later known as Ensenadan, Bonaerian, and Lujanian (Tonni, 2011). The overlying Tehuelche Formation (Glacial) and the Querandina Formation or Post-pampean (Diluvial) (Querandine and Platan stages, with estuarine and freshwater mollusks). Finally, the Arian Formation (alluvial) has recent mammals, including the European one brought by the Spaniards. Although incomplete by modern standards, A. Doering's scheme was remarkably comprehensive, given the limited understanding of Argentine Cenozoic stratigraphy (Doering, 1882; Salgado *et al.*, 2007; Tonni, 2011).

A NEW GENERATION OF ARGENTINE PALEONTOLOGISTS: MORENO AND F. AMEGHINO

Moreno, a museum from Buenos Aires to La Plata

Moreno, known as the "*Perito Moreno*", was born on May 31, 1852, in Buenos Aires city. His father, Francisco Facundo Moreno Visillac (1819–1888) was a prosperous merchant well-known in the "illustrated" society, with many political relationships that undoubtedly helped his son. However, Moreno's achievements were attained by his strong personality, skills, and unwavering purpose rather than merely family wealth. From an early age, Moreno became interested in exploration voyages and natural history collections (Moreno, 1879). Although he lived in the city, his father bought a property, a "*quinta*" called the "*Edén de San Cristóbal*", in the southern part of the city, which was by then a rural area, and currently located within the Parque Patricios neighborhood. In their home, Moreno and his brothers created his first "museum", displaying various objects, including fossils given by the Rector Gutierrez, an old friend of his father, and a dasypodid fossil. Having visited G. Burmeister at the *Museo Público de Buenos Aires*, the Director occasionally visited Moreno's "museum", where he examined the dasypodid, mentioning a few years later that this specimen at Moreno's "*Museo Arqueológico*" (archaeological museum) could belong to a new species (Burmeister, 1879). Between 1867 and 1868, a cholera epidemic struck, claiming many lives, including Moreno's mother and the Argentine vice president, Paz. Then, in 1871, the "*fiebre amarilla*" (Yellow Fever) epidemic devastated the city of Buenos Aires, so Francisco's father sent his family to his brother-in-law's ranch near the Vitel and Chascomús lagoons in southern Buenos Aires Province. While there, young Moreno made significant archaeological and paleontological collections. At his return to Buenos Aires, Moreno brought his new collections to the "*Edén*", which grew increasingly and soon needed dedicated display space. For his 20th birthday, as a gift, his father constructed a building on the farm for his collection,

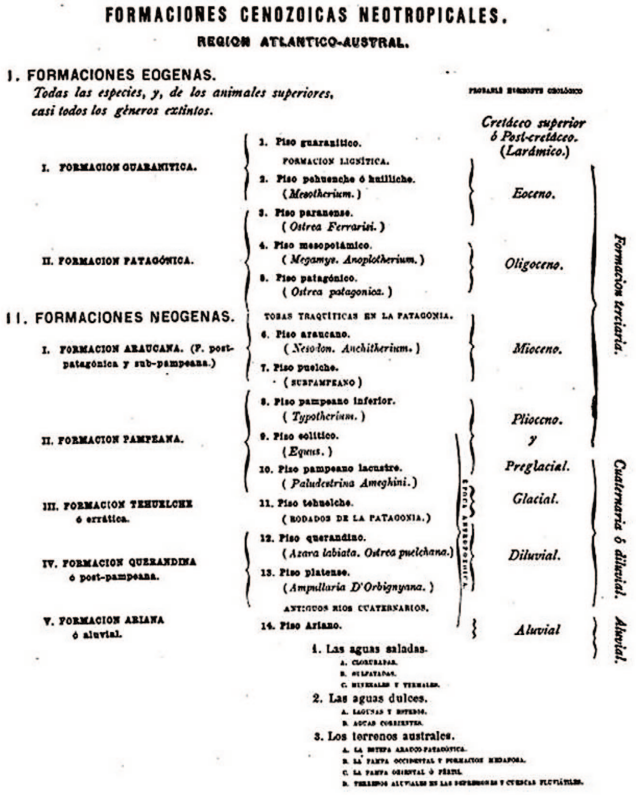

Figure. 5. Stratigraphic scale of Doering (1882) (modified from the original).

including a laboratory and a library (Fasano, 2002; Farro, 2009), designed by the German engineer Otto von Arning (or Arnim, 1824–1889) (De Barrio, 1923; Farro, 2009), a former member of the *Sociedad Paleontológica de Buenos Aires*. This first "museum", inaugurated in November or December 1872, had a neoclassical front (Fig. 6.1) reminiscent of the future *Museo de La Plata* (De Barrio, 1923; Fasano, 2002). There, Moreno received visitors like Manuel Eguía (1808–1880), a founding member of the *Sociedad Paleontológica de Buenos Aires* and fossil collector, who gave Moreno several ideas and advice on the preservation and arrangement of the collection. Even G. Burmeister designed part of the exhibition shelving (De Barrio, 1923).

In 1872, several students of the Department of Exact Sciences of Buenos Aires, among them Estanislao S. Zeballos (1854–1923), decided to create a scientific association, the *Sociedad Científica Argentina* (Argentine Scientific Society), on July 14, at the *Colegio Nacional* (National College). As a prominent exponent of scientific advancement, the Society became closely associated with Moreno, supporting him financially and publishing his works and conferences. Formerly interested in anthropology, mainly indigenous skulls (it was the Age of the Craniology), Moreno decided to visit Patagonia after receiving many materials from Carmen de Patagones (Farro, 2009; Moreno, 2009). So, in 1873, Moreno embarked on his first trip to Patagonia, visiting Carmen de Patagones, the Río Negro, and nearby places, collecting archaeological materials (Ygobone, 1979; Fasano, 2002). He corresponded with the French anthropologist Pierre Paul Broca (1824–1880), and Moreno published his research on Patagonian archaeology in 1874.

After a bounding quarrel with Chile, in 1874, Argentine President Sarmiento sent a naval expedition to Santa Cruz Province. Moreno was accepted as a member and, by agreement between Moreno and G. Burmeister, the zoologist Carlos (Karl) Berg (1843–1902) of the *Museo Público de Buenos Aires* also joined the expedition. They departed on the schooner brig "Rosales" in August 1874, returning in December (with Avellaneda as new President). In the Tertiary layers of Santa Cruz, they collected fossil mollusks, especially *Ostrea*, and remains of fossil cetaceans, one of them later named by Moreno as "*Palaeobalaena bergii*" in homage to his companion and friend, Berg (Moreno, 1882). Above the marine deposits, on the "Tertiary yellow sands", they extracted remains of a "large *Glyptodon*" (Moreno, 1882). This area had been visited by Darwin, who referred to the terrain (marine and terrestrial) as the "Patagonian Tertiary". Currently, the marine sediments on the Santa Cruz Bay represent the Monte León Formation (late Oligocene–Early Miocene; 27 to 20 million years) (Cuitiño *et al.*, 2016) and the overlying terrestrial layers with mammals to the Santa Cruz Formation (late Early–early Middle Miocene; 17 to 16 million years old) (Cuitiño *et al.*, 2016). After his return from Patagonia, Moreno went to Paraná to examine the Tertiary marine formations, compare them with those of Patagonia, and collect fossils (Moreno, 2009). His appointment as an academic of the

Facultad de Ciencias Físicas y Naturales de Buenos Aires (Faculty of Physical and Natural Sciences of Buenos Aires, 1875), and as an assistant to Dr. Berg's Zoology chair, brought criticism from his cousin, Eduardo Ladislao Holmberg (1852–1937), a notable Argentine naturalist and writer. Holmberg satirized Moreno as "Francisco Paleolitez" (Burmeister new sage "*protégé*", Farro, 2009), in his novel "Two Parties in Struggle" (1875), regarding the dispute between "Darwinists" and "anti-Darwinists" scientists at a conference in Buenos Aires, where Darwin participated as a guest. Despite this, Moreno continued his work and projects, being an active member of the "*Sociedad Científica Argentina*". In September 1875, Moreno returned to Patagonia, visiting Darwin's site at Punta Alta in Bahía Blanca. He collected fossil seashells and bones of fossil mammals (Moreno, 2009). He continued his journey and finally reached the Lago Nahuel Huapi, but he was not authorized by Chief Shaihueque (1818–1903) to cross to Chile. Due to this, Moreno returned to Patagonia in March 1876 (Moreno, 1879). Following further explorations in Catamarca Province, Moreno prepared another trip to Patagonia, to the Río Santa Cruz, to reach its headwaters. The government was interested, and President Avellaneda approved this project. So, on October 20, 1876, Moreno departed from Buenos Aires in the schooner "Santa Cruz", a famous Argentine sailor commanded by Luis Piedra Buena (1833–1883). Along the route, they collected many marine

fossils in Chubut Province, in what was by then known as the "Patagonian Tertiary" formation, as recognized by d'Orbigny, exposed in Paraná and along the Patagonian coast. For Moreno, these beds provided evidence of a major marine incursion in the southern part of the continent (Moreno, 1879), with the fossils found there of the same species already recorded in Paraná, indicating a similar age between the Patagonian beds and those from Paraná. Today, it is known that the old "Patagonian Tertiary" includes different formations ranging from the Upper Oligocene to the Upper Miocene (between 27 and 9 million years old), reflecting different Atlantic incursions into the continental territory.

In January 1877, the group of Moreno, accompanied by the Navy Second Lieutenant Carlos M. Moyano (1854–1910) as a cartographer, began the hard ascent of the Río Santa Cruz, towing the boat against the current to reach its headwaters, which were poorly known. In 1834, Fitz Roy (1805–1865) had come close to the objective, whereas G.H. Gardiner in 1867 and Navy Second Lieutenant V. Feilberg (1852–1913) of the Argentine navy in 1873 had reached one of the lakes feeding the river. Moreno and his companions reached the headwaters of the Santa Cruz River on February 14, 1877, naming the lake Lago Argentino and discovering the Viedma and San Martín lakes. On February 4, 1877, while ascending the river, in a series of "yellowish rocks" outcrops not far from the river, Moreno discovered a fossiliferous site with "the tusk of a powerful missing pachyderm", likely from the Eocene period and "not yet reported in Patagonia" (Moreno, 1879, p. 303). In other layers, probably younger, he found more fossils of mammals (*e.g.*, marsupials and edentates) (Moreno, 1879). He also observed layers with *Ostrea patagonica*, which indicated "the immense fossiliferous mantle that extended from Paraná to Tierra del Fuego, on the Atlantic coast", penetrating "the heart of Patagonia" (Moreno, 1879, p. 312).

In the Tertiary layers of the Río Shehuen, he found petrified trees and oysters, and near San Martín Lake, samples of "stone coal" similar to the lignite of Punta Arenas. For Moreno, this suggested an "opulent vegetation" covering "the west of eastern Patagonia" from the early Cenozoic or late Mesozoic (Moreno, 1879, p. 407–408). This discovery was also the first for Santa Cruz Province.

Back at the site where he first found the fossil mammals, Moreno extracted a large part of the "great pachyderm" skull (Fig. 6.2). In other supposedly younger beds, he collected additional mammals (*e.g.*, glyptodonts, dasipodids, and a toxodontid notungulate, *Nesodon*) (Moreno, 1879). Today, all the levels from where Moreno collected the mammals belong to the Santa Cruz Formation.

