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The Colección Paleontología de Vertebrados Lillo, a pioneering role in the research on fossil vertebrates in Argentina

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THE COLECCIÓN PALEONTOLOGÍA DE VERTEBRADOS LILLO, A PIONEERING ROLE IN THE RESEARCH ON FOSSIL VERTEBRATES IN ARGENTINA

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Abstract. Fossils collected by Abel Peirano from Catamarca and Tucumán in the late 1930s constituted the basis for the creation of the Colección Paleontología de Vertebrados Lillo (PVL) in Tucumán. The collection was formally founded in 1957 as Laboratorio de Vertebrados Fósiles (LVF) by Osvaldo Reig, who led many field trips that resulted in the publication and incorporation of emblematic materials from the South American Mesozoic. José Bonaparte became the director of the LVF in 1960, incorporating a large number of Mesozoic fossils from northwest Argentina, Cuyo, and Patagonia. These findings represented an enormous qualitative and quantitative leap in the knowledge of Mesozoic faunas from Gondwana. In 1979, when the LVF was dissolved and the fossil collection became known as PVL, Jaime Powell succeeded Bonaparte as curator and began leading field trips to the Cretaceous and Cenozoic of northwest Argentina and Cretaceous of northern Patagonia, incorporating important material in the collection. In the 1980s, young researchers began to work on fossils stored at the PVL, studying Neogene birds and mammals and Mesozoic archosauriforms and cynodonts. In the 1990s, other scholars under Powell's guidance focused their research on Cenozoic mammals, providing new and relevant material for the collection. Today the PVL has about 7,900 catalogued specimens (130 holotypes) and it represents one of the most important collections of vertebrate palaeontology in Argentina. In 2010, the collection was registered under the national authority on paleontological matters (Law 25.743) and became part of the Facultad de Ciencias Naturales-Instituto Miguel Lillo, Universidad Nacional de Tucumán.

Key words. Cenozoic. History. Mesozoic. Instituto Miguel Lillo. Northwest Argentina. Tucumán. Vertebrate paleontology.

Resumen. LA COLECCIÓN PALEONTOLOGÍA DE VERTEBRADOS LILLO, UN ROL PIONERO EN LA INVESTIGACIÓN SOBRE VERTEBRADOS FÓSILES EN ARGENTINA. Los fósiles colectados por Abel Peirano en Catamarca y Tucumán a fines de la década de 1930 constituyeron la base de la Colección Paleontología de Vertebrados Lillo (PVL). La colección fue fundada formalmente en 1957 como Laboratorio de Vertebrados Fósiles (LVF) por Osvaldo Reig, quien llevó a cabo importantes trabajos de colecta e investigación, resultando en la publicación e incorporación de material emblemático del Mesozoico sudamericano. José Bonaparte quedó a cargo del LVF en 1960, incorporando gran cantidad de fósiles mesozoicos del noroeste argentino, Cuyo y Patagonia, dando un enorme salto cualitativo y cuantitativo en el conocimiento de las faunas mesozoicas de Gondwana. En 1979, al disolverse el LVF y la colección comenzó a ser conocida como PVL, Jaime Powell sucedió a Bonaparte como curador y realizó numerosas campañas al Cretácico del noroeste argentino y norte patagónico, incorporando valioso material a la colección. En la década de 1980, jóvenes investigadores comenzaron a trabajar en el ámbito de la PVL estudiando mamíferos y aves neógenos y arcosauromorfos y cinodontes mesozoicos. Otros discípulos de Powell incorporados a partir de la década de 1990 centraron su investigación en mamíferos cenozoicos y aportaron novedosos y relevantes materiales. La colección PVL cuenta actualmente con unos 7.900 ejemplares (130 holotipos), representando una de las colecciones de vertebrados fósiles de mayor importancia de Argentina. En 2010 la colección fue registrada ante la Autoridad Nacional en Materia Paleontológica (Ley 25.743) a nombre de la Facultad de Ciencias Naturales-Instituto Miguel Lillo, Universidad Nacional de Tucumán

Palabras clave. Cenozoico. Historia. Mesozoico. Instituto Miguel Lillo. Noroeste argentino. Tucumán. Paleontología de vertebrados.

ONE OF THE MOST significant vertebrate paleontology collections in Argentina is the Colección Paleontología de Vertebrados Lillo (PVL), belonging to the Facultad de Ciencias Naturales e Instituto Miguel Lillo (FCN-IML),

Universidad Nacional de Tucumán (UNT), Tucumán Province, Argentina. This collection is the most important in northern Argentina, housing about 7,900 specimens, including 130 holotypes, most of them from different regions of the country. The PVL is known worldwide for its exceptional fossils from the South American Triassic, in particular archosauromorphs and therapsids, many of them represented by holotypes. It is also notable for its Jurassic and Cretaceous dinosaurs and a precious assemblage of Paleogene, Neogene, and Quaternary mammals. The PVL is regularly visited by researchers from all over the world, particularly those who study Mesozoic archosaurs and therapsids. Here, we present a brief summary of the main events that marked the origin and development of this remarkable collection.

When the collection was created at the end of the 1950s, it was called *Laboratorio de Vertebrados Fósiles* (LVF) of the IML. The institute was named after Miguel Ignacio Lillo (1862–1931) (Fig. 1), one of the founding professors and researchers of the UNT. This self-taught Argentine scholar, who developed most of his career as a botanist, was a member of the well-known *Generación del Centenario* (Peña de Bascary, 2020), a celebrated group of intellectuals living in Tucumán Province 100 years after the independence of the country, who, among others things, founded the UNT. Lillo is, without any doubt, responsible for the deeply rooted dedication to natural sciences in Tucumán and it remains his legacy.

Today, there are two main institutions linked to natural sciences teaching and research in Tucumán Province, namely the FCN-IML, belonging to the UNT, and the Fundación Miguel Lillo (FML), which was created in 1931 and currently falls within the Argentine Ministry of Education (Fig. 2). Both institutions occupy the same building and although the PVL is formally part of the FCN-IML, both institutions have collaborated in many ways (funding field trips, provision of technical personnel, facility maintenance, services, etc.) to the creation and maintenance of the fossil collection.

The UNT was created by provincial law in 1914 during the government of Ernesto Padilla (1873–1951) and was elevated to National University status in 1921 (Aceñolaza, 2018). The presence of Miguel Lillo among the committee of authorities of the UNT was very important. He was appointed in 1915 as honorary director of the Museo de Historia Natural of Tucumán Province, founded in that year by a provincial law, which would exhibit samples of regional geology, paleontology, archaeology, minerals, flora, and fauna (Fig. 3) (Peña de Bascary, 2020). In 1925, Tucumán Governor Miguel Mario Campero (1880–1962) authorized the temporary transfer of the museum to a building belonging to the UNT. While the province retained exclusive ownership of its collections, materials, and facilities to be acquired in the future, the UNT was the custodian of the museum, yielding its executive and administrative management to Lillo. The different collections soon increased their patrimony thanks to field trips conducted by the museum

Figure 1. Precursors of the **PVL** collection. **1,** Miguel Ignacio Lillo, 1921 (1862–1931) (Photograph from the archive of the Museo Histórico Dr. Miguel Lillo y su tiempo, FML, free use); **2,** Abel Peirano, *ca.* 1950 (1896–1969) (from Aceñolaza, 2018).

Figure 2. 1, Front and entrance gate to the property of the **FML**; **2,** Statue of Miguel I. Lillo made in granite by the sculptor Roberto Fernández Larrinaga; **3,** Building of the **FCN-IML**, **UNT**.

staff and through the acquisition of natural history collections that were the property of Lillo (Alderete & Vaca, 2008). In 1927, Lillo donated a piece of land that he owned to the UNT for the construction of a definitive museum building and it opened to the public under his direction. It was organized as a scientific institute with several research sections: systematic botany, phytochemistry, zoology, archaeology, and paleontology (Alderete & Vaca, 2008) (Fig. 3). In 1931, after Lillo's death and in honour of his legacy, the IML was created, which included the scientific collections that Lillo himself had donated to the UNT, his library, and the land where the FCN-IML and the FML are currently located (Aceñolaza, 1989, 2018; Alderete & Vaca, 2008; Zaia, 2012; Abdala *et al.*, 2022). According to Alderete & Vaca (2008), in 1935 the Museo de Historia Natural comprised the Zoology, Botany, Archaeology, Mineralogy, Geology, and Paleontology sections.

Figure 3. Museo de Historia Natural of the **UNT**, *ca.* 1927, the main precursor of the **PVL** (photographs provided by the Archivo Histórico de la Universidad Nacional de Tucumán). **1,** Exhibition room of paleontology; **2,** Exhibition room of archaeology; **3,** Exhibition room of botany; **4,** Exhibition room of zoology.

