Publicación Electrónica
ASOCIACIÓN PALEONTOLÓGICA ARGENTINA

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ALBERTO C. RICCARDI[1]

1. Museo de La Plata (MLP), Universidad Nacional de La Plata. Paseo del Bosque s/n, 1900 La Plata, Buenos Aires, Argentina.

Recibido: 01 de septiembre 2022 - **Aceptado:** 15 de octubre 2024 - **Publicado:** 25 de Junio 2025

Para citar este artículo: Alberto C. Riccardi (2025). Historical development of invertebrate paleontology in Argentina: 1835–1957. *Publicación Electrónica de la Asociación Paleontológica Argentina* 25(1): 127–142.

Link a este artículo: http://dx.doi.org/10.5710/PEAPA.15.10.2024.441

ISSN 2469-0228

Asociación Paleontológica Argentina
Maipú 645 1° piso, C1006ACG, Buenos Aires
República Argentina
Tel/Fax (54-11) 4326-7563
Web: www.apaleontologica.org.ar

ARTÍCULO Año 2025 - 25(1): 127–142 PeAPA Publicación Electrónica ASOCIACIÓN PALEONTOLÓGICA ARGENTINA

HISTORICAL DEVELOPMENT OF INVERTEBRATE PALEONTOLOGY IN ARGENTINA: 1835–1957

ALBERTO C. RICCARDI[1]

[1]Museo de La Plata (MLP), Universidad Nacional de La Plata. Paseo del Bosque s/n, 1900 La Plata, Buenos Aires, Argentina. *riccardi@fcnym.unlp.edu.ar*

Abstract. Contributions to fossil invertebrates of Argentina began with the collections of d'Orbigny and Darwin and the publications by Forbes and Sowerby. These were continued with the collections of Stelzner and Bodenbender and the studies of Kayser, Gottsche, Behrendsen, Tornquist, and Steuer. Between 1890 and 1930, studies were conducted by foreign expeditions of Nordenskjöld, Skottsberg, and Hatcher to southern Patagonia and of Weaver to west-central Argentina, and those done from the La Plata Museum by Hauthal and Burckhardt. Studies on Triassic and Tertiary fauna began in the late 1920s. Also during this period, a series of biostratigraphic studies commenced, initially by the División de Minas, Geología e Hidrología, and later from Yacimientos Petrolíferos Fiscales. These studies were done, among others, by Groeber, Keidel, Bonarelli, Wichmann, Windhausen, Feruglio, and Piatnitzky. In 1937, with the studies of Harrington, a national paleontological school was born. Works on Paleozoic faunas by Harrington and Kobayashi, and then by Leanza and Rusconi, duplicated in *ca.* 10 years all previous production on the subject. In the 30s and 40s, Frenguelli studied insects, Upper Paleozoic continental mollusks, and siliceous microorganisms. Between 1936 and 1947, the number of titles dedicated to invertebrates doubled that of the previous decade. The subsequent period had numerous contributions by Rusconi, mainly on trilobites and graptolites. The diversity of studied invertebrates increased significantly, and studies on foraminifera began. The foundation of the Argentine Paleontological Association in 1955 and the publication of Ameghiniana from 1957 onwards, were instrumental to the continuity of researches on the matter.

Key words. Paleontology. Invertebrates. Argentina. History.