Moreno (Fig. 6.4) arrived in Buenos Aires on May 8, 1877, and began writing his voyage narrative. Also, an important event occurred for Moreno and his "museum" that same year. Except for a partial exhibition of Moreno's collection in a rented space at the commercial house of Fusoni Hermanos (Masán, 2023) in Buenos Aires city, the general public had not accessed it. In conversations with Vicente G. Quesada (1830–1913), Minister of Government

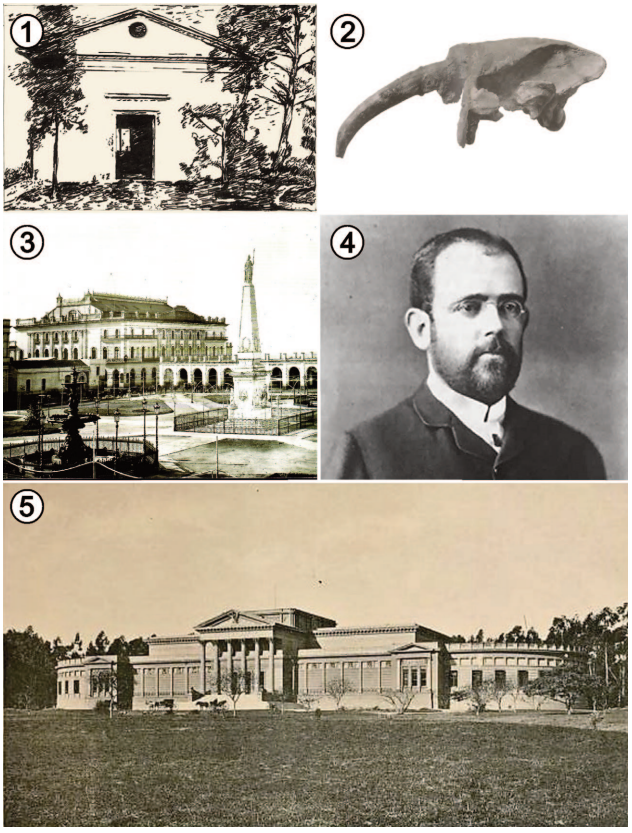

Figure 6. 1, Front of the F. P. Moreno Museum, *ca.* 1872, *quinta El Edén de San Cristóbal*, Parque Patricios, Buenos Aires city (modified from Bond, 2022); **2,** ***Astrapotherium patagonicum*** ("***Mesembriotherium broccae***") skull (type **MLP-PV** 12-94) modified from plate 21, Lydekker (1894c); **3,** Antiguo Teatro Colón, right across the Plaza de Mayo, at Buenos Aires city (modified from Bond, 2022); **4,** F. P. Moreno, in 1882 (modified from Moreno Terrero de Benites, 1988); **5,** Museo de La Plata, *ca.* 1890–1891 (modified from plate 1, Moreno, 1890–1891).

of Buenos Aires Province (under Governor Carlos Casares, 1830–1883), Moreno offered his collections as the basis for the *Museo Antropológico y Arqueológico de Buenos Aires* (Anthropological and Archaeological Museum of Buenos Aires), with the condition of him being appointed as its Director "in perpetuity" and that the collections should not be moved to another establishment. After a debate in the Buenos Aires Chamber of Deputies, and besides some objections, a group of deputies highlighted the importance of Moreno's collection, pointing out that it would be a shame if taken abroad, the project was approved and subsequently passed in the Senate. A Protective Society was organized for the new museum, covering the costs of moving the collections from the "*Edén de San Cristóbal*", renting a suitable place, exhibition shelves, and the doorkeeper's salary. Prominent figures, including Mitre and Sarmiento, contributed with money and donations of archaeological materials and fossils, such as a *Toxodon platensis* by Colonel Alvaro Barros (1827–1892), a prominent frontier chief (Bond, 2022). The law establishing the Museum was promulged on October 17, 1877, with Moreno as its Director (De Santis, 1977; Moreno Terrero de Benites, 1988). On August 1, 1878, *the Museo Antropológico y Arqueológico de Buenos Aires* opened to the public on the fourth floor of the old Teatro Colón (today, the Banco de la Nación Argentina - National Bank of Argentina) (Fig. 6.3), in front of the Plaza de Mayo, where with Moreno delivered a conference on "The study of South American Man".

In March 1879, President Avellaneda appointed Moreno to lead an expedition to Patagonia, which Moreno accepted, requesting the right to incorporate into his museum the materials collected (Ygobone, 1979; Fasano, 2002). That same year, his book "*Viaje a la Patagonia Austral, emprendido bajo los auspicios del gobierno nacional 1876–1877*" (Voyage to Southern Patagonia undertaken under the auspices of the national government 1876–1877) (Moreno, 1879) was published twice by the *Oficina de impresión de La Nación* (Nation Printing Office, Mitre's newspaper). The book aroused official interest, highlighting the southern region's great value, and the Executive branch acquired 500 copies for distribution (Fasano, 2002).

In October 1879, Moreno set out to Patagonia. The expedition faced difficulties from the beginning due to Moreno's disagreements with the ship provided and proposed route modifications, which the new Minister of the Interior, Benjamín Zorrilla (1840–1896), in replacement of Sarmiento, denied. While surveying the ship in Viedma, Moreno, and his companions disobeyed the instructions and went westward on a horse. That year, the traditional defensive strategy against the indigenous tribes had been replaced by an offensive one, relocating the southern border to the Río Negro as proposed by General Roca, Minister of War of President Avellaneda, in what became the "*Conquista del Desierto*". Unsurprisingly, this worried the indigenous groups, who became wary of intruders. So, when Moreno and his companions arrived at Nahuel Huapi, they were imprisoned by Chief Shaihueque. However, Moreno managed to escape, along with his companions, on a raft by the Collón Curá River, reaching an army fort on February 19, 1880.

Despite public acclamation upon the arrival of Moreno to Buenos Aires on March 11, 1880 (Fasano, 2002), Minister Zorrilla and other government members were dissatisfied with Moreno's behavior and called for his resignation. Although congratulated by President Avellaneda, in order to put an end to this problematic situation, Moreno resigned from the commission and, with the permission of Governor Carlos Tejedor (1817–1903), stepped down as the Director of the museum, Moreno traveled to Europe, arriving in Paris to attend university courses, particularly in Anthropology under Professor Broca. In May 1881, he was named a member of the French Geographic Society, receiving the Gold Medal highlighted in Buenos Aires newspapers such as the "La Nación". Moreno also visited London and its museums (Ygobone, 1979), making exchange agreements with European institutions (Barba, 1977). In June 1881, Moreno returned to Buenos Aires, finding a city profoundly changed by political events that occurred while Moreno was in France. Following Moreno's success in the 1879 expedition, General Roca became an optimate candidate to succeed President Avellaneda, with the approval of nearly all the provinces, Roca supported the project of making Buenos Aires the national capital. Against this project was Tejedor, Governor of Buenos Aires, who wanted to maintain the "*status quo*" of coexistence between national and provincial authorities in Buenos Aires, avoiding

its designation as the capital and the nationalization of revenue from the city's port. In April 1880, electors in nearly all provinces supported Roca, with only Buenos Aires and Corrientes supporting Tejedor. The confrontation became inevitable, and after intense fighting and numerous casualties, Buenos Aires and Corrientes were defeated, and Tejedor resigned as governor. In October 1880, Roca was proclaimed president and Buenos Aires was declared the republic's capital. As a result, Buenos Aires required a new capital. While this was under deliberation, Moreno and F. Ameghino, knowing each other, made a plan for a future museo nacional. Moreno expected that his political influences would be determinant in this project. In a letter to his brother Juan in October 1881, Florentino wrote that, with Moreno as Director, he would be in charge of the Paleontological Section of the new *Museo Nacional* and that J. Ameghino, his brother, would be hired as a preparator, confident that the congress would accept this project. He added sarcastically that the G. Burmeister's museo público would be abolished or relocated to the countryside. However, in July 1882, F. Ameghino informed J. Ameghino that the project had failed since the new Minister in charge, Eduardo Wilde (1844–1913), opposed it (Márquez Miranda, 1951). Consequently, G. Burmeister´s museo público was going to become a *Museo Nacional* and Moreno's museum would go to the countryside (the future La Plata city) (Torcelli, 1913–1935; Marquez Miranda, 1951; Podgorny, 2021).

Moreno's *Museo Antropológico y Arqueológico de Buenos Aires* continued in the old Teatro Colón while the location of the new provincial capital was pending. Despite future uncertainties and the lack of support from the new provincial authorities, Moreno's efforts secured donations from abroad (such as from the Paris Museum and British Museum) and locally (from the former museum of the Sociedad Científica Argentina). Then, Dr. Rocha, a former G. Burmeister's Paleontological Society member, became the Governor of Buenos Aires and initiated the construction of the new provincial capital, La Plata, officially founded on November 19, 1882.

During this period, Darwin died (April 1882) and the Argentine Darwinists prepared their homages. So, on May 19, 1882, the Medical Circle organized a "Carlos Roberto Darwin" conference at the Teatro Nacional (National Theater), attended by a large audience. Speakers included Sarmiento and Holmberg, Moreno's former antagonist with whom he had reconciled. Both conferences were interesting and provocative, with Holmberg criticizing G. Burmeister's work, and Sarmiento highlighting F. Ameghino as one of the few followers of Darwin in Argentina, also noting his work showing that humans in these lands were contemporary with the extinct fauna and were much older than previously assumed (Sarmiento, 2009; Holmberg, 1882). Additionally, after the invitation of the Argentine Geographical Institute to the "*Exposición Continental de Buenos Aires*" (Continental exhibition of Buenos Aires,1882), Ameghino gave a two-part conference on the "*La Edad de Piedra*" (The Stone Age), the second one being an homage to Darwin, advocating transformism as an exact science (Ameghino, 1882).

Following Darwin's homages, on July 15, 1882, sponsored by the Sociedad Científica Argentina, Moreno gave a conference entitled "*Patagonia. Resto de un antiguo continente hoy sumergido*" (Patagonia. Remains of an ancient continent today submerged), as a contribution to the collections of the *Museo Antropológico y Arqueológico de Buenos Aires*. The latter was done to highlight the significance of the materials exhibited and their importance in Patagonia's past natural history, noting that natural sciences were gaining prominence in the country. After discussing general points, Moreno proposed that available evidence suggested the southern region as a remnant of a vast, ancient continent, with Patagonia representing an early center of dispersion (Moreno, 1882; Windhausen, 1931; Riccardi, 2019). This dispersal pattern seen in living groups, such as the marsupials, supported the idea of a large southern continent that facilitated the dispersal of certain groups. He noted that Australia was among the first continental masses to separate from the southern continent, isolating those primitive groups, such as the marsupials. Moreno posited that in the Mesozoic and early Cenozoic, the Southern Hemisphere had more continental areas than the boreal ones, and part of South America, with the Brazilian massif, headed towards Southern Africa with other part communicating with Australia, as Antarctica would have splendid forests on its coasts. Moreno pointed out that except for a few mammals found in the Tertiary of

Patagonia, such as *Nesodon*, little was known about the Patagonian mammalian fauna, assumed precursor of the Quaternary Pampean fauna. Then, Moreno listed his findings concerning the fossil mammals in Santa Cruz (see Moreno, 1882; Bond, 2022), first the gigantic mammal skull and tusk, named by G. Burmeister (1879), *Astrapotherium patagonicum* (currently *A. magnum*). Upset by its unauthorized description (see Fernicola, 2011b), Moreno renamed it "*Mesembriotherium broca*" in honor of Professor Broca. However, he found its affinities uncertain as he recalled it as a pachyderm, a carnivore, or even a marsupial. Today, it is the first known cranium of an Astrapotheria (*Museo de La Plata*, MLP-PV 12-94), an extinct order of South American native ungulates (Lydekker, 1894c). In the same levels, Moreno collected a small marsupial named "*Palaeothentes aratae*" after his friend, Professor Pedro Arata (1849–1922), which corresponded to the Caenolestidae family. Moreno also discussed toxodontid remains, such as a *Nesodon*, which he and Lista found in Santa Cruz. In his Santa Cruz collecting site, Moreno also recovered small mammals, which he described as transitional between rodents and toxodonts, naming them "*Toxodontophanus australis*", *Interatherium rodens,* and "*Tembotherium holmbergi*", the latter in honor of his cousin "friend and colleague" Holmberg. These three species are currently recognized as *Protypotherium australe* for the first species nominated by Moreno and *Interatherium rodens* for the other two (Fernández & Muñoz, 2019; Fernández *et al.*, 2019). These were later studied by F. Ameghino, who represented the first recognized Interatheriidae remains, a group of small rodentiforms, Notoungulata.