THE ARRIVAL OF ABEL PEIRANO

At the request of Lillo, one of his disciples, the Argentine Abel Antonio Peirano (1896–1969; Fig. 1), began his activities at the UNT in 1930 as a museum employee, cataloging and determining minerals, rocks, and fossils from the collections. Peirano, born in Buenos Aires, completed his primary and high-school studies in Tucumán Province at the Colegio Nacional, where he was a student of Lillo. In 1919, he graduated as a pharmacist at the Universidad de Buenos Aires and in 1936 he was designated as director of the Instituto de Mineralogía y Geología (IMG) of the UNT, created at his request. Peirano carried out several fieldworks, related mainly to mining, in areas west of the Sierra del Aconquija and Cumbres Calchaquíes mountain ranges in Catamarca and Tucumán provinces (Aceñolaza, 2020). In some of these expeditions during 1939, Peirano prospected and collected fossils in the Santa María and El Cajón valleys. He collected a large number of fossil vertebrates (currently identified as Colección Peirano) and published a series of stratigraphic and paleontological contributions describing outcrops and fossils found in two localities in Catamarca Province (Caspinchango and El Cajón valley) and two in Tucumán Province (Salinas de Amaicha and Tiopunco) (Peirano, 1943, 1946). Most of the fossils reported by Peirano are mammals (xenarthrans, notoungulates, litopterns, caviomorph rodents) and turtles. These 570 specimens would be the basis of the future PVL and represented approximately half of the fossils collected by Peirano (the other half is at the Museo de Geología, Mineralogía y Paleontología of the Instituto de Geología y Minería, Universidad Nacional de Jujuy). The IMG also received the collections of minerals, rocks, and fossils from the Museo de Historia Natural, which led in 1939 to the creation of a paleontology section in the institute for the preparation, reconstruction, and determination of fossil materials, in addition to the elaboration of files and catalogs (Alderete & Vaca, 2008). Activities at the IMG practically stopped in 1946 when Peirano was transferred to San Salvador de Jujuy, Jujuy Province, to develop research and teaching in mineralogy and geology (Alderete & Vaca, 2008).

Figure 4. Osvaldo Alfredo Reig (1929–1992; the only one standing with glasses), the founder of the **LVF** and first curator of the vertebrate fossil collection (the future **PVL**), with colleagues from the **IML** in 1959 (from Aceñolaza, 2018).

OSVALDO REIG ARRIVES AT THE IML AND FOUNDS THE LVF

In 1953, the UNT created the Escuela Universitaria de Ciencias Naturales as an academic section of the IML, with the aim to create university careers in natural sciences (Aceñolaza, 2018). The creation of this institution (currently part of the FCN-IML) entailed the need of trained teaching staff. The Moroccan paleobotanist of Russian origin Sergio Archangelsky (1931–2022) was hired in 1955. He created and organized the paleobotanical collection of the IML and taught as well (Archangelsky, 2014). At request of Archangelsky, the IML hired the autodidact Argentine biologist Osvaldo Reig (1929–1992) to conduct teaching and research projects in vertebrate paleontology (Ponsá Fontanals, 2012; Farina, 2019; Abdala *et al.*, 2022) (Fig. 4).

At that time, the intervening authority of the IML, Carlos F. Cuenya, requested the rector of the UNT, Argentine Eugenio Flavio Virla (1913–1986), the appointment of Osvaldo Reig as *Profesor de Investigación del Departamento de Geología* (Research Professor of the Department of Geology) of the IML to organize the zoo-paleontology section and to teach Historical Geology and Paleontology II (the latter aimed at studying fossil vertebrates) for the Geological Sciences PhD program (see Supplementary Information, p. 1). Despite the lack of a formal academic degree, Cuenya justified the request based on Reig´s high scientific background, as he was already a renowned researcher with important articles on both living mammals and fossil vertebrates (*e.g.*, Reig, 1955a, 1955b, 1956, 1957;

Contreras & Giacchino, 2003; Ponsá Fontanal, 2012; Abdala *et al.*, 2022). Reig arrived at the IML in November 1957.

Reig's priority was to establish a relevant paleontological collection. In May 1958, he sent a note to the director of the IML, the Dutch entomologist Abraham Willink (1920–1998), suggesting the acquisition of an important fossil vertebrates collection offered by the renowned Argentine paleontologist Carlos Rusconi (1898–1969). Reig indicated that Rusconi's collection consisted mainly of Ensenadan mammals from the Buenos Aires Province, Puelchean vertebrates from Buenos Aires city and its surroundings, and mammals from the Sacanana Formation, Colhuehuapan of Chubut Province. In his note, Reig mentioned that the collection of Ensenadan mammals contained several holotypes and other remains already described in the literature and that the Puelchean fossils were the only known from this stage and representatives of the early Quaternary (see Supplementary Information, p. 2). The Colección Rusconi arrived at the LVF of the IML in August 1958 (see Supplementary Information, p. 3), consisting of about 1,300 specimens: fishes (124), amphibians (two), reptiles (two), birds (four), and mammals (670), including 42 holotypes and around 500 unidentified specimens (Tab. 1).

In May 1958, Reig insisted to the authorities on the urgent need to incorporate personnel into LVF, especially a technician for prospecting in the field and preparation of material in the laboratory, as well as two assistants for conditioning and cataloging the collection (see Supplementary Information, p. 4). He also noted the need for optical equipment, including a binocular magnifying glass and a *camera lucida* (see Supplementary Information, p. 5). Reig also acted as curator of the living amphibian collection of the IML (see Supplementary Information, p. 6).

The North American paleontologist Alfred Romer (1894–1973), from Harvard University, led a successful paleontological expedition at the Ischigualasto area, San Juan Province in 1958 (see Romer & Cox, 1962). This prompted Reig and the LVF to urgently organize a field trip to the same area (Bonaparte & Migale, 2015; Abdala *et al.*, 2022; Alcober & Martínez, 2022). This first expedition was organized by the Escuela de Ciencias Naturales and the FML in June 1958, financed by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and had the logistical support of the IML, as summarized by Reig´s annual report to the IML. In addition to some of Reig's students, to this first trip went Archangelsky, who took advantage of the trip to make botanical collections, the Argentine geologist Rogelio Bellmann from the Instituto de Geología y Minería of Jujuy Province, the renowned Argentine fossil preparator Galileo J. Scaglia (1915–1989), who was at the time director of the Museo Municipal de Ciencias Naturales de Mar del Plata (Buenos Aires Province, Argentina), the young Argentine technician and self-taught paleontologist José F. Bonaparte (1928–2020), director of the Museo Popular de Ciencias Naturales Carlos Ameghino in Mercedes (Buenos Aires Province, Argentina), and staff from the La Rioja section of the Comisión Nacional de Energía Atómica, who gave important logistical support such as two vehicles and field materials (see Supplementary Information, p. 7). The discovery of a huge number of Triassic therapsids and archosauromorphs led to the organization of a second longer field trip in the following year.

In a note dated August 1958 and addressed to the head of the Geology Department of the IML, the Argentine geologist Celestino Danieli (1920–1987), Reig insisted on the urgent hiring of a technician with experience, at least temporarily, for the preparation of the materials obtained, for their immediate study and publication, recommending Scaglia for that position (see Supplementary Information, p. 10).

The first annual report presented in December 1958 on the activities carried out by the LVF (see Supplementary Information, p. 7–9) highlighted and provided important details of the four field trips that took place in 1958 and the state of the collection at that time. Reig indicated the importance of organizing a proper fossil laboratory with all the necessary tools for preparation, as well as furniture for the growing collection. Reig pointed out that the personnel for these tasks in the laboratory consisted of himself and María Stella Cabezas, a student assistant from the *Cátedra de Paleontología*. According to the mentioned report, in 1958 four paleontological field trips for prospecting were carried out: 1) in Patagonia, between January 15th and February 28th to Miocene outcrops of Neuquén Province, in the Colloncuran levels of the Limay river valley and Eocene

deposits of the Chico river, and to the south of the Colhué Huapí lake, Cañadón Hondo, and Cañadón Vaca, in Chubut Province. Field trip members were Archangelsky and Scaglia; 2) to Ischigualasto, in June (see above); 3) to the Quebrada de Humahuaca, Jujuy Province, between September 21st and 28th. In this trip, R. Bellmann, G. J. Scaglia, and the students Juan Carlos Viera, M. S. Cabezas, and the German-born Rafael Herbst (1937–2017) participated. Herbst would be the first graduate in Geological Sciences from the UNT in 1959; 4) to the Las Conchas river ravine and Calchaquí valley, Salta, Tucumán, and Catamarca provinces, between December 3rd and 17th, to collect fossil amphibians and fish remains of possible Cretaceous age and recognize the stratigraphic units of the Santa María valley. Members of this trip were J. C. Viera and M. Ibañez, member of the Comisión Nacional de Energía Atómica, Salta sectional. Based on numerous specimens from this trip at Las Conchas ravine, near Alemanía, Salta Province, Reig described *Saltenia ibanezi* from the Las Curtiembres Formation (Reig, 1959). The holotype of this species, housed at PVL, corresponds to an impression and counter-impression of an almost complete skeleton.

In the annual report, Reig also referred to the state of the collection (see Supplementary Information, p. 8–9) with around 2,500 specimens of fossil vertebrates, mainly mammals, although the work of cataloging was still ongoing. The collection comprised as follows: around 100 specimens of Miocene mammals from the Colloncuran of the Limay river donated by Reig; over 1,300 specimens including numerous holotypes from the Miocene of Sacanana, Chubut Province, part of the Colección Rusconi; Eocene mammals from Patagonia; a large collection of mammals from the Pliocene of Chapadmalal, Buenos Aires Province; an important collection of Triassic tetrapods; a valuable set of Jurassic anurans found by Archangelsky in Santa Cruz Province; Plio–Pleistocene mammals referable to Uquian units; a large number of Cretaceous anurans from Salta Province, the first known for South America for this period; and an important collection of fossil casts donated by the Museo de La Plata. Reig emphasized that the Lillo collection was the only one with mammals from the "*Arenas Puelchenses*" of the subsoil of the Buenos Aires city (as part of the Colección Rusconi). Reig also indicated the lack of space, furniture, and personnel in the collection and urged to hire a permanent technician.