Resumen. DESARROLLO HISTORICO DE LA PALEONTOLOGIA DE INVERTEBRADOS EN LA ARGENTINA: 1835–1957. Las contribuciones al conocimiento de los invertebrados fósiles de la Argentina comenzaron con las colecciones de d'Orbigny y Darwin y las publicaciones de Forbes y Sowerby. Prosiguieron con Stelzner, Bodenbender y los estudios de Kayser, Gottsche, Behrendsen, Tornquist y Steuer. Entre 1890 y 1930 muchos estudios se debieron a las expediciones extranjeras de Nordenskjöld, Skottsberg y Hatcher a la Patagonia austral, de Weaver al centro-oeste argentino y las del Museo de la Plata por Hauthal y Burckhardt. A fines de la década de 1920 comenzaron estudios sobre insectos triásicos y terciarios. En este lapso comenzaron estudios desde la División de Minas, Geología e Hidrología, y Yacimientos Petrolíferos Fiscales. Estos estudios estuvieron vinculados a, entre otros, Groeber, Keidel, Bonarelli, Wichmann, Windhausen, Feruglio y Piatnitzky. En 1937, Harrington inició una escuela paleontológica nacional. Trabajos de faunas del Paleozoico, debidos a Harrington y Kobayashi, y luego Leanza y Rusconi llegaron en *ca.* 10 años a duplicar la producción previa sobre el tema. En los años 1930 y 1940, Frenguelli realizó estudios sobre insectos, moluscos continentales del Paleozoico superior y microorganismos silíceos. Entre 1936 y 1947 la cantidad de títulos duplicó la de la década anterior. El período subsiguiente contó con numerosas contribuciones de Rusconi referidas principalmente a trilobites y graptolites. La diversidad de phyla estudiados aumentó y se iniciaron estudios sobre foraminíferos. La fundación de la Asociación Paleontológica Argentina en 1955 y el inicio de la publicación de Ameghiniana en 1957, contribuyeron a la continuidad de las investigaciones y la publicación de sus resultados.

Palabras clave. Paleontología. Invertebrados. Argentina. Historia.

Among the earliest contributions to the knowledge of fossil invertebrates of Argentina are those resulting from the travels of Alcide D'Orbigny (1802–1857) (Fig. 1.1) and Charles R. Darwin (1809–1882) (Fig. 1.2) during the first half of the nineteenth century. D'Orbigny visited Argentina between 1826 and 1833 when he toured northeastern Argentina and the Patagonian coast along the vicinity of the Negro River mouth. The fossil invertebrates he collected in Paleogene/Neogene units were described in 1842 in one of the nine volumes of his work entitled "*Voyage dans 1'Amérique Méridionale*" published between 1835 and 1847 (d'Orbigny, 1835–1847).

Around the same time, between 1832 and 1835, Robert Fitz Roy (1805–1865) and Darwin visited different places

in Argentina. The invertebrate fossils collected by Darwin were included in two appendices of his work "Geological Observations on the volcanic islands and parts of South America" (Darwin, 1846). One of the appendices was authored by the naturalist Edwards Forbes (1815–1854), dealing with fossils from the Cretaceous mount Tarn in the vicinity of the Strait of Magellan, nowadays Chile (Forbes, 1846). The other appendix was authored by the British naturalist George B. Sowerby (1788–1854), dealing with fossil invertebrates found in the Cenozoic of the Atlantic coast (Sowerby, 1846). They also gave rise to a short contribution on echinoderms (Desor, 1846).

Burmeister (1858) and Bravard (1858) identified invertebrates in their studies on the "Tertiary" (Neogene) of Paraná, Entre Ríos Province, Argentina, some of which were later described by Philippi (1891, 1893).

THE SCIENTIFIC STUDIES BETWEEN 1876 AND 1930

Darwin's observations on the southern Patagonian Cordillera were expanded by the German geologist Gustav Steinmann (1856–1929) (Fig. 1.3), who in 1883 visited Punta Arenas (Chile) and described the main geological features of the region located between the Strait of Magellan and Lake Argentino. The fossils he collected and those that the German geologist Rudolf Hauthal (1854–1928) collected between 1898 and 1900 while working for the Museo de La Plata were studied by Wilckens (1907a, 1907b) and Paulcke (1907).

Contributions on fossil invertebrates only began to have greater relevance at the end of the nineteenth century due to the activities of the Academia Nacional de Ciencias of Córdoba. The creation of this institution was proposed by the Director of the Museo Público de Buenos Aires Hermann Burmeister (1807–1892) and its first geologist was the German Alfred W. Stelzner (1840–1895) (Fig. 1.4).

Stelzner stayed in Argentina between 1871 and 1874 and he recognized the differences between the Sierras Pampeanas in the central region of the country from the geological units located to the west, referred respectively to as the Antecordillera or Precordillera and the Cordillera Principal, in which he recognized fossils from the Paleozoic and Jurassic. The invertebrates collected by Stelzner were studied in Germany by Emanuel Kayser (1845–1927) (Fig. 1.5) and Karl Gottsche (1855–1909). Thus, the first important contributions to the knowledge of the fossil invertebrates of the Argentine territory—after Sowerby—were made by Kayser (1876) and Gottsche (1878). These authors described the Paleozoic faunas of the Precordillera (Kayser) and the Jurassic faunas from Paso del Espinacito in the San Juan Province (Gottsche).