Regarding the "Edentates" or xenarthrans, characteristic of South American Quaternary faunas, Moreno considered that although they had also been recorded in North America for Pliocene times, the accurate center of appearance would be the southern region. Among his findings in Santa Cruz was the glyptodont "*Hoplophorus australis*" (now *Paleohoplophorus australis*). All these fossil mammals indicated to Moreno that Patagonia was once a terrestrial center of development prior to the emergence or formation of the Pampas and that the last changes occurred as migrations through the Isthmus of Panama (probably also one of the first to recognize the Great American Biotic Interchange). He attributed the extinction of the Patagonian faunas to geological changes, volcanic eruptions, and glaciations. In conclusion, Moreno wrote that Patagonia, including Tierra del Fuego, were remnants of a Southern Continent, where the animals that still inhabit parts of South America, New Zealand, Tasmania, Australia, and Africa first appeared and evolved. He saw that the Southern Hemisphere was a zoogenic nucleus like the Old World and North America. For Moreno, the principal task of the *Sociedad Científica Argentina* was "*el conocimiento físico y moral de nuestro país, desde los tiempos geológicos más remotos, hasta nuestros días, y su relación con las demás regiones de la Tierra*" (the physical and moral knowledge of our country, from the oldest geological times, to the present day, and its relationship with the other regions of the Earth) (Moreno, 1882, p.131).

The remains found by Moreno in the Río Santa Cruz River from the Santa Cruz Formation (Miocene, 17–15 million years) made him the first national collector of these fossil-rich sediments, later exploited by C. Ameghino and numerous national and foreign collectors.

In 1884, the Museum of Buenos Aires was nationalized, and G. Burmeister became the Director of this new (at least in name) National Museum. In that same year, the provincial authorities of Buenos Aires moved to the new capital, La Plata. The collections of the *Museo Antropológico y Arqueológico de Buenos Aires* became the basis for a new provincial museum and were temporarily relocated to La Plata (Barba, 1977; De Santis, 1977). That year, Moreno was appointed Director of the *Museo de La Plata*, officially founded by provincial decree on September 17, 1884. The museum's construction began in October, with a partial official opening on July 20, 1885, and the new institution officially named *Museo de La Plata* (Fig. 6.5) (Moreno, 1890–1891) was inaugurated in 1887, with the presence of Sarmiento. Synthetically, regarding the mammalian paleontology in La Plata, Florentino Ameghino, invited by Moreno, left his post as a professor in Córdoba and was appointed as Vice-Director and Secretary in July 1886, with his brother Carlos as traveling naturalist. Carlos began his famous trips to Patagonia (two for the *Museo de La Plata*) and Monte Hermoso, collecting numerous fossil specimens in Santa Cruz. Although Moreno and Ameghino had a former

project of a museum in common, their partnership ended, and in February 1888, Florentino resigned due to his discrepancies with Moreno, beginning a long-standing feud with him. Carlos accompanied his brother and left his post during his second trip (Fernicola, 2011a, 2011b). Nonetheless, following Carlos' leaving, the remaining staff (Antonio Seinfeld and Eduardo Botello) continued collecting, this time in Chubut, obtaining fossil mammals and some notable dinosaur bones (von Huene, 1929). Subsequent expeditions provided more fossil specimens of mammals and birds.

In 1884, the taxidermist and preparator Antonio Pozzi was incorporated into the museum briefly (Laza, 2019). During this time, Moreno began a museum's journal, the "*Revista del Museo de La Plata*", published between 1890–1891 and featuring many works on paleontology by Moreno, Mercerat, and the forthcoming researchers incorporated into the paleontological section. After F. Ameghino's departure, the Swiss geologist Mercerat (Fig. 7.1) led the Paleontological Section in 1889 and became the Vice Director and Secretary of the *Museo de La Plata* (Ramos, 2023) in 1891. Mercerat conducted an expedition to Patagonia in 1892 but resigned his position in 1893, due to personal differences with Moreno, subsequently working as a land surveyor. Mercerat published different articles from 1891 to 1925, mainly in the *Revista del Museo de La Plata* and the *Anales del Museo Nacional de Buenos Aires*, covering fossil mammals, birds, and geological notes on Patagonia (Mercerat, 1893). His work on birds was written in collaboration with Moreno, and it was published in the first volume of the new Anales del *Museo de La Plata* (1891), inaugurating a "*Paleontología Argentina*" series. This contribution was entitled "*Catálogo de los pájaros fósiles de la República Argentina conservados en el Museo de La Plata*" (Catalogue of the fossil birds preserved at the *Museo de La Plata*) (Moreno & Mercerat, 1891), with a bilingual text (Spanish and French) and magnificent plates with drawings and photographs produced by the museum print. Mercerat's descriptions of new mammal genera and species based mainly on La Plata's fossil vertebrate collection were severely criticized by G. Burmeister, Ameghino, and finally, Kraglievich (see Reig, 1962; Bondesio, 1977). However, recent reevaluations of Mercerat's works have validated some of his species and ideas (*e.g.*, Kramarz & Bond, 2008).

In the meantime, with no paleontologist in charge, in October 1893, the British paleontologist, Richard Lydekker (1849–1915), a prominent figure of its time, arrived in La Plata, invited by Moreno. Lydekker would make a second visit from July to September 1894. His main goal was to review and write about the fossil vertebrate collections of the museum, ranging from dinosaurs to mammals. However, probably Moreno's invitation intended that Lydekker checked and corrected the identifications and descriptions of the genera and species made by Ameghino and accepted or rejected them and of other taxa described by other researchers (*e.g.,* Burmeister, Mercerat) (Bondesio, 1977). Lydekker's visit resulted in its "Contributions to a knowledge of the fossil vertebrates of Argentina" published in the *Anales del Museo de La Plata* as volumes 2 and 3 (1894) of the series "*Paleontología Argentina*". With bilingual text (Spanish and English), this work was printed at La Plata with high-quality plates depicting dinosaurs, cetaceans, ungulates, edentates, and carnivores. Despite the quality of the illustrations, the text contained errors, mainly taxonomic. It was severely censured by Ameghino (1894, 1895), who attributed some of Lydekker's mistakes to the short time the author spent writing this work (Bondesio, 1977). Ameghino wrote an extensive critique of Lydekker's work in an 1895 letter to his brother Carlos, stating that

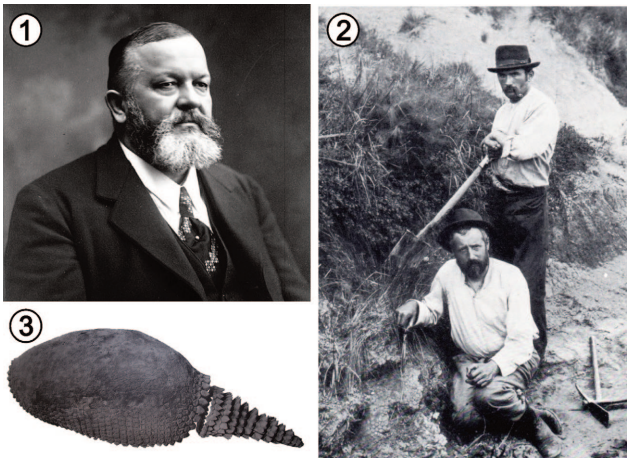

Figure 7. 1, Alcides Mercerat, chief of the Paleontology Section at the Museo de La Plata (modified from Ramos, 2023); **2,** Santiago Roth (kneeled) extracting a glyptodont, *ca.* 1890, near Pergamino (northeastern Buenos Aires Province) (modified from Weigelt, 1951); **3, *Glyptodon clavipes***, carapace and tail (modified from plate 1, Lydekker, 1894c).

"*Lydekker, como paleontólogo, ha sido arruinado por el Museo de La Plata*" (Lydekker, as a paleontologist, has been ruined by the La Plata Museum) (Reig, 1962, p.81). During his time in La Plata, Lydekker's most notable works were on the dinosaurs and cetaceans, but the exceptional quality of the plates merits a special mention. Lydekker himself wrote "The excellence of the photo-gravures with which the memoir is illustrated reflects the highest credit on the staff of the Museum, to whom the thanks of my readers and myself are due" (Lydekker, 1894a, Preface), underscoring the high printing standards of the *Museo de La Plata* at that time. Additionally, photographs of some materials and skeletons, in particular those of the glyptodonts, hold great documentary value, as many were later damaged or poorly reassembled (late 20th century), with Lydekker's plates capturing their original condition (Fig. 7.3). As Moreno's guest, Lydekker did not meet with Ameghino in La Plata, surely missing the opportunity of a profitable talk and specimen comparisons with Ameghino's personal collection. Lydekker felt that such a visit would offend Moreno, his host (Scott, 1939; Simpson, 1984; Soria, 2001). After his return to England, Lydekker (1896) published his classic work "A Geographical History of the Mammals", with a chapter on the "*Neogaeic*" (Neotropical) realm, with interesting comments, as well as drawings and photographs of fossil mammals from the *Museo de La Plata*. For those forms that Ameghino described as primitive, generalized ancestral mammals, such as the Microbiotheriidae, Lydekker correctly stated that they appeared to be "minute polyprotodont marsupials of an Australian type" (Lydekker, 1896, p. 109). Lydekker's visit revealed the importance that the *Museo de La Plata* and its collections, attained in a brief period, and the interest that it aroused in many illustrious foreign paleontologists. In addition to the other fossils, the *Museo de La Plata* collected the extraordinary mummified remains of the extinct ground sloth *Glossotherium* and other mammals from the "*Mylodon*'s Cave", making this collection one of the largest and most important in the world, being mainly collected by the German geologist Rudolph Hauthal (1854–1930), who worked for Moreno´s museum between the years 1892–1904 (see Pérez *et al.*, 2018).

In 1895, needing a qualified paleontologist, Moreno invited the Swiss Roth to become Head of the Paleontological Section of the *Museo de La Plata*, probably impressed by his skill as a fossil collector (Fig. 7.2) and his travels to Patagonia. Roth born in Herisau, Switzerland, became promptly interested in natural history collecting (Machon, 1925; Torres, 1927; Weigelt, 1951; Sánchez-Villagra *et al.*, 2023). He arrived in Argentina at age 16 and rapidly became a well-known and skillful collector, especially of Pleistocene Pampean mammal fossil remains, and for assembling and selling notable collections to European museums. One notable discovery was the "Pontimelos" or "Fontezuelas" fossil man in 1881, found near Arrecifes River (Argentina), consisting of a human skeleton beneath a glyptodont caparace, potentially suggesting the coexistence of early Americans and the extinct Quaternary Megafauna (Politis & Bonomo, 2011; Sánchez-Villagra *et al.*, 2023).