Reig organized a second trip to Ischigualasto of 45 days, during May and June 1959, and was accompanied by Scaglia and Bonaparte, who were hired as technicians for this fieldwork (Abdala *et al.*, 2022; Apesteguía *et al.*, 2022a). Other members were the by then students Viera, Herbst, Cabezas, and the technician Tomás Fasola, from de IML. There were also auxiliary personnel, such as drivers, one cook, the local guide Don Victorino Herrera and his son, a botany collector named Alberto Cuezzo, a zoology collector José M. Gómez, and R. Bellmann (Bonaparte & Migale, 2015). This expedition was very successful, with a large number of fossils collected (Bonaparte, 1996, 1997; Bonaparte & Migale, 2015).

Reig worked as a researcher and professor at the Escuela de Ciencias Naturales of the IML until 1960, when he was removed from his position for political reasons by university authorities during the government of president Arturo Frondizi (1908–1995), and moved to the Universidad de Buenos Aires (Abdala *et al.*, 2022). Fossils of great relevance resulting from collections during Reig's short period at the IML were the anuran *Saltenia ibanezi*, the archosauriform *Proterochampsa barrionuevoi*, the rauisuchid *Saurosuchus galilei*, and the basal dinosaur *Herrerasaurus ischigualastensis*, all described by Reig himself (*e.g.*, Reig, 1958, 1959, 1963) and housed in the PVL. These important findings of international relevance from Ischigualasto were headline news in the country's main newspapers (see Supplementary Information, p. 11).

From his workplace in Buenos Aires city, Reig led his last expedition to Ischigualasto in 1960, supported by CONICET and with the collaboration of the IML and FML and in agreement with the Museo de La Plata and the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" of Buenos Aires. In this field trip, the logistical organizer was Bonaparte (Fig. 5), with the participation of Scaglia, the Argentine paleontologist and anthropologist Rodolfo Casamiquela (1932–2008), researchers and technicians from the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" and the Instituto de Geología y Minería of Jujuy Province. In this expedition also participated Martín Vince, a gardener from the IML and FML, who would then become

the main technician of Bonaparte for the next two decades (Fig. 5) (Bonaparte & Migale, 2005; Puerta & Isasi, 2022).

JOSÉ F. BONAPARTE IN CHARGE OF THE LVF

After the removal of Reig in 1960, the LVF was left in charge of Bonaparte, who continued the exploration and collection of fossils in Mesozoic deposits and made key discoveries that provided a new vision of the evolution of the South American Mesozoic fauna (Abdala *et al.*, 2022). Due to the abundant recent literature on the work of Bonaparte from the LVF (and PVL collection) of the IML, with multiple references to field trips, academic activities, and various aspects of his life in Tucumán (*e.g.*, Bonaparte & Migale, 2015; Abdala *et al.*, 2022; Alcober & Martínez, 2022; Apesteguía *et al.*, 2022a, 2022b; Martinelli *et al.*, 2022), we will only present a summary of its main activities and some little-known details since he arrived in 1960 until his departure in late 1978.

Bonaparte continued exploring Mesozoic localities by organizing methodical and continuous expeditions to Triassic, Jurassic, and Cretaceous continental outcrops since 1961 (Bonaparte & Migale, 2015; Abdala *et al.*, 2022). He collected notable Mesozoic tetrapods from the Triassic of San Juan, La Rioja, and Mendoza provinces and from the Cretaceous of San Luis Province (Apesteguía *et al.*, 2022a), generating a large number of materials and new information on archosauromorphs and therapsids (Abdala *et al.*, 2022a; Alcober & Martínez, 2022; Bona *et al.*, 2022; Martinelli *et al.*, 2022). The LVF under the Bonaparte's leadership reached a remarkable hierarchy because of the prompt and uninterrupted publications made it one of the most important paleontological centers in Argentina (Abdala *et al.*, 2022; Martinelli *et al.*, 2022) (see Supplementary Information, p. 11). Due to his great contributions to paleontology, the UNT awarded Bonaparte the title of *Doctor Honoris Causa* (Aceñolaza, 2018) in 1974, which allowed him to join the FCN-IML as a full professor of vertebrate paleontology, between 1975–1979 (Abdala *et al.*, 2022; Apesteguía *et al.*, 2022a, 2022b).

In 1974, Bonaparte began a series of paleontological explorations to several localities in southern Salta Province, such as the notable Cretaceous sites of El Brete and El Ceibal, where important remains of dinosaurs (*e.g.*, *Saltasaurus loricatus* and *Noasaurus lealí*) and postcranial bones of enantiornithine birds were discovered (Bonaparte *et al.*, 1977; Bonaparte & Powell, 1980; Bonaparte & Migale, 2015; Abdala *et al.*, 2022; Apesteguía *et al.*, 2022a; Bona *et al.*, 2022). In addition, technicians Vince and Juan Carlos Leal and the geology student Jaime Powell—who would become the first disciple of Bonaparte—participated in these field trips (Bona *et al.*, 2022). It is also worth noting the findings made in 1975 in the Pampa Grande area, southern Salta Province, where Eocene outcrops of the Lumbrera Formation yielded many articulated cranial and postcranial remains of new mammals (*e.g.*, Carbajal *et al.*, 1977; Bond, 1981; Bond & Vucetich, 1983).

Bonaparte organized several field trips to Patagonia, from 1976 to 1978, to explore Jurassic and Cretaceous localities of Neuquén, Chubut, and Santa Cruz provinces. These resulted in several noteworthy discoveries, such as the associated remains of the sauropods *Patagosaurus fariasi* and *Elaltitan lilloi* (Powell, 1986, 2003; Mannion & Otero, 2012) and a large number of other theropod and sauropod dinosaurs. It was also of paramount importance the finding of the first nest of prosauropod dinosaurs from the Late Triassic that included eggs, newborn individuals, and a complete juvenile specimen, all referred by Bonaparte to the species *Mussaurus patagonicus* (Bonaparte & Vince, 1979).

A forgotten aspect in the most recent publications that deserves comment is the collaboration provided by Bonaparte and the LVF to create a Vertebrate Paleontology Section at the Universidad Provincial Domingo Faustino Sarmiento, San Juan Province, in 1965. It included training technicians and an associated field trip between staff of this university and the IML to search for fossils. This university, founded in August 1964, offered Bonaparte a contract as a full-time researcher in October 1965 (see Supplementary Information, p. 12). Finally, in December 1965, the Universidad Provincial de San Juan accepted Bonaparte's offer of technical collaboration for the newly created *Departamento de Paleontología* and formally appointed him as a consultant. Among other points, Bonaparte suggested the creation of a private library for the department, the development of three disciplines for the new institute (paleobotany, paleoinvertebrates, and paleovertebrates), with

permanent positions for each area and also for an historical and/or sedimentary geologist. He envisaged the main purpose of the *Departamento de Paleontología* to be the development of paleontological research for this region and the creation of a paleontological museum open to the public.

Similarly, Bonaparte and the LVF collaborated in developing a paleontology institute at the Universidad Provincial de La Rioja. This cooperation started in 1974 by donating

Figure 5. 1–2, José Fernando Bonaparte working in his office at the **FML**, *ca.* 1976 (photograms from the documentary *Nuevo Yacimiento Paleontológico* by Jorge Wyngaard, Instituto de Cinematografía of the **UNT**); **3,** José F. Bonaparte and the technician Martín Vince in the field in 1970 (from the Historical Archive of the Colección Paleontología de Vertebrados Lillo); **4,** Technicians Juan Carlos Leal and Martín Vince in a campsite in 1969 (from the Historical Archive of the Colección Paleontología de Vertebrados Lillo); **5–6,** Martín Vince preparing fossils, *ca.* 1976 (photograms from the documentary *Nuevo Yacimiento Paleontológico* by Jorge Wyngaard, Instituto de Cinematografía of the **UNT**).