Stelzner was succeeded at the Academia Nacional de Ciencias of Córdoba by the Germans Ludwing Brackebusch (1849–1906) and later by Guillermo Bodenbender (1857–1941). The former elaborated the first geological map of northwestern Argentina and collected fossil invertebrates in the Paleozoic outcrops of the region, which were later studied by Kayser (1897, 1898) and by Thomas (1905). Other fossils collected by the German geologist Richard Stappenbeck (1880–1963) while working at the Dirección General de Minas, Geología e Hidrología, were studied by Clarke (1912) in the USA.

Work sponsored by the Academia Nacional de Ciencias of Córdoba resulted in a series of studies on Late Jurassic and Lower Cretaceous invertebrates from the Andes published by Behrendsen (1891, 1892), Steuer (1897), and Tornquist (1898). Such works were continued between 1907 and 1931 as a series of studies based on material sent to Steinmann or collected by himself during several trips through western South America between 1882 and 1908. Thus, after his 1902–1903 trip, fossil material from the Upper Jurassic of Cerro Lotena sent to him by the Museo Nacional de Buenos Aires led to a publication on ammonites (Haupt, 1907). Material from the Lower and Middle Jurassic sent to Steinmann by the German geologist Johann Keidel (1887–1954) were studied by Jaworski (1914, 1915, 1926), while Middle Jurassic and Oxfordian material were described by Stehn (1923). Many of these studies were published between 1893 and 1925 in a series under the title "*Beiträge zur Geologie und Paläontologie von Sudamerika*".

Of the material collected by the German paleontologist and geologist Arnold Heinrich P. Gerth (1884–1971) (Fig. 1.6), he studied the Cnidaria and ammonoids (Gerth, 1925, 1926, 1928) and the rest were included in other authors'

publications. Faunas of the Lower Jurassic were partially studied by E. Jaworski (1890–1973) and those of the Tithonian and Lower Cretaceous by Krantz (1928) and Indans (1954). Similarly, material collected by M. Récopé (?–?) during fieldwork in Neuquén Province led to a study at the School of Mines of Paris (Douvillé, 1910).

To the Academia Nacional de Ciencias also belonged the German Adolf Doering (1848–1925), who, as a member of