As head of the paleontological section in the *Museo de La Plata*, Roth became Carlos Ameghino's (1865–1936) antagonist as his rival collector of vertebrate fossils in Patagonia, where he found reptiles (*e.g.*, dinosaurs and turtles) and mammals from the Paleogene and from the Neogene (*e.g.*, Miocene, Collón-Curá beds). Roth supported the idea, based on the poorly known Patagonian stratigraphy, that some of the mammal-bearing beds of Patagonia were older (probably from the uppermost Cretaceous), an error later corrected, especially from the 1930s onward, due to the efforts of geologists and researchers like Simpson (Feruglio, 1949; Simpson, 1984; Bond & Deschamps, 2010). Roth described the new mammals he found in different scientific papers (1899–1903), mainly in the *Revista del Museo de La Plata*, often exchanging critiques with Florentino Ameghino. One remarkable paper (Roth, 1903) was devoted to the auditory region of South American native ungulates, where Roth recognized the order Notoungulata, grouping forms such as *Periphragnis* and *Toxodon*, and differentiating them from other South American groups such as the Litopterna, and discussing its relationships with other native ungulates (Roth, 1903). Roth's recognition of the Notoungulata as an independent order from the Holarctic ungulates ended a long debate on the relationships of these native ungulates, although Ameghino continued to place many notoungulates lineages within different Holarctic and African orders. A posthumous work by Roth (1927) on the mammalian

dentition, especially Southern ungulates, included a Spanish synopsis of Cope and Osborn's tritubercular theory, edited by Dr. Miguel Fernández (1882–1950), a recognized zoologist and also Roth's friend. A skilled expedition leader, Roth participated as a geologist in exploratory trips to Patagonia and, under Moreno's directives, in the Argentine commission surveying the border limits between Argentina and Chile (Riccardi, 2017). He also studied some fossils of the "*Mylodon* Cave", collected by Hauthal (Roth's son-in-law). An expert on Pleistocene pampean sediments, Roth (1921) wrote a classic work describing them. At the museum, he managed the display and the maintenance of the vertebrate fossil collections, making a descriptive catalog of some of the materials, such as those of the Toxodontia (Roth, 1898). His efforts led to the acquisition of exceptional specimens such as skeletons of *Toxodon*, *Macrauchenia*, several glyptodonts, and ground sloths, among other mammalian fossils. Roth cataloged the fossil vertebrate collection, and each taxonomic group was preceded by a general number, followed by specimen number; for example, the Ungulata had the collective number 12, so the skull type of *Astrapotherium patagonicum* (or "*Mesembriotherium brace*") had the collection number 12–94.

Then, in January 1906, the Museum was incorporated into the recently created *Universidad Nacional de La Plata* (National University of La Plata), with a *Facultad de Ciencias Naturales* (Faculty of Natural Sciences) and different departments, including a *Departmento de Ciencias Geológicas* (Department of Geological Sciences) directed by Roth, who became the first professor of paleontology and geology that same year.

This event deeply affected Moreno, who was proud of his creation, the *Museo de La Plata*, as an institution. In 1906, he resigned from his position as Director of the museum, and the Uruguayan archaeologist Samuel Alejandro Lafone Quevedo replaced him, holding the position until 1920. In the Departmento de Ciencias Geológicas, Roth also carried out important hydrogeological studies in different provinces under the commission of the *Museo de La Plata* (see Sánchez-Villagra *et al.*, 2023). Known for his kindness, who had once been a rival of Florentino Ameghino, later befriended him. Florentino even recognized Roth as one of the best experts on the Quaternary Pampean geology (Roth, 1921). When the Czech-north American anthropologist Alex Hrldička (1869–1943) visited Argentina in 1910 with other researchers to examine the controversial fossil human remains, Roth, along with the Ameghino brothers and Moreno, were among those who received and accompanied these foreign researchers to the sites (Hrldička *et al.*, 1912). With Roth's passing in 1924, the *Museo de La Plata* lost its principal reference on fossil vertebrates, particularly mammals. Although Roth's scientific production cannot be compared with that of Ameghino, some of his works, such as that on the auditory region of the South American native ungulates, deserve special recognition, as do his studies on the geology of the Collón Curá River, (Neuquén Province) and the Quaternary Pampean sediments.

In 1915, Dr. Eduardo Carette (?–1946) was incorporated as an Adjunct Professor in the Department of Geological Sciences under Roth, publishing two works on fossil mammals: a note on fossil mastodonts (Carette, 1919) and a study on fossil and actual Cervidae of South America (Carette, 1922). In 1911, Carette founded the *Asociación Argentina de Ciencias Naturales* (Argentine Association of Natural Sciences), which edited the scientific journal Physis, where many paleontological articles were published. From 1920 to 1932, the lawyer and archaeologist Dr. Luis María Torres (1878–1937) became the new Director of the *Museo de La Plata*. The prestigious German paleontologist Friedrich von Huene (1875–1969) was contracted to study the dinosaurs stored at the museum and undertook several trips to Patagonia (von Huene, 1929). Concerning the fossil mammals, following Roth's death, Torres hired the young and capable Argentine paleontologist Kraglievich, whose main task was to catalog the museum's fossil vertebrates Kraglievich incorporated new specimens in the catalog book using a new system of correlative numbering (Bondesio, 1977) based on the year, month, day, and specimen number, a system still used at the *Museo de La Plata* today. With the assistance of Antonio Castro, a museum preparator, Kraglievich catalogued over 10,000 specimens. Then, Kraglievich returned to the *Museo Nacional de Buenos Aires* (National Museum of Buenos Aires). Almost immediately after, Torres hired the prominent Spanish zoologist and paleontologist Cabrera Latorre, who arrived in La Plata in

1925, marking the beginning of a new epoch for Argentine vertebrate paleontology (see Reig, 1962; Bond, 2013). The *Museo de La Plata* stands as one of the foundational pillars of the Argentine vertebrate paleontology, along with G. Burmeister's museum in Buenos Aires.

After his resignation as Director of the *Museo de La Plata* in 1906, Moreno reconciled with his old rival Ameghino. Interested in the politics of helping impoverished children, he became a national deputy, advocating for educational reforms. In 1912, he promoted the government acquisition of the Ameghino collection as an invaluable patrimony for Argentine geology and paleontology. Moreno, using his income for schools and other causes, nearly losing all of his patrimony, eventually moved into a modest house in the city. Finally, on 22 November 1919, Moreno, the Argentine "*Perito*" (expert in geographical limits), the founder of the *Museo de La Plata*, died in a rented house in Buenos Aires (Ygobone, 1979; Teruggi, 1989; Fasano, 2002; Riccardi, 2019).

The journey had been long, from the private museum at the "*Edén de San Cristóbal*" to the *Museo Antropológico y Arqueológico de Buenos Aires* (Anthropological and Archaeological Museum of Buenos Aires) in the old Teatro Colón (Colón Theater), to the new *Museo de La Plata*, which in a short time gained international recognition. This legacy, despite past and present criticism (Podgorny, 1997), was undeniably the result of the iron will of one man, Francisco P. Moreno, the Argentine "*Perito*".

THE AMEGHINO BROTHERS: FLORENTINO AND CARLOS

No doubt in paleontology, the Ameghino brothers are Florentino (1853–1911), the elder and "sage" (Fig. 8.1), and the younger Carlos (1865–1936) (Fig. 8.2), the explorer and collector, who supported Florentino's endeavors for much of his life. Although involved with the two, their brother Juan (1859–1932) was almost exclusively involved within the business as administrator, mainly bookstores, that Florentino established to maintain his family and their scientific activities. The life of Florentino is well-known by the general public, as his scientific contributions are essential for paleontologists working with fossil vertebrates from the Tertiary and Quaternary of Argentina and South America. Florentino Ameghino was born in Moneglia, near Genova, Italy (then Kingdom of Sardinia and Piedmont), on September 19, 1853 (Paoli, 1960; Vanni *et al.*, 2018, Boscaini *et al.*, 2021). He arrived with his family in Luján, Buenos Aires Province, in 1854. Florentino developed his scientific career in Argentina, where he undoubtedly became a true Argentine sage. Following his studies, Florentino became a young preceptor in Mercedes, near Luján, along the Luján River. Like the Arroyo Frías, its ravines and streams were rich in fossil mammal bones, sparking Ameghino's interest in natural history and leading him to collect fossils and archaeological artifacts. Ameghino's deep knowledge of the stratigraphy of the area led him, in 1870, to discover two human skeletons in the Pleistocene layers of the Arroyo Frías, seemingly contemporaneous with extinct Quaternary fauna (Politis & Bonomo, 2011; Toledo, 2016). Ameghino enthusiastically presented these fossils to G. Burmeister at the Public Museum of Buenos Aires. However, G. Burmeister rapidly dismissed the remains, probably rudely, doubting the reliability of the finding. Ameghino felt disappointed, being this situation the genesis of his long-standing feud with G. Burmeister (see Burmeister, 1883–1892; Márquez Miranda, 1951; Podgorny, 2021; Toledo, 2022). Although the origin and the antiquity of the human species were one of the primary interests Ameghino, the new vertebrate fossils from the Miocene of Paraná collected by his friend Professor P. Scalabrini and those later collected by Carlos in Patagonia dominated his time. However, in his final years, Ameghino once again devoted his time to the study of the human fossil in South America, this way, closing the cycle. In 1875, in one of his first publications, Ameghino made a note on the Frías human fossil in France (Casinos, 2012) and, in 1877, once settled in Mercedes, Buenos Aires Province, wrote about the archaeological artifacts from Uruguay. He even pioneered photographic plates in these works, as G. Burmeister had done (Toledo, 2022). Ameghino also sent an essay on the Pampean Formation to the Sociedad Científica Argentina for a scientific contest, but it was rejected by Moreno, who disagreed with Ameghino's ideas. Although his findings on fossil humans were controversial, they garnered international interest, with the American Naturalist (1878) and European anthropologists, like Broca, examining the Frías fossils. In 1879, Florentino Ameghino traveled to France

with several important paleontological and archaeological collections to participate in the Paris Universal Exposition. There, Ameghino stayed for three years, displaying intense activity, visiting archaeological and paleontological sites, and establishing connections with important scientists (Márquez Miranda, 1951; Casinos, 2012; Podgorny, 2021). During this period, he published an article on fossil mammals of Argentina with the naturalist Henri Gervais (1845–1915), others on the human remains found by Seguin in Argentina, and archaeological instruments of France. In Paris, he married a French lady, Leontine Poirier (Toledo, 2021a). To support himself, Ameghino sold part of his collection to different people, including the prominent and wealthy North American paleontologist Edward Drinker Cope (1840–1897). He also acquired flint tools, mainly, from the Chellean industry. In Paris, he published the book "*La antiguedad del hombre en el Plata*" (Ameghino,1880) on the antiquity of humans in the River Plate area, a classic on the theme not only for specialists, but also for the general public, with several reprints in Argentina. Returning to Buenos Aires in 1881, Ameghino was informed that he had lost his teaching position in Mercedes, so he sought new income sources to maintain his family. He even produced a stenographical system, "*Taquigrafía Ameghino*", and a new cleaning product, but both were unsuccessful. As mentioned above, in 1880, Ameghino and Moreno intended to create a new National Museum. Hoping to garner government support for a national museum, Ameghino offered a donation of 4,000 pieces from his collection (of around 15,000 archaeological and paleontological pieces) to Manuel Pizarro, the minister in charge of the project. However, this project failed due to the lack of interest of the new minister, Eduardo Wilde.

In 1882, Ameghino opened a bookstore, "*Librería Glyptodon*" (Glyptodon Bookstore), on Piedras Street, later relocating it to Rivadavia (now Avenue) (Mercante, 1911; Márquez Miranda, 1951: Rusconi, 1962, 1965; Simpson, 1984: Casinos, 2012; Podgorny, 2021). He continued collecting fossils, writing to his brother Juan in July 1882 that his house was a gathering place for naturalists from the La Plata region, receiving fossils from all parts of the Republic that he scarcely had time to sort (Casinos, 2012; Podgorny, 2021).