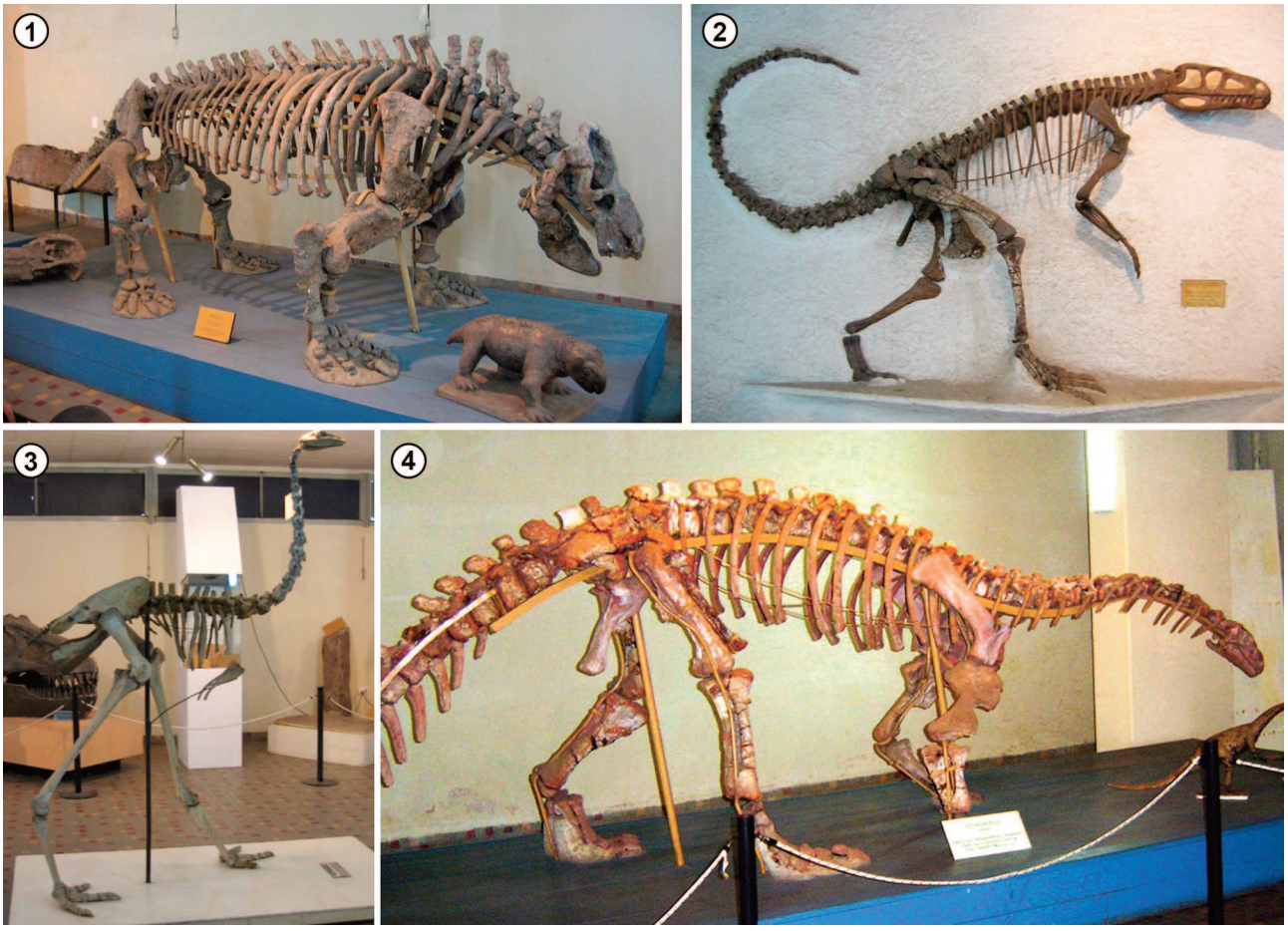

Figure 6. Some mounted original skeletons of specimens belonging to the **PVL** in the old exhibition of the Museo de Ciencias Naturales of the **FML** (from the Historical Archive of the Colección Paleontología de Vertebrados Lillo). **1,** ***Ischigualastia jenseni***; **2,** ***Herrerasaurus ischigualastensis***; **3,** ***Dinornis maximus***; **4,** ***Riojasaurus incertus***.

fossil casts, original fossil material, and loaning tools to prepare specimens. The collaboration also included advice in the field and the technical and scientific guidance for the cataloguing and conservation of specimens in the collection (see Supplementary Information, p. 13–15). Bonaparte considered it appropriate to make a formal cooperation agreement between the Universidad Provincial de La Rioja and the IML (see Supplementary Information, p. 13–16). The IML also made available its facilities in the LVF to train personnel and advice on the paleontological research possibilities offered by the fossils of that province. In addition, the possibility of making joint field trips between the interested parties was agreed (see Supplementary Information, p. 17–18). This cooperation agreement, however, would only be formally signed in 1984 (see Supplementary Information, p. 19–20).

Outreach activities carried out during Bonaparte's direction of the LVF were important, using exhibited sculptures, assembled fossils and explanatory diagrams in the museum and distributing modern brochures to the public (Figs. 6–10) (Abdala *et al.*, 2022). In this regard, it is necessary to mention here the work of the Uruguayan sculptor Roberto Fernández Larrinaga (1918–1988), who in the 1960s was hired by the IML to build sculptures of fossil animals of the Triassic of Argentina and to assemble skeletons of fossil specimens for the natural science museum managed by the FML (Figs. 6, 7, 10) (Abdala *et al.*, 2022). It is also worth noting that the Russian artist Alejandro Gavriloff (1914–1993) served as a scientific illustrator in the FML and collaborated in the exhibition (Martinelli *et al.*, 2021; Abdala *et al.*, 2022). Another of Bonaparte's outreach activities was to participate in documentaries developed by the Instituto de

Figure 7. 1–3, Setting of the original material of the dinosaur ***Elaltitan lilloi*** in the old exhibition of the Museo de Ciencias Naturales of the **FML**, late 1970s (from the personal archive of Agustín Guillermo Martinelli).

Figure 8. Brochures with slides on extinct Mesozoic reptiles and information on the search and extraction of fossils edited by the **FML** in 1974 (from the Historical Archive of the Colección Paleontología de Vertebrados Lillo).

Cinematografía of the UNT. Three documentaries portray the paleontological research developed at that time at the LVF. Two of them, *Dinosaurios* (1965) and *Reptiles fósiles triásicos de Argentina* (1965) were directed by the prominent Argentine documentalist Jorge Preloran (1933–2009) (Departamento de Documentación y Archivo Cine UNT, 2024a, 2024b); the third documentary, *Nuevo Yacimiento Paleontológico* (1975), documented the extraction and preparation of fossils from the Cretaceous of Salta Province, northwest Argentina, by the Argentine producer Jorge Wyngaard (1929–2008) (Departamento de Documentación y Archivo Cine UNT, 2024c).

JAIME POWELL, CURATOR OF THE PVL COLLECTION

When Bonaparte left the IML at the end of 1978, the LVF dissolved and the fossil collection became known as PVL.

Figure 9. New Museo Miguel Lillo de Ciencias Naturales, which now exhibits fossil replicas. **1,** Front of the museum; **2,** ***Herrerasaurus ischigualastensis***; **3,** ***Riojasaurus incertus***; **4,** Partial view of the museum with the temnospondyl amphibian ***Pelorocephalus mendozensis*** in the foreground; **5,** sector dedicated to Quaternary fossils with the gomphothere ***Cuvieronius hyodon***, the ground sloth ***Megatherium americanum***, and the glyptodont ***Glyptodon reticulatus***; **6,** skull of the saber-toothed tiger ***Smilodon***; **7,** skull of the dicynodont therapsid ***Ischigualastia jenseni***.

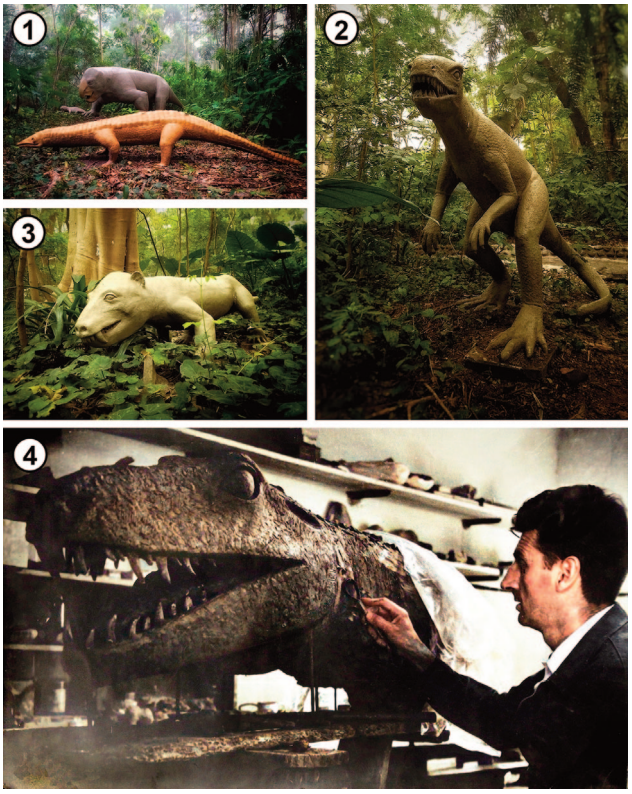

Figure 10. Sculptures of Triassic fossils of Ischigualasto made by Roberto Fernández Larrinaga located in the gardens of the **FML**. **1,** ***Aetosauroides scagliai*** in foreground, ***Ischigualastia jenseni*** in the center, and ***Hyperodapedon sanjuanensis*** in the background; **2,** ***Herrerasaurus ischigualastensis***; **3,** ***Exaeretodon argentinus***; **4,** Roberto Fernández Larrinaga sculpting ***Saurosuchus galilei***, which unfortunately it was never mounted.