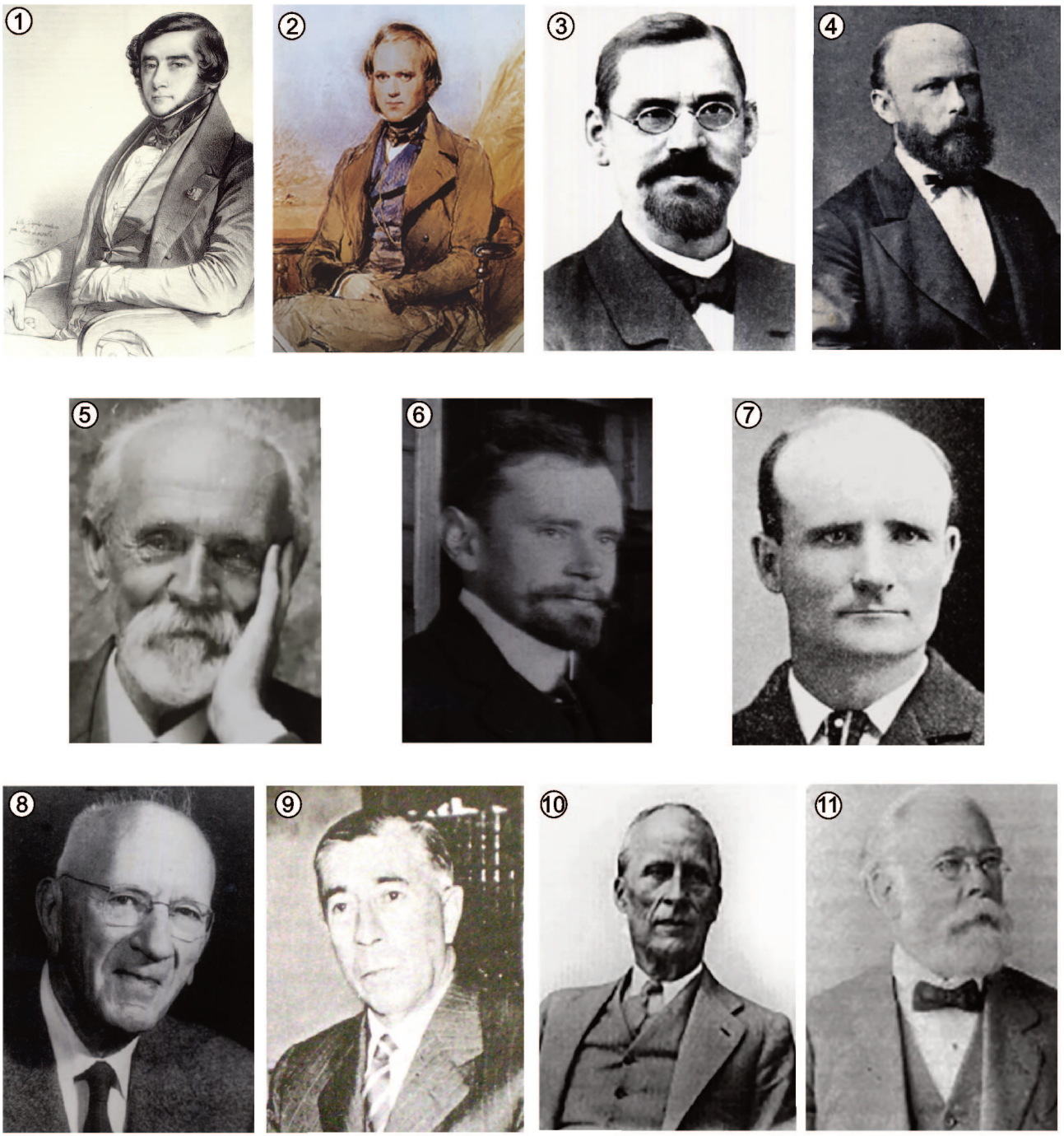

Figure 1. 1, Alcide D'Orbigny (1802–1857). **2,** Charles R. Darwin (1809–1882). **3,** Gustav Steinmann (1856–1929). **4,** Alfred W. Stelzner (1840–1895). **5,** Emanuel Kayser (1845–1927). **6,** Arnold H. P. Gerth (1884–1971). **7,** John B. Hatcher (1861–1904). **8,** Charles E. Weaver (1880–1958). **9,** Martín Doello Jurado (1884–1948). **10,** Carl J. Burckhardt (1869–1935). **11,** Hermannn von Ihering (1850–1930).

the Scientific Commission accompanied to the Argentine army commanded by Julio Argentino Roca (1843–1914) in his campaign through northern Patagonia in 1879. In the official report of that commission, Doering (1882) proposed a classification of the Cenozoic in which many invertebrates would be later located.

However, contributions to the knowledge of fossil invertebrates only acquired an almost continuous flow from 1890 onwards, following a pattern that would only be modified in the mid-1930s. During those 40 years, publications included mostly monographs that established the basic knowledge about the megafaunas of the Lower Paleozoic, Jurassic, Cretaceous, and Paleogene/Neogene of Argentina. Many of these studies—except for those originating in the Museo de La Plata and the Academia Nacional de Ciencias of Córdoba—were possible thanks to expeditions organized by foreign institutions, such as those led by the Swedish geologist Otto Nordenskjöld (1869–1928), the Swedish botanist Carl J. F. Skottsberg (1880–1963), and the American geologist and explorer John B. Hatcher (1861–1904) (Fig. 1.7) to southern Patagonia; by the American geologist Charles E. Weaver (1880–1958) (Fig. 1.8) to west central Argentina; and by the South African geologist Alexander Du Toit (1878–1948) to the Precordillera.

The most important foreign expeditions included two of Swedish origin and two from the USA. The first Swedish expedition, between 1895 and 1897, under the direction of Nordenskjöld, was carried out in Tierra del Fuego Province, although he extended his studies to the region of Ultima Esperanza and the eastern slope of the Cordillera down to 51° S. Invertebrates were studied by Steinmann & Wilckens (1908). The second expedition, under the direction of Skottsberg, was carried out between 1907 and 1909 and led to a study by Stolley (1912) on Cretaceous invertebrates.