In 1883, President Roca sent Ameghino the first dinosaur fossils discovered in Argentina, collected by the national army in Neuquén Province (Coria & Salgado, 2000), a testament to Ameghino's prominence in Argentine society. The same year, Ameghino began studying Miocene vertebrate fossils from Paraná, which was sent by professor and naturalist Pedro Scalabrini, who was actively collecting fossils to reactivate the Paraná Museum. From 1883 to 1886, Ameghino described the fossil mammals of Paraná in the *Boletín de la Academia de Córdoba* at the suggestion of

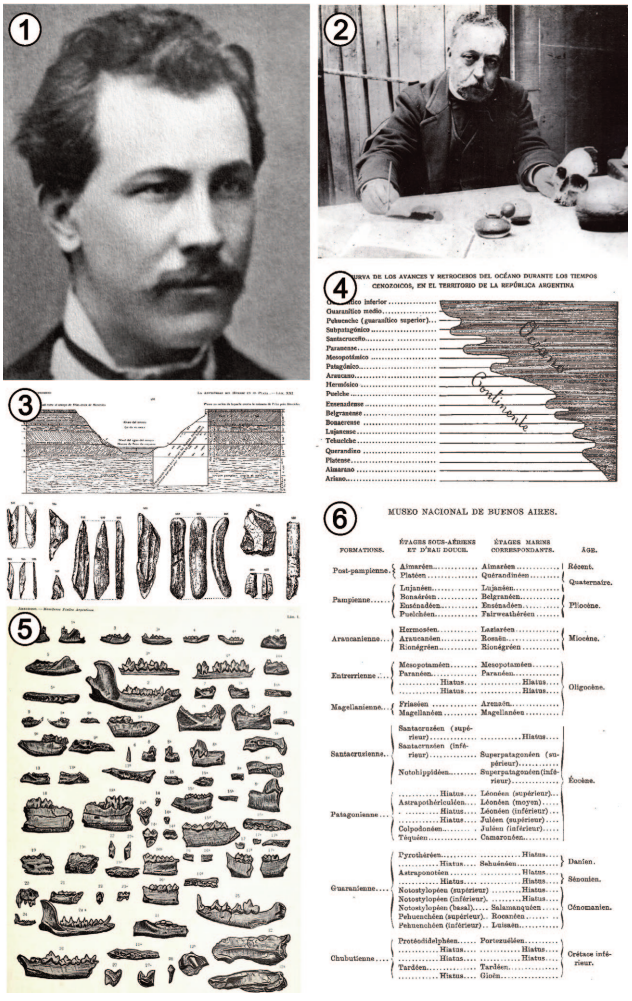

Figure 8. 1, Florentino Ameghino, *ca.* 1878 in Mercedes (modified from Orquera, 1970); **2,** Carlos Ameghino photograph from the personal collection of M. Bond; **3,** Stratigraphic profile of the Frías rivulet, fossil bones and supposed instruments made by fossil men taken from plate 21 (Ameghino, 1880) but modified from Ameghino (1918); **4,** Changes in sea levels during the Cenozoic in the Argentine Republic (Ameghino, 1889; modified from the original figure published in page 42); **5,** plate 1 modified from Ameghino (1889); **6,** The Étages of Ameghino with the equivalence of the terrestrial (subaerial or freshwater) with the marine ones (modified from original Tableau Sypnotique in page 498, Ameghino, 1906).

the Doering brothers. Among other works, some of them published in foreign journals, Ameghino (1884) published "*Filogenia*" ("Philogeny"), mainly aided by his friend Zeballos (Casinos, 2012). In the same year, he also published "*Las secas y las inundaciones en la provincia de Buenos Aires*" (The droughts and inundations in Buenos Aires Province), proposing solutions for a recurrent and cyclical problem that, despite official reprints, were never implemented. Ameghino went to Córdoba, accepting the Doering brothers' offer to lead a new anthropological and paleontological museum at the *Facultad de Ciencias Físicas y Matemáticas* (Faculty of Physic Sciences and Mathematics) at the *Universidad Nacional de Córdoba* (National University in Córdoba). Appointed professor of Zoology and an active member of the Academy of Sciences in Córdoba, he joined a failed expedition to Chaco in 1885, led by E. Holmberg and joined by C. Ameghino and, among others, the German botanist Federico Kurtz. Despite his stable friendship with Holmberg, Florentino returned early due to conflicts with him. In 1886, Moreno, Director of the provincial *Museo de La Plata*, offered him a position as Vice-Director and Secretary of the museum and Carlos as a paleontological preparator. In May 1866, Florentino resigned as a professor in Córdoba, having been awarded an honorary doctorate by the Facultad de Córdoba (Márquez Miranda, 1951; Casinos, 2012; Podgorny, 2021).

F. Ameghino arrived in La Plata, bringing part of his collection (archaeological and paleontological) and deposited it in the museum. In a well-known account, a conflict with Moreno erupted in December 1887, resulting in Florentino's resignation post and Carlos' dismissal (Fernicola, 2011a, 2011b). With his family established at La Plata, this left Ameghino in a challenging situation. However, he received support from friends, such as O. Doering, who offered to publish his works in the *Academia Nacional de Ciencias* in Córdoba. In 1887, Ameghino finished a work on Toxodontia that was intended to begin the paleontological contributions of the *Museo de La Plata*, edited by the museum. However, due to the Moreno-Ameghino conflict, it was not officially distributed until 1936, with only a few copies circulating privately.

Despite these obstacles, Florentino began to privately publish the results of the campaigns made by Carlos in Patagonia and Monte Hermoso (1887–1888), marking the beginning of the extraordinary association of the Ameghino brothers, Carlos as the field collector and keen observer, and Florentino as the fossil describer and geological interpreter (Simpson, 1948, 1984). Florentino also had the idea of synthesizing all Argentina's fossil mammals in a monumental work accompanied by an illustrated Atlas with numerous plates and figures. He aimed to present it at the 1889 Paris International Exhibition. However, he could not officially manage funds for his monumental project without his position at the *Museo de La Plata*. Once again, his good friends, the Doering brothers appeared and used their contacts to secure official support for publishing this work. This fundamental contribution to Argentine and South American paleontology, "*Contribución al conocimiento de los mamíferos fósiles de la República Argentina*" (Contribution to the knowledge of fossil mammals of the Argentine Republic), was published in 1889 as volume 6 of the *Actas de la Academia Nacional de de Ciencias en Córdoba* and was on time for the Paris Exposition.

As mentioned above, to support his family and finance Carlos's collecting campaigns in Patagonia, Florentino had a bookstore in Buenos Aires and later opened a new one named "Rivadavia", on 60th street, n° 793 in La Plata (Rusconi, 1962). The income from these libraries and some properties he owned funded all these tasks. Some fossils from his private collection were occasionally sold to foreign museums to recuperate money spent on their research. The money obtained from these sales was not used to increase Ameghino's wealth but to support his livelihood, fund new expeditions, and publish the findings. Carlos collected hundreds of specimens during his first voyage to Patagonia (Santa Cruz Province) and Monte Hermoso (Buenos Aires Province) as a collector for the *Museo de La Plata* in 1887–1888. On a second trip to Patagonia (Chubut), in 1888–1889, Carlos was accompanied by Steinfeld and Botello. Due to the conflict between Florentino and Moreno, Carlos was dismissed, but he retained some of the fossil specimens collected, which he gave to Florentino. As a result of these expeditions, Florentino described nearly 100 new mammal species from the Patagonian Tertiary terrestrial beds, currently recognized as the Santacrucian Miocene beds and the pre-Pampean or pre-Quaternary

beds of Monte Hermoso (Montehermosan, Pliocene). Previously, only about a dozen genera of fossil mammals were known from the Patagonian Tertiary. In their constant collaboration, Carlos collected specimens, and Florentino described them, although Carlos' letters from the field often contained accurate observations on the new taxa that Florentino did not always accept (*e.g.*, the avian nature of the *Phorusracus* mandible, initially attributed to an edentate by Florentino, or the marsupial nature of the *Argyrolagus* mandible that Florentino believed to be an early lagomorph) (see Bond, 2000). Carlos authored only a few papers on Patagonian geology. However, as a keen observer, he recognized during his first trip in 1887 that the rich mammal-bearing beds (currently identified as Santacrucian) were distinct and not mixed with the marine beds of the so-called Patagonian Formation. Although their exact stratigraphic position was unclear, in some places, appearing to overlap and in others to underlie the marine beds (Ameghino, 1889).

Additionally, recognizing the mammal-bearing beds as distinct from the marine ones of the then Patagonian (the latter also divided into different formations) provided the basis for distinguishing the Santa Cruz Formation as a separate terrestrial unit. Florentino recognized biochronological units characterized by their fossil mammals, which represented a time or "*Étage*", sometimes named after a characteristic fossil mammal, within larger sedimentary units known as "Formations". These "*Étages*" were later widely recognized as the "South American Land Mammal Ages" (or SALMAs), inspired by, but distinct from, the North American Land Mammal Ages (Pascual *et al.*, 1965; Simpson, 1971; Cione & Tonni, 1985). Beyond names and concepts, the development of our chronological scale for the Cenozoic (Paleogene and Neogene) of Argentina, which was later extended to South America, is the result of the pioneering work of the Ameghino brothers (Kraglievich, 1930; Simpson, 1948, 1984). During his second to sixth trips (1888–1893), Carlos recognized the new "*Étages*" ("*Notohippidén*" and "*Astrapothericuléen*") related to the Santacrucian and Patagonian "Formations", but older (see Pasotti, 1956).

With Carlos collecting in Patagonia and sending his findings, Florentino engaged in extensive research; his "*Contribución...*" (Ameghino, 1889) was awarded a prestigious Gold Medal in the Universal Exposition in Paris that year (it also earned recognition at the Chicago Exposition in 1892). Additionally, he founded a new scientific journal, the *Revista Argentina de Historia Natural*, which featured many articles by Ameghino himself and by Holmberg and Zeballos, among other collaborators. However, the journal published only one volume in 1891, and it had an adverse impact on Ameghino's finances. In 1892, following the accident and subsequent death of G. Burmeister, C. Berg was elected Director of the *Museo Nacional de Buenos Aires*, frustrating Ameghino's intention to become G. Burmeister's successor (Casinos, 2012). Between 1894 and 1895, Carlos made his seventh and eighth Patagonian expeditions, during which he discovered fossil vertebrates in beds beneath the Patagonian marine layers in the Deseado area (Santa Cruz Province). This fauna was older than the Santacruzian, *Astrapothericuléen,* and *Notohippidéen* faunas. These new beds contained rare and curious mammals, including complete remains of a strange form named by Florentino as *Pyrotherium*, previously known only by isolated teeth. Florentino named these new beds the "*Étage Pyrotheréen Étage*" (currently known as the Deseadan SALMA; Oligocene) (Ameghino, 1895, 1897). For Ameghino, the most important aspect was that these fossils came from levels of the "Formation Guaranienne", believed to be, at that time, Uppermost Cretaceous or Lowermost Tertiary. These discoveries drew considerable attention from international scientific circles and museums, awakening the interest in Patagonian fossil vertebrates (see Simpson, 1948, 1984). This interest led the skilled North American collector John Bell Hatcher (1861–1904) to make three expeditions to Patagonia (1896–1898), collecting fossils for Princeton University (Simpson, 1984). Hatcher did not agree with Ameghino's interpretations of the great ages of the formations, and although their relationships were not always in good terms, Ameghino respected Hatcher's fieldwork. Hatcher visited Carlos in Santa Cruz, and Florentino at his house in La Plata, requesting details about the fossil sites. However, Ameghino did not give him precise information, telling von Ihering in an 1897 letter, "*Si quieren materiales que los busquen*". (If they want materials, they have to look for them) (Casinos, 2012, p. 260). In those years, Ameghino sold to the British Museum a large collection of the gigantic

Phorusrhacidae birds, making also arrangements with the Museum of Munich and the German paleontologist Karl A. von Zittel (1839–1904), selling to this institution, fossils from Patagonia (Zittel, 1925). However, much of the collection was later destroyed during World War II.

Florentino displayed a prolific scientific, educational, and philosophical career during this time. In 1897, he was named professor of Geology and Mineralogy at the *Facultad de Ciencias Físicas y Matemáticas* (Faculty of Physical and Mathematical Sciences) in La Plata. He was elected Academic Member of the provincial University. His numerous works, published in the *Boletín de la Academia de Ciencias de Córdoba*, *Anales de la Sociedad Científica Argentina*, *Anales del Museo Nacional de Buenos Aires*, and other foreign journals, reflect his enormous productivity and the wide scope of his research.