The Argentine geologist Jaime Eduardo Powell (1953–2016, Fig. 11), who had recently graduated at the FCN-IML, was left in charge of the PVL, serving as curator of the collection from 1979 to 2016. Powell also acted as a professor of vertebrate paleontology at the FCN-IML and as a CONICET researcher. He began his research on South American titanosaur dinosaurs under the direction of Bonaparte (Bonaparte *et al.*, 1977; Powell, 1978, 1979, 1980, 2003; Bonaparte & Powell, 1980), defending his Ph.D. thesis in 1986. Powell, along with Bonaparte, drew particular attention to the remarkably complete titanosaur *Saltasaurus loricatus*, the first sauropod known to possess an armour of bony plates embedded in its skin (Powell, 1979, 1980, 1986, 2003). As part of his Ph.D. thesis, Powell carried out exploratory fieldwork to northern Patagonia and Cretaceous localities in Salta and Tucumán provinces. His only field trip to northern Patagonia allowed incorporating important remains of dinosaur eggs and nests into the PVL collection, some of which were studied afterward (*e.g.*, Powell, 1992, Moratalla & Powell, 1994; Figueroa & Powell, 1999). More details of these discoveries and their respective publications have been recently summarized by Abdala *et al.* (2022). It is also necessary to mention the work of another important artist linked to the vertebrate paleontology research in the IML and the FML since the early 1980s, the plastic artist Enrique Guanuco. He made scientific illustrations of fossils that were included in the scientific production of various IML and FML researchers for decades (Abdala *et al.*, 2022) (Fig. 12).

In the earliest 1980s, Powell began to explore Paleogene localities in northwestern Argentina, which resulted in the discovery of important fossiliferous deposits such as the El Tonco valley and Alemanía, in the south of

Figure 11. Jaime Eduardo Powell (1953–2016) (photographs from the Historical Archive of the Colección Paleontología de Vertebrados Lillo). **1,** Jaime E. Powell and José F. Bonaparte in the preparation laboratory showing the recently discovered dinosaur eggs in northern Patagonia; at the background, the renowned paleontologists Guiomar Vucetich and Zulma Brandoni de Gasparini, in 1986; **2,** Jaime E. Powell in a field trip to Eocene deposits from El Simbolar, Salta Province, in 2014; **3,** Jaime E. Powell with a technician at the El Brete locality, Salta Province, preparing the motorcycle used to transport fossil pieces to the camp, *ca.* 1975; **4,** Jaime E. Powell at the **PVL** in 2007.

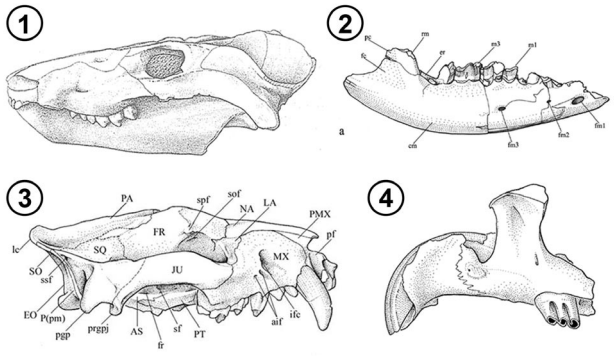

Figure 12. Some of the scientific illustrations made by the artist Enrique Guanuco. **1,** Skull of the holotype of the cynodont ***Cynognathus minor*** (**PVL 3859**) (reproduced from Abdala, 1996); **2,** Right mandible of the metatherian Borhyaenoidea aff. ***Stylocynus*** (**PVL 4651**) (from Babot & Ortiz, 2008); **3,** Skull of the holotype of the carnivorous metatherian ***Callistoe vincei*** (**PVL 4187**) (from Babot *et al.*, 2002); **4,** Anterior fragment of the skull of a paratype of the sigmodontine rodent ***Tafimys powelli*** (**PVL 5450**) (from Ortiz *et al.*, 2000).

Salta Province, and the Paleocene locality of Río Loro, nearby the city of Tucumán (Powell & Palma, 1981; Soria & Powell, 1981; Goin *et al.*, 1986; Gasparini *et al.*, 1993; Powell *et al.*, 2011; Babot *et al.*, 2017). Powell made remarkable discoveries of peculiar crocodiles and mammals where the Paleocene Río Loro Formation outcrops (Powell & Palma, 1981; Soria & Powell, 1981; Gasparini *et al.*, 1993). Among the most important mammals discovered and described in those years are the basal ungulates *Eoastrapostylos riolorense* (Soria & Powell, 1981), *Notonychops powelli* (Soria, 1989a), and *Satshatemnus bonapartei* (Soria, 1989b). Powell and his students continued to explore these outcrops in successive years, leading to the discovery of novel mammalian and crocodilian taxa such as the very peculiar crocodile *Lorosuchus nodosus* (Pol & Powell, 2011; see below). Moreover, Powell continued excavating the rich Eocene Pampa Grande deposits in Salta Province, where he found the litoptern *Indalecia grandensis* (Bond & Vucetich, 1983), the notoungulates *Boreastylops lumbrerensis* (Vucetich, 1980), *Colbertia lumbrerense* (Bond, 1981), and *Pampahippus arenalesi* (Bond & López, 1993), and the spectacularly almost complete articulated skeleton of the carnivorous proborhyaenid metatherian *Callistoe vincei* (Babot *et al.*, 2002). Other important discovery made by Powell in his field trips south of Salta Province was the sebecid crocodile *Bretesuchus bonapartei* from the Paleogene Maíz Gordo Formation in the area of El Brete (Gasparini *et al.*, 1993).

In the following decades, Powell expanded his line of research to the Neogene and Quaternary, making important discoveries in Late Miocene Saladillo Formation outcrops, such as the small megatheriid *Anisodontherium* sp. (Brandoni *et al.* 2012), and in the Quaternary of Tafí valley, northwestern Tucumán Province. In this valley were discovered the glyptodonts *Glyptodon clavipes* and *G. reticulatus*, the megatheriid *Megatherium americanum*, the mylodontid *Paraglossotherium elmollarum*, the gomphotheriid *Cuvieronius* cf. *C. hyodon*, the equid *Hippidion* sp., and the camelid *Vicugna vicugna*, many of them later studied by Powell's students (Esteban, 1988, 1993; Rufino & Mulé, 1994; Torres-Carro *et al.*, 2021; see also Powell & Ortiz, 2014; Ortiz *et al.*, 2019a). Throughout his entire time as a curator, Powell always petitioned the FCN-IML authorities to improve the conditions and space for the collection, the fossil preparation lab, and the museum but his efforts were always unsuccessful (see Supplementary Information, p. 21).

In the mid-1980s, Powell began attracting students of the FCN-IML. Among them, it is worth mentioning Andrea Arcucci, who began her studies on Argentine Triassic archosaur reptiles mostly from the PVL collection (*e.g.*, Arcucci, 1989a, 1989b, 1990; Sereno & Arcucci, 1990). Arcucci completed her Master's degree at the FCN-IML on Triassic dinosauriforms and her Ph.D. thesis at the Universidad Nacional de San Luis on proterochampsid archosauriforms. Also, FCN-IML students Norma Nasif and Graciela Esteban began working on fossils from the PVL collection. Nasif finished her undergraduate research work with Neogene flamingos from northwestern Argentina (Nasif, 1988) and Esteban finished her undergraduate degree studying Quaternary megatheriid and mylodontid xenarthrans (Esteban, 1988, 1993). Later, Esteban developed her Ph.D. thesis on mylodontids, whereas Nasif did it on Neogene dinomyid rodents. From the early 1990s, Nasif and Esteban continued exploring and studying Neogene mammals from northwestern Argentina, organizing multiple field trips to Miocene–Pliocene outcrops in the Calchaquí valleys of Tucumán, Catamarca, and Salta provinces (Nasif, 1998; Nasif *et al.*, 2000, 2007) and nearby areas of La Rioja Province (Georgieff *et al.*, 2004) (Fig. 13). These trips yielded a vast record of fossils, including new species of dasypodids such as *Neophractus martae*, *Vetelia gandhii*, and *Chasicotatus*

peiranoi (Esteban & Nasif, 1996) and the toxodontid *Calchaquitherium mixtum* (Nasif *et al.*, 2000, 2019). Esteban's work focused on the study of the fossil xenarthrans (Esteban *et al.*, 2014 and references therein), describing important fossils from the Andean intermountain valleys, some of them new taxa such as *Paraglossotherium elmollarum* and *Glossotherium emmersonni* (Esteban, 1988, 1993; Esteban & Nasif, 1996). During this period, both Nasif and Esteban were also professors at the FCN-IML, working in collaboration with Herbst, by this time an eminent paleobotanist, the geologist Sergio Georgieff, and the paleontologist Fernando Abdala (Fig. 13).

Fernando Abdala was also Powell's student, finishing his Ph.D. thesis in 1996 at the FCN-IML on Triassic cynodonts of South America, a topic in which he continues working today (Fig. 14). Since 1998, he moved abroad (Brazil and South Africa) and returned to the IML paleontological community in 2016. He redescribed the only known South American cynognathid specimen, originally referred as *Cynognathus minor* (Abdala, 1996), and published mainly on cynodonts and other therapsids from South America, Africa, and China (*e.g.*, Abdala & Giannini, 2002; Abdala & Ribeiro, 2003; Abdala & Teixeira, 2004; Abdala *et al.*, 2008, 2013; Liu & Abdala, 2022).

Many FCN-IML students who worked for a short period in the 1990s with specimens from the PVL collection also contributed to the knowledge of the regional paleofauna with some scientific publications (*e.g.*, Rufino & Mulé, 1994; Duarte, 1997; Nasif *et al.*, 2000). Pablo Ortiz and Judith Babot (Figs. 15, 16), also former students of Powell, continue working on paleomammalogy in the FCN-IML and the FML to this day. The research of Ortiz, focused on the study of Neogene and Quaternary cricetid rodents and small mammal assemblages, allowed recognizing extinct taxa such as the cricetids *Tafimys powelli* (Ortiz *et al.*, 2000, 2011, 2019a, 2019b; Ortiz & Pardiñas, 2001) and *Pardinamys humahuaquensis* (Ortiz *et al.*, 2012a, 2012b) (Figs. 15, 16), as well as other small vertebrates like the lizard *Uquiasaurus heptanodonta* (Daza *et al.*, 2012) and the anura *Rhinella xerophylla* (Ponssa *et al.*, 2022). In addition, Ortiz's studies have contributed to the understanding of paleoenvironmental fluctuations in the late Quaternary, a novel research program for the region (Figs. 15, 16). Babot conducted her Ph.D. studies in cranial and postcranial anatomy and phylogeny of sparassodonts from the Paleogene of Argentina, among which is the notable proborhyaenid *Callistoe vincei*, documented by a nicely preserved and complete articulated skeleton (Babot *et al.*, 2002, 2022; Argot & Babot, 2011; Babot & Forasiepi, 2016)

Figure 13. Graciela Esteban and Norma Nasif on field trips at late Neogene sites of Catamarca Province in the 1990s. **1,** Norma Nasif (left) and Graciela Esteban; **2,** The biologist Sebastián Musalén (left), Norma Nasif, and the paleobotanist Rafael Herbst (right); **3,** Sebastián Musalén (right), Graciela Esteban, and three field assistants; **4,** The geologist Sergio Georgieff (left), Norma Nasif, Graciela Esteban, and two field assistants.

Figure 14. Some field trips of Fernando Abdala. **1,** From left to right: field assistant, Andrea Arcucci, Fernando Abdala, Guillermo Rougier, Marcelo de la Fuente, Diego Pol, and Santiago Reuil in outcrops of Los Colorados Formation, La Rioja Province in 1992; **2,** from left to right: Graciela Esteban, the student Claudia Gómez Cardozo, Norma Nasif, and Fernando Abdala in a late Neogene outcrop, Catamarca Province in 1990s; **3,** From left to right: Guillermo Rougier, Fernando Abdala, Marcelo Isasi, and Diego Rougier at Talampaya National Park, La Rioja Province in 1992; **4,** Fernando Abdala (left) and Brazilian paleontologists Ana Maria Ribeiro and Max Cardoso Langer in Triassic outcrops of the Santa Maria Formation, Rio Grande do Sul, Brazil in 2005.

(Figs. 12, 15). She also worked on Neogene metatherians (*e.g.*, Babot & Ortiz, 2008), including argyrolagids (García-López & Babot, 2015a; Babot & García-López, 2016). More recently, her work has focused on prospecting Paleogene outcrops of the Argentinian Puna through traditional and screening sampling techniques, the latter rarely used in Paleogene outcrops in the region (Fig. 17). This resulted in a notable increase on the knowledge of Eocene small vertebrates (Babot *et al.*, 2012, 2020; García-López & Babot, 2015b; Armella *et al.*, 2016; Ciancio *et al.*, 2016).

Continued efforts of other former students of Powell in the 2000s have increased (and continue to increase) the PVL collection with new and peculiar fossils studied by themselves: Daniel García-López, Claudia Herrera, Virginia Deraco, and Carolina Madozzo-Jaén (Figs. 16–20). García-López's research led to the discovery of new notoungulates and other native ungulates from the Paleogene of northwestern Argentina (*e.g.*, García-López & Powell, 2009, 2011; García-López & Babot, 2015b; Deraco & García-López, 2015; García-López *et al.*, 2018), such as *Griphotherion*

Figure 15. Field trips of the vertebrate paleontology group led by Jaime E. Powell in the 1990s. **1,** From left to right: Rossana Duarte, Jaime E. Powell, Pablo E. Ortiz, and the technician Juan M. Ballesteros in Tafí valley, Tucumán Province in 1992; **2,** From left to right: Pablo E. Ortiz, Juan M. Ballesteros, Jaime E. Powell, Dolores Juri, and Judith Babot in late Pleistocene outcrops at La Angostura, Tucumán Province in 1997; **3,** From left to right: the technician José Aguilar, Judith Babot, and the biologist Marcos Mirande in Neogene deposits of Campo del Pucará, Catamarca Province in 1999; **4,** José Aguilar, Pablo E. Ortiz, and Judith Babot in Quaternary outcrops at La Angostura, Tafí valley, Tucumán Province in 2000.

Figure 16. Field works in Quaternary outcrops of Catamarca and Tucumán provinces. **1,** From left to right: Daniel García-López, the biologist Pablo Jayat, and Pablo E. Ortiz at Las Juntas, Catamarca Province in 2006; **2,** Dry screening of sediments near Tafí del Valle, Tucumán Province in 2006; **3,** From left to right: Virginia Deraco, Pablo E. Ortiz, Franck Barbière, and Vanessa Torres Carro screen washing sediments at La Mesada, Tucumán Province in 2015; **4,** Daniel García-López and Carolina Madozzo-Jaén screen washing sediments at Salí river, Tucumán Province in 2006; **5,** Campo del Pucará, Catamarca Province in 2013; **6,** From left to right: the field assistant Günther Ortiz Tempel, Carolina Madozzo-Jaén, the biologist Sofía d'Hiriart, Daniel García-López, and Pablo E. Ortiz at Las Chacritas, Catamarca Province, in 2013.

peiranoi, *Dolichostylodon saltensis*, and *Pampahippus powelli*, and to the expand the knowledge of other groups (García-López, 2011; Armella *et al.*, 2016; García-López *et al.*, 2018, 2019, 2020) (Figs. 16–20). Herrera's main research is on the anatomy and phylogeny of Paleogene Dasypodidae (Xenarthra) from northwest Argentina, discovering new armadillos with peculiar features in the skull, dentition, and mobile osteoderms, such as *Pucatherium parvum* and *Lumbreratherium oblitum* (Powell *et al.*, 2011; Herrera *et al.*, 2012, 2016, 2019, 2021; Ciancio *et al.*, 2016; Herrera & Esteban, 2017) (Figs. 17, 18, 20). The research of Deraco on systematic, phylogeny, and biogeography of Paleogene notoungulates, mainly toxodonts, from northwest Argentina (Deraco *et al.*, 2008) has led to the discover of new important taxa such as *Coquenia bondi* and *Pampahippus secundus* (Deraco *et al.*, 2008; Deraco & García-López, 2015; García-López *et al.*, 2018, 2019) (Figs. 17, 18, 20). Madozzo-Jaén's research on Neogene caviid rodents resulted in the recognition of new species for the region, such as *Paleocavia mawka*, and solving several taxonomic problems of the group (Madozzo-Jaén & Pérez, 2016; Madozzo-Jaén *et al.*, 2018, 2021; Madozzo-Jaén, 2019) (Figs. 16, 18–20).

The paleontologists linked to the PVL collection organized the first symposium for the study of the Miocene–Pleistocene in central and northern Argentina in September 2012 (Fig. 18). This meeting created an interdisciplinary space to integrate paleontological, biostratigraphic, and chronological information of the Miocene–Pleistocene interval to solve regional problems and since then is held every two years.

Other researchers of the FCN-IML and FML paleontological community are Sara Bertelli, working on living and extinct tinamous birds and enantiornhites (Bertelli *et al.*, 2006, 2011, 2014) (Fig. 20); Nadia Haidr, mainly focused on fossil penguins (Haidr & Acosta Hospitaleche, 2012, 2017) (Figs. 17, 20); Matías Armella, studying Neogene native ungulates (Armella *et al.*, 2016, 2018, 2020; Armella, 2022) (Figs. 17–20); the Belgian Christophe Hendrickx, who

Figure 17. Field works in Paleogene outcrops. **1,** Daniel García-López and Luis Saade at El Simbolar, Salta Province in 2022; **2,** From left to right: Judith Babot, Matías A. Armella, Claudia Herrera, and Daniel García-López at Antofagasta de la Sierra, Catamarca Province in 2014; **3,** From left to right: Norberto Giannini, Guillermo Rougier, Virginia Deraco, Sara Bertelli, Judith Babot, and Claudia Herrera at El Simbolar, Salta Province in 2019; **4,** From bottom to top: Judith Babot, Rodrigo González, and Daniel García-López at Antofagasta de la Sierra, Catamarca Province in 2016; **5,** From left to right: Gonzalo Bravo, Luis Saade, Vanessa Torres Carro, Daniel García-López, Judith Babot, Nadia Haidr, the student Diego Cantone, and Jaime Morales at Pampa Grande, Salta Province in 2022.