In 1898, Carlos made his ninth expedition. He began collecting in the "*Gran Barranca*" (Great Barranca) at Lago Colhué-Huapí in central Chubut Province, one of the most renowned sites in Patagonia, where a notable rich succession of "*Étages*" were distinguished (Simpson, 1948, 1984; Madden *et al.*, 2010). This area was also exploited by the French collector André Tournouër (1871–1929), who worked in Patagonia from 1898 to 1903. Tournouër had a friendly relationship with Carlos and Florentino, and he sent his collection to the Museum of Paris, where some specimens were studied by the French paleontologist Jean Albert Gaudry (1827–1908) and published in different contributions (Simpson, 1948, 1967, 1984). On his tenth journey (1898–1899), Carlos wrote to Florentino that he could identify a lower mammalian fauna at Colhué-Huapi, representing a new and more ancient "*Étage*" below the "*Pyrotheréen*", which Florentino subsequently named the "*Notostylopéen*" after the characteristic notoungulate genus *Notostylops* (Ameghino, 1900–1902, 1906; Simpson, 1948, 1984). This new level (the Casamayoran, Vacan and Barrancan, SALMA; Eocene), more ancient than the "*Pyrotheréen*" was undoubtedly considered by F. Ameghino Cretaceous (Cenomanian) in age, since in those beds Carlos found serrated reptilian teeth resembling those of theropod dinosaurs, reinforcing Florentino's idea about the age of these beds and the contemporaneity of its mammals with the dinosaurs (see Ameghino, 1906). Ameghino observed that the new mammals described from these beds, supposedly Cretaceous, were more complex and derived than the Cretaceous mammals known by then from North America. This indicated that southern faunas were more advanced than the northern ones and that Patagonia might have been a center of origin for mammalian orders on other continents. However, after Florentino and Carlos's deaths, the supposed dinosaurian teeth, which had supported the Cretaceous dating of the "*Notostylopéen*" (or Casamayoran), were later demonstrated to belong to the peculiar extinct Tertiary Sebecidae crocodiles, whose teeth resembled those of theropods (see Colbert, 1946; Bond, 2000). Almost simultaneously, S. Roth of the *Museo de La Plata* collected mammals in beds near others with dinosaurs, but the exact position of these was unclear, so Roth labeled many collected mammals as coming from the Upper Cretaceous from the "Musters", which was the Colhué Huapi Lake. Roth intentionally misidentified the lake to prevent Carlos from collecting in the same places, which did not work (see Simpson, 1967; Bond & Deschamps, 2010).

In his last expeditions to Patagonia (1900–1903), Carlos collected fossils that allowed Florentino to recognize two new mammalian faunas, the "*Colpodonéen*" and the "*Astraponotéen*" "*Étages*", currently recognized as the Colhuehuapian (Oligocene–Miocene) and Mustersan (Uppermost Eocene) SALMAs. In 1901, the renowned North American paleontologist William Berryman Scott (1858–1947) visited Florentino Ameghino (Scott, 1939) in La Plata, studying and photographing his fossil collection, which was by then stored at his house (see Simpson, 1984; Vizcaíno *et al.*, 2017). Scott also visited the La Plata and Buenos Aires museums. He studied many of the fossil mammals collected by Hatcher in a series of magnificent volumes published between 1903 to 1932 and in his book "A History of land mammals in the Western Hemisphere" (Scott, 1913, 1937). Scott's visit and comments on his relationship with Ameghino (Scott, 1939) illustrated the high regard Ameghino had earned nationally and internationally (see Casinos, 2012).

In 1902, Florentino was appointed Director of the *Museo Nacional de Buenos Aires* and designated Carlos as a traveling naturalist. In 1903, Florentino made his final trip to Patagonia, but now on behalf of the Museum of Buenos

Aires (see Simpson, 1948, 1984). Florentino made his first and only trip to Patagonia as a warm and fraternal action, where both brothers visited some of the main collecting places.

As Director of the *Museo Nacional de Buenos Aires*, Florentino continued publishing his significant studies, especially in the *Anales del Museo Nacional de Buenos Aires*, on diverse topics, such as fossil penguins, tarsal morphology of fossil mammals, molar morphology of the fossil ungulates ("*Recherhes de morphologie phylogenetique...*"; Ameghino, 1904), as well as the magnificent synthesis on Patagonian geology and its fossil faunas, "*Les Formations Sédimentaires du Crétacé Superieur et du Tertiaire de Patagonie...*" (Ameghino, 1906). At the museum, Ameghino hired the preparator Santiago Pozzi (1849–1929) (Laza, 2019) and, in 1903, designated the Argentine anthropologist Juan Bautista Ambrosetti (1865–1917) as chief of the archaeological section. Ambrosetti, son-in-law of Ameghino's friend Holmberg, Ameghino's friend, had worked on paleontology in Entre Ríos Province with Scalabrini. He became the director of the new Ethnographical Museum of Buenos Aires in 1906, which housed some pieces of Ameghino's archaeological collection. That same year, Florentino was designated professor of Geology and an academic of the *Facultad del Museo* de *la Universidad Nacional de La Plata* (Casinos, 2012; Podgorny, 2021). He also advocated for a new building for the old museum, which was still at the "*Manzana de las Luces*" and only obtaining some rented properties to expand the space.

In 1908, Florentino made several trips to the Atlantic coast of Buenos Aires, near Mar del Plata and Chapadmalal, and published a work describing the geology of the cliffs and the fossil fauna. He recognized as new geological horizon, called "Chapalmalense" (Ameghino, 1909), currently the Chapadmalal Formation. Although Ameghino's "Chapalmalense" included additional horizons now recognized as Barrancalobian and others of Lower Pleistocene age (Cione *et al.*, 2015), he correctly inferred that the Chapadmalal sediments differed from those at Monte Hermoso and lay between that horizon and the Pampean beds (Pliocene and Pleistocene).

In the last years, before his death in 1911, Ameghino revisited his early interest in the study of fossil humans. As Simpson (1948) wrote, Florentino's first works from 1875 to 1882 and the latest from 1907 to 1911 were mainly on fossil man, its artifacts, and the stratigraphy related to its antiquity, being the intermediate period from 1883 to 1906, dedicated to the study of the Cenozoic fossil mammals. The impact of his paleoanthropological findings was significant: his discoveries, such as the atlas from Monte Hermoso and the fossils like *Diprothomo*, raised interest, resulting in over 150 papers by Ameghino and other researchers from 1900 to 1932 (Castellanos, 1937). In 1910, the Czech-American anthropologist Aleš Hrdlička from the Smithsonian Institution visited Argentina with some collaborators to examine the reputed fossil human remains found here, some attributed by Ameghino to the Tertiary and Quaternary. They were received by Moreno, Roth, Florentino and Carlos Ameghino. Disagreeing with Ameghino's theories of a South American origin for humans, Hrdlička supported the Asiatic origin, via Beringia, of the early American indigenous people. After their work, they concluded that the fossils examined showed no substantial differences from contemporary indigenous tribes living in South America (Hrdlička *et al.*, 1912). This outcome challenged Ameghino's theories on human antiquity and evolutionary origins. Nonetheless, later research verified that some discoveries, such as the Frías skeleton, were from the Late Pleistocene, though not as ancient as Ameghino had originally proposed (see Politis & Bonomo, 2011). Additionally, Ameghino's hypothesis that human evolution could have originated from fossil primates like *Homunculus* from Patagonia, which were later confirmed as platyrrhine primates, was also refuted.

AMEGHINO AND ITS AFTERMATH

Florentino Ameghino died in La Plata on August 6, 1911, and his Civic Funeral was on September 18. He was honored by the principal personalities of that time, including the French socialist politician Jean Jaurés (1859–1914), who was visiting Argentina and had planned to visit the Paleontological Section of the *Museo de La Plata* (Torcelli, 1913–1935; Casinos, 2012). This tribute shows the remarkable impact of Florentino Ameghino.

Despite criticisms surrounding Florentino Ameghino, his legacy remains extraordinary, as much of his scientific

work has established him as an essential pillar of Argentine paleontology. Between 1875 and 1911, he wrote at least 181 articles, among monographic and other unpublished works (see Torcelli, 1913–1935; Mercante, 1911), F. Ameghino's contributions are noteworthy, including his description of many new vertebrate fossil taxa, mainly mammals, and his observations on the stratigraphy and geochronology of Argentina. Although F. Ameghino made mistakes in some descriptions and/or interpretations (as Simpson, 1984, p. 93, said "as who does not?"), such as the case of *Arhinolemur* from the Miocene of Paraná, the first lemuriform primate, then as a transitional form between reptiles and mammals (Ameghino, 1898, 1899), and later recognized as a fish. This is the reason why Ameghino omitted any other ulterior mention on this "extraordinary and intermediate" fossil (see Simpson, 1945; Bogan *et al.*, 2012). This curious example reflects Ameghino's occasional tendency to prioritize his phylogenetic interpretations. Despite his keen observational skills, Ameghino was not an anatomist expert like G. Burmeister.

Any paleontologist working on South American Tertiary and Quaternary geology and paleontology has undoubtedly read Florentino's works, as they provide indispensable insights. Ameghino's contributions hold scientific and historical value. If we have to choose just a few of his significant scientific production in order to illustrate his influence in our discipline, from a personal point of view, I would select the following: "*La antiguedad del Hombre en el Plata*" (Ameghino, 1880); "*Filogenia*" (Ameghino, 1884); "*Contribución al conocimiento de los Mamíferos Fósiles de la República Argentina*" (Ameghino, 1889); "*Recherches de Morphologie Phylogénétique sur les molaires supérieures des Ongulés*" (Ameghino, 1904); and "*Les formations sédimentaires du crétacé supérieur et du tertiaire de Patagonie avec un paralléle entre leurs faunes mammalogiques et celles de l'ancien continent*" (Ameghino, 1906).

The first, "*La Antigüedad del hombre en el Plata*" (The Antiquity of Man in the Plata), published in Spanish and edited in Paris and Buenos Aires in 1884, presents an early synthesis of his paleoanthropological studies dating back to 1875. In the prologue, F. Ameghino stated his aim: to demonstrate that humans coexisted with the extinct giant fauna in the Argentine Pampas, such as the megaterids and others. He also acknowledged the contributions of those interested in the antiquities of our territory, including Zeballos and Moreno and his *Museo Antropológico y Arqueológico de Buenos Aires*.

After an introduction and discussion on different chronological, anthropological, and historical aspects of the pre-Columbian civilizations, showing that he had consulted a wide range of bibliography on the topic and engaged with ideas of ancient connections between different civilizations, as the Maya and the Egyptians, among others, as well as theories of lost land connections/bridges. He also discussed the Quaternary Pampean Formation and its genesis, providing an excellent synthesis of these ideas (*e.g.*, Bravard and Burmeister). He acknowledged G. Burmeister's accuracy in his idea of the Pampean beds' mixed origin (fluvial and eolian), aligning with his opinion. Then, Ameghino reviewed what was known about fossil humans in Argentina then, describing his findings in different places in the vicinities of Luján and Mercedes, including the Arroyo Frías fossil human site. He provided its stratigraphy, the fossil faunal remains found in those sites, including purported human-made tools and worked bones (Toledo, 2021b). The book is illustrated with fascinating plates (Fig. 8.3), with many figures depicting the instruments and fossil bones with marks attributed by Ameghino to the action of ancient man. With all justice, this work can be considered an invaluable source of information and a landmark in the history of Argentine archaeology and paleoanthropology. While some of Ameghino's conclusions were later proven incorrect, the confirmation of the Late Pleistocene age of the Frías fossil human and the rediscovery of artifacts and marked bones, originally studied and illustrated by Ameghino (Toledo, 2021b; Simón *et al.*, 2023) brought renewed interest and value to "*Antiguedad*" (see Toledo, 2011, 2016; Casinos, 2012; Podgorny, 2021; Simón *et al.*, 2023). Upon its publication, this highly readable book found success among specialists and the general public, posteriorly reimpressed in popular editions, as the 1918 reprint by "*La Cultura Argentina*". This reflects the general cultural interest in Argentina's ancient human, their origins, and the antiquities of America.