Figure 18. 1, Attendees of the *Primer Simposio del Mioceno–Pleistoceno del Centro y Norte de Argentina* in San Miguel de Tucumán, September 2012; **2,** From left to right: Carolina Madozzo-Jaén, Pablo E. Ortiz, and Norma Nasif in late Neogene outcrops of El Cajón valley, Catamarca Province in 2012; **3,** From left to right: Pablo E. Ortiz, Judith Babot, Norma Nasif, Carolina Madozzo-Jaén, and Graciela Esteban in late Neogene outcrops of El Cajón valley, Catamarca Province in 2012; **4,** From left to right: Daniel García-López, Judith Babot, Matías A. Armella, Vanessa Torres Carro, and Pablo E. Ortiz in late Neogene outcrops of Palo Pintado Formation near Santa Rosa, Salta Province in 2013.

studies the dentition of Triassic cynodonts and the paleobiology of dinosaurs (Hendrickx *et al.*, 2020a, 2020b) (Fig. 20); and the French Franck Barbière, studying cricetid rodents (Barbière *et al.*, 2016a, 2016b, 2019a, 2019b) (Figs. 16, 19). Other Ph.D. students, Jaime Morales, Luis Saade, Gonzalo Bravo, and Vanessa Torres Carro, have been incorporated to the vertebrate paleontology area in the FCN-IML or the FML in the last decade, studying Cretaceous enantiornitheans birds, Paleogene ungulates and crocodiles, Neogene octodontid rodents, and Pleistocene camelids (*e.g.*, Bravo *et al.*, 2021; Torres Carro *et al.*, 2021; Saade *et al.*, 2023) (Figs. 16–20). The technical staff currently working at the PVL are the fossil preparator José Aguilar, who has been in the preparation lab since the 1990s, and Rodrigo González and Flavia Germano, both collection managers since 2013 and 2023, respectively. Both Aguilar and González were part of the team that frequently accompanied Powell on his field trips and helped develop the projects of researchers and students working with material of the collection (Figs. 15, 17, 20).

PRESENT AND FUTURE

As a result of more than 60 years of continuous work of collecting and research on fossil vertebrates in the PVL collection, around 7,900 specimens have been cataloged to date (Fig. 21). After Bonaparte's departure at the end of 1978 and until 2016, the director of the PVL collection was Powell, and since then it has been Ortiz. On August 2010, after the procedures started by Powell, the PVL collection was registered with the national authority on paleontological matters (Pablo Tubaro, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"), Law 25.743 for the protection of archaeological and paleontological heritage, under the name FCN-IML.

Figure 19. Field works in late Neogene outcrops. **1,** Levels of the India Muerta Formation near Vipos, Tucumán Province in 2012; **2,** Outcrops of the Andalhuala Formation at Encalilla, Tucumán Province in 2015; **3,** Daniel García-López, Matías A. Armella, Vanessa Torres Carro, and Carolina Madozzo-Jaén in Encalilla, Tucumán Province in 2017; **4,** From left to right: Franck Barbière, Claudia Herrera, Graciela Esteban, Carolina Madozzo-Jaén, Pablo E. Ortiz, and Norma Nasif in Chiquimil Formation outcrops near San José, Catamarca Province in 2015; **5,** Pablo E. Ortiz and Graciela Esteban prospecting outcrops of the Andalhuala Formation at Entre Ríos, Santa María valley, Catamarca Province in 2015; **6,** Carolina Madozzo-Jaén and Vanessa Torres Carro prospecting outcrops of the Andalhuala Formation at Puerta de Corral Quemado, Catamarca Province in 2021.

The development of the LVF in its early days, especially under the direction of Bonaparte, strongly stimulated the field of vertebrate paleontology, becoming a national and international point of reference for research in the continental Mesozoic. Currently, the collection is regularly visited by researchers worldwide, mainly for its remarkable unique collection of archosaurs and therapsids from the South American Triassic. The lack of Mesozoic terrestrial continental outcrops in Tucumán Province and the fact that the majority of Argentine provinces with continental Mesozoic records currently have research institutions and important groups of local paleontologists, resulted in the end of the incorporation of vertebrate material of this age to PVL (Abdala *et al.*, 2022). Therefore, in the last three decades PVL has grown due to the contribution of researchers who do fieldwork locally and thus, more closely linked to the study of Cenozoic mammals. Currently, the PVL collection and the *Cátedra de Paleontología* of the FCN-IML encompass a large group of paleontologists linked to different institutions (CONICET, Instituto Superior de Correlación Geológica, FML, Unidad Ejecutora Lillo and FCN-IML), most of them researching on mammal paleontology (Fig. 20).

The "Lillo", as the FCN-IML and the FML as a whole are known, is the oldest natural history institution in northwest Argentina, with great visibility among the scientific institutions of Tucumán. Since creatures from the remote past awake the imagination and fascination of visitors, the fossils from the PVL collection exhibited at the Museo Lillo de Ciencias Naturales are its main attraction (Fig. 9). The PVL collection also stands out within the "Lillo" for preserving a large number of holotype specimens and materials of high scientific value that are key reference for researchers around the world. Publications of a high academic level developed by Lillo researchers linked to the PVL collection and the several ongoing projects maintain the relevance of the collection and allow creating new lines of research. The increase in the number of students and scholars in recent years is promising for the future of vertebrate paleontology in northwest Argentina.

Figure 20. Staff that currently carries out vertebrate paleontology fieldwork in institutions related to "El Lillo" (**FML**, **FCN-IML**, Unidad Ejecutora Lillo [**FML-CONICET**]), Instituto Superior de Correlación Geológica (**UNT-CONICET**). **1,** Rodrigo González; **2,** Pablo E. Ortiz; **3,** Carolina Madozzo-Jaén; **4,** José Aguilar; **5,** Norma Nasif; **6,** Claudia Herrera; **7,** Graciela Esteban; **8,** Judith Babot; **9,** Fernando Abdala; **10,** Daniel García-López; **11,** Virginia Deraco; **12,** Matías A. Armella; **13,** Vanessa Torres Carro; **14,** Gonzalo Bravo; **15,** Luis Saade; **16,** Christophe Hendrickx; **17,** Jaime Morales; **18,** Sara Bertelli; **19,** Nadia Haidr.

TABLE 1 – List of type specimens housed in the Colección Paleontología de Vertebrados Lillo

Taxon	Holotype	Author, year	Comments
Ctenomys dasseni	PVL 739	Rusconi, 1931	Rusconi coll. 161
Dicoelophorus chapadmalensis	PVL 1270	Rusconi, 1932	Rusconi coll. (no number)
Ceratophrys ensenadensis	PVL 767	Rusconi, 1932	Rusconi coll. 413
Rhea americana anchorenense	PVL 1286	C. Ameghino & Rusconi, 1932	Rusconi coll. 639
Tremacebus harringtoni	PVL 619	Rusconi, 1933	Rusconi coll. 661
Plataeomys castellanosi	PVL 1252	Rusconi, 1933	Rusconi coll. 425
Nothydrochoerus fontanai	PVL 645	Rusconi, 1933	Rusconi coll. 509
Macrocavia simpsoni	PVL 1026	Rusconi, 1933	Rusconi coll. 501
Microcavia parca	PVL 1009	Rusconi, 1948	Rusconi coll. 1421
Palaeolama weddelli parodii	PVL 1203	Rusconi, 1933	Rusconi coll. 418
Pseudalopex proplatensis inexpectatus	PVL 1287	Rusconi, 1933	Rusconi coll. 438
Notopachyrukhos tambuttoi	PVL 550	Rusconi, 1933	Rusconi coll. 514
Tetrastylus angustidens	PVL 1040	Rusconi, 1934	Rusconi coll. 704
Diaphoromys fiegi	PVL 540	Rusconi, 1934	Rusconi coll. 741
Glossotherium incertum sanluisence	PVL 1525	Rusconi, 1935	Rusconi coll. 1050
Xenohydrochoerus ballesterensis	PVL 705	Rusconi, 1934	Rusconi coll. 556
Tapirus (Tapiralum) greslebini	PVL 718	Rusconi, 1934	Rusconi coll. 562
Eumysops incertus	PVL 1020	Rusconi, 1935	Rusconi coll. 854
Stereotoxodon tehuelche guinazui	PVL 1527	Rusconi, 1936	Rusconi coll. 1176
Acrotypotherium tapiai	PVL 1526	Rusconi, 1936	Rusconi coll. 1175
Canis (Dusicyon) avus	PVL 532	Rusconi, 1936	Rusconi coll. 107
Notocaiman stromeri	PVL 752	Rusconi, 1937	Rusconi coll. 1205
Leiosaurus marelli	PVL 906	Rusconi, 1937	Rusconi coll. 1215
Glossotherium robustum flexum	PVL 895	Rusconi, 1944	Rusconi coll. 1195
Pseudolestodon puelchensis	PVL 696	Rusconi, 1944	Rusconi coll. 830
Plesiomegatherium triangulatum	PVL 828	Rusconi, 1944	Rusconi coll. 738
Myocastor brevirostris	PVL 1059	Rusconi, 1944	Rusconi coll. 1212
Cardiomys (Pseudocardiomys) puelchensis	PVL 1043	Rusconi, 1944	Rusconi coll. 1228
Plexochoerus puelchensis	PVL 1010	Rusconi, 1944	Rusconi coll. 1301
Toxodontherium triangulatum	PVL 548	Rusconi, 1944	Rusconi coll. 1325
Tramyocastor majus	PVL 1037	Rusconi, 1945	Rusconi coll. 1392
Diaphoromys arctus	PVL 1042	Rusconi, 1945	Rusconi coll. 1395
Gyriabrus latidens	PVL 1034	Rusconi, 1945	Rusconi coll. 1136
Gyriabrus quadratus	PVL 1041	Rusconi, 1945	Rusconi coll. 1302
Myocastor brevirostris ballesterensis	PVL 1195	Rusconi, 1945	Rusconi coll. 1403
Isostylomys laevis	PVL 1035	Rusconi, 1945	Rusconi coll. 1162
Scelidotherium parodii puelchense	PVL 902	Rusconi, 1948	Rusconi coll. 1373
Xenohydrochoerus gracilis	PVL 704	Rusconi, 1949	Rusconi coll. 1409
Trigodon gaudryi quadratus	PVL 539	Rusconi, 1949	Rusconi coll. 1018
Onohippidium compressidens magnum	PVL 716	Rusconi, 1949	Rusconi coll. 1211
Saltenia ibanezi	PVL 2010	Reig, 1959	
Saurosuchus galilei	PVL 2062	Reig, 1959	