The second work chosen, "*Filogenia. Principios de Clasificación Transformista basados sobre Leyes Naturales y*

Proporciones Matemáticas" (Phylogeny. Principles of a transformist classification based on natural laws and mathematical proportions), was published in Buenos Aires in 1884, with an important financial support of his friend Zeballos (see Casinos, 2012). Its title reflects its content. Undoubtedly, Ameghino's main work explains the conceptual and theoretical principles he used in the morphological and taxonomical analyses of mammalian relationships. In the prologue, Ameghino discussed extinct ungulates, such as *Toxodon* and *Typotherium,* noting the difficulty of including them within existing classifications due to their unique characteristics and the inadequacies of prior classificatory systems. He aimed to apply a new methodology he named "mathematical zoology", to achieve an objective classification of the living beings. Conscious of the challenge, Ameghino stated that his critics would probably disqualify him as a madman. In "*Filogenia*", Ameghino also included his 1882 conference, "*La Edad de la Piedra*", where he paid tribute to Darwin by describing transformism as an exact science. The proposed new methodology, based on mathematical principles, was intended to establish a non-subjective classification, as Ameghino believed that since the apparition of Darwinism and the evolutionary theory in biological sciences, a new zoological classification was necessary. Throughout the book, different methods and principles were described, showing how some of them, such as the number of teeth and/or the reduction of digits, would provide an exact method to classify the taxa, understanding their relationships with other forms. Despite Ameghino's idea that the book would impact taxonomy and phylogeny, it had no effect in contemporary taxonomical studies except in Ameghino's works (Simpson, 1984). In a good analysis of "*Filogenia*", Casinos (2012) showed Haeckel's influence, notably in the trees that Ameghino used in his later works. However, it may be an exaggeration to interpret Ameghino's phylogenetic schemes as precursors to cladistics. On the other hand, Soria (2001) argued that in "*Filogenia*", Ameghino proposed a methodology for genealogical classifications and consider him a pioneer in evolutionary systematics. Soria (2001) also commented that Ameghino, in his seriation method, ordered the groups in a presumed evolutionary succession, suggesting the idea that unknown intermediate forms could be predicted with mathematical precision, despite the inherent difficulties. In his study of horse evolution, Ameghino recognized at least 41 intermediate stages between the earliest forms and the modern genus. In human evolution, Ameghino recognized some theoretical intermediate forms, such as *Diprotohomo* and *Tetraprothomo*, which he will later claim to discover and describe (Hrldička *et al.*, 1912; Casinos, 2012). Not less important, in "*Filogenia*", Ameghino developed a curious concept determinant in his ideas on the classification and evolution of the mammalian orders. In the first chapter, "Imperfections and deficiencies of the actual classifications", Ameghino wrote, that despite the accepted the idea of classifying living mammals into three groups characterized by their reproductive system (the "ornitodelfos" or monotremes; the "didelfos", metatherians or marsupials; and "monodelfos" or eutherians), that the marsupial stage of the didelfians should not be considered an "independent natural group", but rather a stage in the reproductive development. Ameghino supported this rejection also by stating that the "monodelfians" or eutherians had "extreme modifications" of primitive "didelfians" types, grouping animals, such as tigers, lions, and dogs, along with the *Thylacine* (marsupial wolf) and dasyures. This idea of phylogenetic links between metatherians and eutherians, with one ancestral to the other, is unique and distinctive of Florentino Ameghino's evolutionary and classificatory schemes (Simpson, 1984), as at that time marsupials were sometimes considered derived from eutherians, rather than ancestral to them. "*Filogenia*" is a book on evolution and it was unusual for the Argentine society of that time, suggesting there were people interested in this topic (despite Simpson, 1984). Its publication was noted in leading newspapers, including an extensive and enthusiastic article by Bartolomé Mitre in "La Nación". Holmberg (1884) critiqued Ameghino's "*Filogenia*", discussing if mathematics was a proper method to apply in taxonomy, disapproving Ameghino's rejection of all previous classificatory systems, while acknowledging some aspects of Ameghino's ideas (Holmberg, 1884; Podgorny, 2021). The importance of "*Filogenia*" to Ameghino can be seen in a letter he wrote to the Minister Wilde, reporting the book's publication and mentioning that it

would keep "*bien alto el nombre científico de la República Argentina*" (very high the scientific name of the Argentine Republic) (Márquez Miranda, 1951, p. 254). He also complained about the high cost of the edition and suggested that government support might be secured through a subscription. From many points of view, this theoretical book is outstanding; probably not as accessible to the general public as the "*Antigüedad...*", "*Filogenia*" which had many reeditions in different editorial houses, showing the interest in this curious "evolutionary or transformist book".

The third work, "*Contribución al conocimiento de los mamíferos fósiles de la República Argentina*" (Ameghino, 1889), appeared as volume VI of the *Actas de la Academia Nacional de Ciencias de Córdoba*, printed on May 20, 1889, with Peuser (Buenos Aires) and Masson (Paris) as editors. It was written in nearly 18 months and supported by official funding; it was awarded a gold medal at the 1889 Universal Exposition in Paris. The prologue acknowledged numerous individuals who positively contributed to the book pointing to F. P. Moreno as someone who made all efforts against its publication. Given the conflict between Moreno and Ameghino, a series of letters and documents regarding this issue followed (Ameghino, 1889; Márquez Miranda, 1951; Casinos, 2012; Fernicola, 2011a, 2011b; Podgorny, 2021), showing how this matter affected Ameghino. Undoubtedly, the "*Contribución...*" represents a monumental work that alone would place Florentino Ameghino as a remarkable figure in Argentine vertebrate paleontology. The text, with over a thousand pages (1008), began with a historical synthesis and comments on zoological nomenclature applied to Paleontology. This is followed by a geological summary of the Tertiary and Quaternary, mainly based on Doering´s scheme, but expanded with new "*Pisos*" or "Stages", increasing to 20 from Doering's 14 in 1880, representing a significant advance in the understanding of the Argentine stratigraphic succession at that time. In the "Eogeno", the "Formación Guaranítica" was a mixture of "*Pisos*" or "Stages" referred to the Cretaceous and to the "Palaeoceno", as the upper Stage or "Pehuenche" had fossil mammals like *Pyrotherium* alongside dinosaurs. Although the exact relationship between the dinosaur and mammal fossil beds was unclear, they were considered contemporaneous. A new "*Piso*" named "Santacruzeño" (now known as the Santacrucian SALMA) was characterized by mammals identified by Ameghino as multituberculate Plagiaulacidae and carnivorous Creodonta (now Caenolestidae and Sparassodonta metatherians) within the "Santacruzeña" Formation, which rich in fossil vertebrates, especially mammals (*e.g. Nesodon* and *Astrapotherium*) (Fernicola *et al.*, 2019).

As observed by Carlos, the position of the "Santacruzeño" beds was unclear relative to the marine "Patagónico", in some areas, apparently overlying marine beds with *Ostrea*, while in others, they underly marine beds identified as "Paranense", "Mesopotámico", or "Patagónico". Thus, in the "*Contribución*", the "Santacruzian" appeared inverted beneath the Patagonian coast, marine beds, with the distinction that the "Santacruzeño" mammals like *Nesodon* were not mixed with the marine faunas as in earlier geological schemes. Ameghino also recognized the "Hermósico" stage for Monte Hermoso above the Araucanian, and in the "Pampean" (considered to be Pliocene), from older to younger, he used the names: Ensenadan, Belgranian, Bonaerian, and Lujanian, all of which are still in use today, except for the Belgranian.

The book included a figure (Fig. 8.4), illustrating the advances and retreats of the ocean during the Argentine Cenozoic, a pioneering interpretation of sea level changes over time and their relation to different sedimentary formations in Argentina (Ameghino, 1889). Following this exceptional geological synthesis, particularly on "Pampean" sediments, the work continued with remarkable authority on fossil humans and descriptions of mammalian taxa, many of them new. Ameghino noted that of the 570 species of mammals mentioned, 450 were new. Ameghino methodically described each taxon (genus or species), discussing their relationships (at the ordinal and/or familiar level) using the methodology from "*Filogenia*", including diagrams (dichotomic or trichotomic) for orders, genera, and species. In the text and diagrams, Ameghino used theoretical forms that had not yet been discovered. Additionally, as pointed out in "*Filogenia*", it is challenging to establish direct ancestral or kinship relationships between metatherians and eutherians. For instance, while discussing Carnivora, Ameghino considered a primitive Mesozoic mammal (*Phascolotherium*) as an ancestral form in his

relationships diagram. He also positioned the dasyuran carnivorous metatherians as a sister group of eutherian Carnivora. On the other hand, based on dental similarities, he included the Santacrucian extinct Sparassosonta (now metatherians) within Creodonta, a group of primitive carnivorans, an interpretation some European authors subsequently adopted. One thing we must consider in many Ameghino's phylogenetic interpretations is that he considered every anatomical similarity as an indicator of a close relationship, often overlooking the possibility of convergence or homoplasy. This is particularly evident in his interpretation of South American native ungulates as being related to, or ancestral to, ungulates from other regions. However, these shortcomings do not overshadow the monumental, encyclopedic nature of Ameghino's work, which is not merely a compilation but a contribution that describes and names numerous new taxa. Detailed diagnoses of species, genera, families, and major groups are given, along with anatomical descriptions, making Ameghino's work unparalleled, encapsulating all knowledge of both fossil and extant mammals of Argentina (and beyond) and their relationships. The work ended with comparing extinct faunas and a "*Suplemento*" (Supplement) with additional observations and descriptions of new species. Hundreds of new species, many from Patagonia, Monte Hermoso, Paraná, and other sites, expanded the knowledge of Argentina's extinct faunas and laid the foundations for Ameghino's phylogenetic schemes, inaugurating biostratigraphic and biochronologic successions that would lead to his final geochronological scheme, or "*étages*". Although Ameghino was excluded from the *Museo Público de Buenos Aires* by G. Burmeister and from the *Museo de La Pata* by Moreno, he continued with this work with the support of O. Doering and the Academy of Córdoba, which aided in printing and disseminating the work despite the political issues that sometimes disrupted official support Florentino also use personal incomes for editing the book. A massive Atlas of 98 plates accompanied the text and numerous figures (Fig. 8.5); some of these plates had more than 30 drawings in different views. Although many of the drawings were not of the quality seen in the plates of G. Burmeister's *Anales del Museo Público de Buenos Aires*, they were good enough for the described specimens. These plates were produced by the "*Compañía Sudamericana de Billetes de Banco*", one of the best printing companies at that moment, and mainly drawn by Zacarías Bommert, Ameghino's friend (see Simón *et al.*, 2023) within eight months for near-daily work. Despite contemporary critiques (see Burmeister, 1883–1891) and modern comments (Podgorny, 2021), the "*Contribución...*" remains essential, and all paleontologists that focus their work in the Cenozoic South American mammalian faunas recognize it as an extraordinary work that positioned Ameghino as a founding figure in Argentine paleontology.

The other notable work is the "*Recherches de Morphologie Phylogénétique sur les molaires supérieures des Ongulés*", published in 1904 in the *Anales del Museo Nacional de Buenos Aires*, although focused on a specific group, the South American native ungulates. In this work, Ameghino illustrated many species he had previously described but not figured out, and he synthetized his dental evolution ideas. He rejected Cope's tritubercular theory, proposing instead that tooth complexity developed through an accretion of conules, forming a nearly quadritubercular structure. Ameghino also suggested that brachydont teeth, in some instances, were a modification of hypsodont teeth rather than the way around. Most remarkably, he interpreted that some Tertiary mammals, such as the toxodonts from the Santacrucian (Miocene), presented three dental replacement series instead of the two (deciduous and permanent) normally accepted, indicating that more deciduous series represented an ancestral state. Ameghino even proposed multiple replacement teeth for carnivorous marsupials. Other researchers did not accept these ideas; for example, Scott, who studied the Santacrucian Toxodontidae and did not endorse Ameghino's ideas after having examined the materials. Despite this, the work remains significant concerning the relationships of the studied South American native ungulates (*e.g.*, litopterns, astrapotherians, and toxodonts). Ameghino accurately and skillfully resolved inter-generic and some familial relationships. However, his interpretations at the supra-familial or ordinal level often suggested links to Holarctic or African taxa, positing greater antiquity for South American lineages as ancestral forms. Despite its now outdated theoretical foundations, the "*Recherches...*"

remains a valuable reference for those paleontologists studying South American native ungulates.