TABLE 1 – Continuation

Taxon	Holotype	Author, year	Comments
Proterochampsa barrionuevoi	PVL 2063	Reig, 1959	
Aetosauroides scagliai	PVL 2073	Casamiquela, 1960	
Argentinosuchus bonapartei	PVL 2091	Casamiquela, 1960	
Shelania pascuali	PVL 2186	Casamiquela, 1960	
Vieraella herbsti	PVL 2488	Reig, 1961	
Herrerasaurus ischigualastensis	PVL 2566	Reig, 1963	
Promastodonsaurus bellmani	PVL 2092	Bonaparte, 1963	
Trialestes romeri	PVL 2561	Reig, 1963	
Proexaeretodon vincei	PVL 2565	Bonaparte, 1963	
Ischignathus sudamericanus	PVL 2564	Bonaparte, 1963	
Kannemeyeria argentinensis	PVL 3465	Bonaparte, 1966	
Pisanosaurus mertii	PVL 2577	Casamiquela, 1967	
Bufo pisanoi	PVL 2197	Casamiquela, 1967	
Riojasuchus tenuisceps	PVL 3827	Bonaparte, 1969	
Pseudhesperosuchus jachaleri	PVL 3830	Bonaparte, 1969	
Hemiprotosuchus leali	PVL 3829	Bonaparte, 1969	
Riojasaurus incertus	PVL 3808	Bonaparte, 1969	
Strenusaurus procerus	PVL 3663	Bonaparte, 1969	
Andescynodon mendozensis	PVL 3833	Bonaparte, 1969	
Neoaetosauroides engaeus	PVL 3525	Bonaparte, 1969	
Vinceria andina	PVL 3831	Bonaparte, 1969	
Cynognathus minor	PVL 3859	Bonaparte, 1969	
Rusconiodon mignonei	PVL 3840	Bonaparte, 1970	
Jachaleria colorata	PVL 3841	Bonaparte, 1970	
Pterodaustro guinazui	PVL 2571	Bonaparte, 1970	
Venaticosuchus rusconii	PVL 2578	Bonaparte, 1971	
Cromptodon mamiferoides	PVL 3858	Bonaparte, 1972	
Lagosuchus lilloensis	PVL 3871	Romer, 1972	
Puntanipterus globosus	PVL 3869	Bonaparte & Sánchez, 1975	
Callopistes bicuspidatus	PVL 4618	Chani, 1976	
Bolomys bonapartei	PVL 2396	Reig, 1978	
Phyllotis (Auliscomys) formosus	PVL 2397	Reig, 1978	
Mussaurus patagonicus	PVL 4068	Bonaparte & Vince, 1979	
Patagosaurus fariasi	PVL 4170	Bonaparte, 1979	
Piatnitzkysaurus floresi	PVL 4073	Bonaparte, 1979	
Volkheimeria chubutensis	PVL 4077	Bonaparte, 1979	
Bonapartherium hinakusijum	PVL 4018	Pascual, 1980	
Chaliminia musteloides	PVL 3857	Bonaparte, 1980	
Saltasaurus loricatus	PVL 4017-92	Bonaparte & Powell, 1980	
Noasaurus leali	PVL 4061	Bonaparte & Powell, 1980	
Fasolasuchus tenax	PVL 3850	Bonaparte, 1981	
Enantiornis leali	PVL 4035	Walker, 1981	
Eoastrapostylops riolorense	PVL 4216	Soria & Powell, 1981	
Colbertia lumbrerense	PVL 4607	Bond, 1981	

TABLE 1 – Continuation

Taxon	Holotype	Author, year	Comments
Indalecia grandensis	PVL 4186	Bond & Vucetich, 1983	
Pseudolagosuchus major	PVL 4629	Arcucci, 1987	
Glossotherium emmersoni	PVL 3874	Esteban, 1988	
Notonychops powelli	PVL 4298	Soria, 1989	
Satshatemnus bonapartei	PVL 4297	Soria, 1989	
Tropidosuchus romeri	PVL 4601	Arcucci, 1990	
Yungavolucris brevipedalis	PVL 4053	Chiappe, 1993	
Lectavis bretincola	PVL 4021	Chiappe, 1993	
Soroavisaurus australis	PVL 4690	Chiappe, 1993	
Bretesuchus bonapartei	PVL 4735	Gasparini *et al.*, 1993	
Pampahippus arenalesi	PVL 4192	Bond & López, 1993	
Paraglossotherium elmollarum	PVL 4633	Esteban, 1993	
Neophractus martae	PVL 4795	Esteban & Nasif, 1996	
Chasicotatus peiranoi	PVL 4796	Esteban & Nasif, 1996	
Vetelia gandhii	PVL 4800	Esteban & Nasif, 1996	
Lessemsaurus sauropoides	PVL 4822-1	Bonaparte, 1999	
Calchaquitherium mixtum	PVL 4794	Nasif *et al.*, 2000	
Limenavis patagonica	PVL 4731	Clarke & Chiappe, 2001	
Tafimys powelli	PVL 4825	Ortiz *et al.*, 2000	
Callistoe vincei	PVL 4187	Babot *et al.*, 2002	
Martinavis vincei	PVL 4054	Walker *et al.*, 2007	
Coquenia bondi	PVL 5853	Deraco *et al.*, 2008	
Dolichostylodon saltensis	PVL 6219-A	García-López, 2009	
Martinavis saltariensis	PVL 4025	Walker & Dyke, 2009	
Martinavis whetstonei	PVL 4028	Walker & Dyke, 2009	
Martinavis minor	PVL 4046	Walker & Dyke, 2009	
Elbretornis bonapartei	PVL 4022	Walker & Dyke, 2009	
Megapaloelodus peiranoi	PVL 3327	Agnolin, 2009	
Chasicotatus powelli	PVL 3212	Scillato-Yané *et al.*, 2010	
Lorosuchus nodosus	PVL 6219-B	Pol & Powell, 2011	
Griphotherion peiranoi	PVL 5903	García-López & Powell, 2011	
Uquiasaurus heptanodonta	PVL 6388	Daza *et al.*, 2012	
Pardinamys humahuaquensis	PVL 6316	Ortiz *et al.*, 2012	
Pucatherium parvum	PVL 6398	Herrera *et al.*, 2012	
Pampahippus secundus	PVL 6426	Deraco & García-López, 2015	
Gaimanophis powelli	PVL 6547	Albino, 2017	
Powellvenator podocitus	PVL 4414-1	Ezcurra, 2017	
Lumbreratherium oblitum	PVL 4262	Herrera *et al.*, 2017	
Tucmanableps cionei	PVL 2412	Sferco *et al.*, 2017	
Sachajenynsia pacha	PVL 7036	Sferco *et al.*, 2017	
Toxodon caravela	PVL 6579	Armella *et al.*, 2018	
Rodcania kakan	PVL 7583	Gelfo *et al.*, 2020	
Sebecus ayrampu	PVL 2606	Bravo *et al.*, 2021	
Philander massoiai	PVL 3118	Goin, 2021	

Figure 21. The **PVL** collection today. **1,** Drawer with mammals of the Colección Rusconi; **2,** Drawer with fishes from the La Cantera Formation, San Luis Province; **3,** Shelves with dinosaur material; **4,** General view of drawers and shelves; **5,** Shelves with remains of the dinosaur ***Piatnitzkysaurus floresi***.

Figure 22. 1, Last photo of Jaime E. Powell on a field trip at Sierra de la Candelaria, Salta Province in October 2015. From left to right: Jaime E. Powell, the geologist Pablo Alonso-Muruaga, Rodrigo González, Daniel García-López, Vanessa Torres Carro, and Carolina Madozzo-Jaén; **2,** Last visit of José F. Bonaparte to the **PVL** in April 2018. From left to right: the geologist Florencio G. Aceñolaza, José F. Bonaparte, Rodrigo González, Pablo E. Ortiz, and Fernando Abdala.

Much remains to be done, especially regarding spaces, furniture, staff, and building infrastructure to house the increasing collections. Despite the efforts of many teachers and researchers over the decades, the enormous scientific and educational importance of the PVL collection has not yet triggered the interest of the authorities of the local university and the Tucumán government. This is precisely the challenge that the current generation of paleontologists has to make to the authorities with decision-making power, as an effective way of honoring the great legacy left by Osvaldo Reig, José Bonaparte, and Jaime Powell (Fig. 22).

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