The last selected work, "*Les Formations Sédimentaires du Cétacé Supérieur et du Tertiaire de Patagonie avec un paralléleentre leurs faunes mammalogiques et celles de l'ancien continent*", was published in 1906 also in the *Anales del Museo Nacional de Buenos Aires*. As mentioned, foreign scientific circles strongly criticized Ameghino's interpretation on the relationships of mammals and the inferred antiquity of fossil-bearing strata. Ameghino's geological synthesis of Patagonia was initially published in different fascicles from 1900 to 1902 in the *Anales de la Sociedad Científica Argentina* (Ameghino, 1900–1902). In 1905, the German geologist Otto Wilckens (1876–1943) wrote a paper on the marine beds of the Cretaceous and Tertiary (with marine fossils, invertebrates, sharks, and fishes) of Patagonia, examining not only the Patagonian marine beds but also the mammalian fossil beds, criticizing Ameghino's inferred ages. In response, Ameghino produced "*Les Formations Sédimentaires...*" (The sedimentary formations...), a superb work of 568 pages, which synthesized all that was by then known of Patagonian geology from the Cretaceous (with dinosaurs) and Tertiary (with marine fossils, invertebrates, sharks, and fishes), the biochronological faunal successions, and a broad view of the vertebrate faunas present in the Patagonian beds, mainly the mammalian ones, with comparisons with the faunas from other continents. Simpson (1984, p. 88), reviewed F. Ameghino's production and stated "it is the most instructive and for many purposes the most useful...".

The text included numerous figures, some illustrating previously unpublished specimens, along with rudimentary but useful maps and profiles, with the distribution of each "Formations" and "*Étages*" (Stages), summarizing the latter with its principal characteristics, geological context, sedimentological aspects, and fossil content. Florentino Ameghino examined the relationships between some non-South American fossil mammal faunas with those of Argentina, the hypothesized ancient connections between America, Africa, and Europe, and discussed the influence of marine barriers in faunal distribution. He also discussed the geological and geographical distribution of fossil mammals in Patagonia, providing faunal lists of his "*Étages*" and the temporal distribution of the different families. The final part also examined the interrelationships between marine and terrestrial "*étages*" (Fig. 8.6).

"*Les Formations...*" (The formations...) represents the final synthesis of the biochronological scale that would become the basis for the *reconnaissance* of the South American Land Mammal Ages and establishing a provincial South American temporal or biochronological framework (Pascual *et al.*, 1965). For Ameghino, this mammal-based biochronological subdivisions or "*Étages*" were true "*chronometres géologiques*" (geological chronometers) (Ameghino, 1906, p. 20). In one section in which F. Ameghino described the geological distribution of mammals in Patagonia and their relationships with similar forms related or supposedly related from other continents, it is necessary to highlight, as already pointed out by Simpson (1948), that F. Ameghino was a keen observer of the morphological differences, but sometimes overestimated its significance resulting in an inflated taxonomy of genus and species, describing new taxa that now are interpreted as individual variations. For example, several specimens of the notoungulate *Henricosbornia lophodonta* from the Casamayoran Eocene were categorized by F. Ameghino in at least three different orders and four families. As mentioned, despite this tendency toward a "splitting" taxonomy, F. Ameghino's interpretations of inter-familial and inter-generic relationships were generally accurate. However, this cannot be extrapolated to ordinal relationships. This led F. Ameghino to a dual phylogeny wherein South American group similarities were generally accurate, while comparisons with Holarctic or African groups proved more problematic or wrong. Of course, F. Ameghino didn't know it, but South America exemplifies homoplasy on a grand scale, and here, many mammal lineages evolved adaptive radiations closely resembling unrelated Holarctic or African ones. As Simpson (1948, p. 23) pointed out "The only key to this great, complex puzzle is homoplasy, and Ameghino did not use this key". Interestingly, F. Ameghino briefly considered this possibility in his 1906 work but dismissed it shortly after, convinced of the South American origin of all the mammalian lineages. As an example, F. Ameghino believed the Polydolopidae were related to caenolestids and multituberculates, though now we know

that Polydolopidae are metatherians related to caenolestids and unrelated to the Multituberculata (Simpson, 1948). In "*les Formations...*" such examples abound, and as we noted in "*Filogenia*" (Phylogeny), F. Ameghino did not consider marsupials or metatherians as a separate group from placentals but as intermediate or primitive relatives. For example, F. Ameghino considered the extinct bunodont Caroloameghinidae marsupials to be ancestral to the generalized "ungulate" condylarths, or the still-living Microbiotheriidae marsupials as related to Polydolopidae marsupials and thereby to Rodentia (see Ameghino, 1903). In another example, the South American native ungulate Pyrotheria was considered related to the African Proboscidea, or some notoungulates, as well as African Hyracoidea. Regarding the origin of humans, Ameghino placed the ancient relatives of primates, the Microbiotheriidae marsupials, at the base of his phylogenetic tree (Fig. 9). Despite these now-outdated phylogenetic relationships for some mammalian groups, "*Les Formations...*" remains as one of our reference books for the biochronological framework of the South American

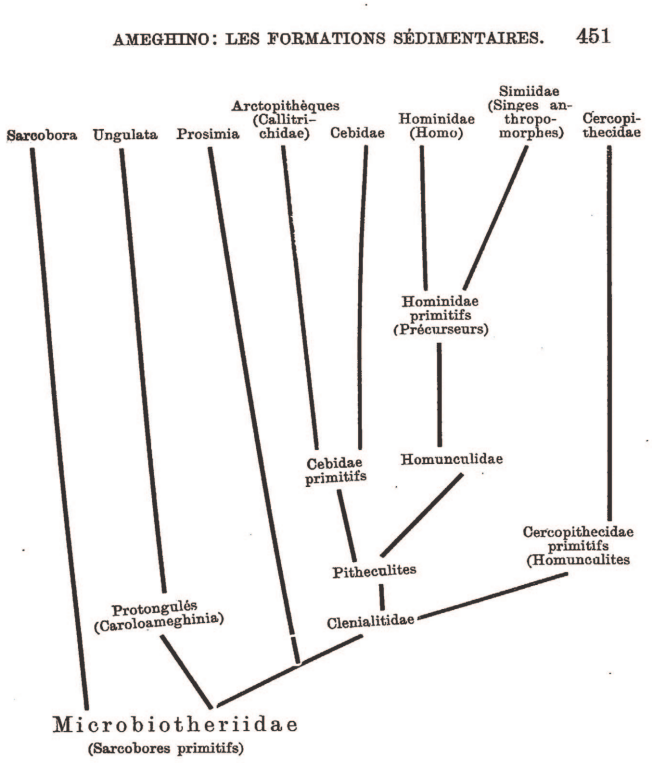

Figure 9. Phylogenetic relationships of the Primates (modified from page 451, Ameghino, 1906).

mammalian evolution and also as outstanding review of the Patagonian geology.

THE SIGNIFICANCE OF F. AMEGHINO'S WORK

These selected works of F. Ameghino, drawn from his vast publications, are more than enough to understand why he occupies such a prominent place in the development of our science as a figure recognized in the scientific circles of that time in Europe and North America, and an example for the rest of South America. We owe much of our knowledge of many fossils of vertebrate genera, especially mammals, to Florentino's descriptive and interpretative work. Despite the reinterpretations, corrections, and critiques of his studies, his monumental contribution to the biochronological scale for Argentina endures (undoubtedly aided by Carlos, whose collections and observations were crucial to Florentino's work). As Simpson (1984, p. 93), one of the first to fully appreciate Carlos' role, noted "The partnership of the Ameghino brothers was an outstanding example of teamwork, and their achievement was one of the most remarkable in scientific history". Finally, F. Ameghino was recognized and respected even by his critics, renowned in foreign scientific circles of North America and Europe. His work was referenced by notable scientists, such as Cope, Scott, Lydekker, Gaudry, and Zittel, among others, and his works were cited in many significant books of the late 19th and early 20th centuries, such as Flower & Lydekker (1891), Lydekker (1896), Gregory (1910), and Zittel (1925). Undoubtedly, Florentino was instrumental in worldwide recognizing the Argentine vertebrate paleontology.

AFTER F. AMEGHINO

Following F. Ameghino's passing, the naturalist Ángel Gallardo (1867–1934) assumed as the Director of the *Museo Nacional de Buenos Aires* from 1912–1916 (Lascano González, 1980). Gallardo, though not a vertebrate paleontologist, oversaw a period in which the museum collaborated with the *Museo de La Plata* in studying and collecting fossils from the cliffs of Chapadmalal and Miramar, which were linked to the controversial fossil human discoveries there (Tonni *et al.*, 2001; Bonomo, 2002). Agustín G. Péndola (1841–1936), Secretary of the Museum,

served as Director from 1916–1919, and then C. Ameghino, who had been in charge of the Paleontological Section since 1917, was appointed as Director from 1919–1923 (Lascano González, 1980). During these years, the Argentine vertebrate paleontology continued to be studied in the *Museo de La Plata* and the *Museo Nacional de Buenos Aires*. In contrast to the *Universidad Nacional de La Plata* (see above), the discipline at the *Museo Nacional de Buenos Aires* was maintained by self-taught people, encouraged and protected by C. Ameghino, who worked with a certain reverence for the figure of Florentino and were resistant to critiques to his work (see Cabrera, 1944; Reig, 1962). These figures would become leading proponents of the discipline: Lucas Kraglievich, Carlos Rusconi (1898–1968), Alfredo Castellanos (1893–1975), and the skilled preparator Lorenzo Julio Parodi (1890–1969), all working at the Museum until 1930 (Cornero & Tonni, 2023).

Additionally, we must mention the Italian geologist Gaetano (Cayetano) Rovereto (1870–1952), who worked in Argentina for several years, focusing on geomorphology, Quaternary studies, and paleontology. Rovereto collaborated with C. Ameghino at the *Museo Nacional de Buenos Aires* and published a study on fossil crocodiles of the Paraná Miocene ("*Mesopotamiense*") in the *Anales del Museo*. In 1914, and the volume 25 of the same series, Rovereto published a large and classic study of the Neogene fossil-bearing "Estratos Araucanos", which included the "Rionegrense", "Araucaniano", "Hermoseano", and "Chapalmalense". These were initially to the Pliocene, but are currently considered to span from the upper Miocene to the upper Pliocene (Cione *et al*., 2015). For Rovereto, the South American vertebrate faunas found in older beds than the Araucanian were autochthonous, probably due to isolation since the Cretaceous. Interestingly, he noted affinities between some Araucanian taxa and those from Europe and Africa, possibly related to a hypothetical Guyano-Senegalan bridge, and recognized North American affinities in some of the land mammals of the Pampean Quaternary beds. Rovereto reviewed many known vertebrate species and described several new ones. The text was accompanied by numerous figures and complemented with 31 plates with high-quality photographs. Despite certain outdated aspects, it remains a reference work for the Mio–Pliocene Argentine vertebrates, especially mammals. Before returning to Italy, Rovereto (1915) published a work on the longirrostrine dolphins from the Miocene of Paraná, Entre Ríos.

In summary, Argentine vertebrate paleontology, particularly in the field of mammals, rose to worldwide recognition from a humble origin with Muñiz, a strong impulse made by G. Burmeister at the *Museo Público de Buenos Aires*, the efforts of Moreno in La Plata, and then the Ameghino brothers, Florentino and Carlos. Despite some critiques, Argentine vertebrate paleontology became a globally respected field.

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