The first USA expedition was conducted between 1896 and 1899 and was led by Hatcher from Princeton University. It resulted in an extensive geological and paleontological study, mostly in the area to the north of Lake San Martin, that was published in eight volumes under the direction of the American vertebrate paleontologist William B. Scott (1858–1947). Cretaceous invertebrates were studied by T. W. Stanton (1860–1953) and those from the Tertiary by A. E. Ortmann (1863–1927) and resulted in two important publications (Stanton, 1901; Ortmann, 1902).

The second USA expedition, between 1919 and 1926, was led by Weaver from the University of Washington and sponsored by Standard Oil of California and had an exploratory purpose linked to the search for oil. As a result, an important stratigraphic and paleontological work was published (Weaver, 1931) entitled "Paleontology and stratigraphy of the Jurassic and Cretaceous of West Central Argentina".

A special mention deserves the "Italian-Argentinian Expedition of 1881-1882", with the Italian explorer Giacomo Bove (1852–1887) as chief scientist, and the one organized by Du Toit in the 1920s. The first of these expeditions, in which the Italian geologist Domenico Lovisato (1842–1916) participated, was supported by the Instituto Geográfico Nacional and travelled along the Atlantic coast down to the Isla de los Estados and the Beagle Channel. The material collected by Lovisato, with the addition of specimens provided by the Argentine biologist and paleontologist Martín Doello Jurado (1884–1948) (Fig. 1.9), Director of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" between 1928 and 1943, and obtained thanks to Steinmann, gave rise to the study of Richter (1925), which included the first description of microfossils from Tierra del Fuego Province.

The second expedition was led by Du Toit, who worked for different South African institutions. In the 1920s, Du Toit requested financial support from the Carnegie Institution of Washington, USA, to make observations in South America to provide evidence to support the Theory of Continental Drift of Alfred Wegener (1880–1930). The expedition lasted two months in 1923, covering Argentina's entire central region, from the Buenos Aires Province to the Cordillera. The results were analyzed in "A geological comparison of South America with Southern Africa" (Du Toit, 1927). It included an appendix in which the English paleontologist and geologist Frederick R. C. Reed (1860–1946) from the Sedgwick Museum in Cambridge, described fossils (mainly brachiopods, bryozoans, bivalves, and gastropods) from the Upper Paleozoic of the Precordillera (Reed, 1927).

The studies originated in the Museo de La Plata were associated with the Argentinean naturalist and Director of

the Museo de La Plata Francisco P. Moreno (1852–1919), Hauthal, the Swiss geologist Carl J. Burckhardt (1869–1935) (Fig. 1.10), and the Swiss paleontologist Kaspar J. Roth (1850–1924). The latter, between 1895 and 1924, was Director of the Paleontological section of the Museo de La Plata. Moreno, in addition to his own expeditions, was in charge of all the expeditions under the museum's sponsorship. They were mainly focused on the Patagonian region and resulted in collections that served as the basis for studies of Paleogene and Neogene echinoderms by Lahille (1896, 1898, 1899). Hauthal, a geologist associated with the Museo de La Plata between 1898 and 1900, studied the area between the Seno de la Ultima Esperanza, Lake Argentino, and the 47° S latitude. He drew a geological map that was published by Wilckens (1907a), who also studied Cretaceous and Cenozoic invertebrates (Wilckens, 1907b, 1921). The Late Cretaceous cephalopods collected by Hauthal and Steinmann were studied by Paulcke (1907); those from the Early Cretaceous of the Argentino and Belgrano lakes by Favre (1908); while other mollusks of the Cretaceous and Cenozoic were studied by Ihering (1897) and Wilckens (1907b). The invertebrates collected by Burckhardt and the Swiss geologist Leo Wehrli (1870–1954) in Neuquén and Mendoza provinces were studied by Burckhardt (1900a, 1900b, 1903). Roth (1899) discovered the fossiliferous levels of the Cretaceous/Paleogene boundary of General Roca. Those invertebrates were later studied by Burckhardt (1902a), Ihering (1903a), and Wilckens (1905). Roth also described the marine fauna from the Lower Jurassic of Piedra Pintada (Roth, 1902), although some invertebrates were also studied by Burckhardt (1902b). Among the geologists from the Museo de La Plata was the German Johann Valentin (1867–1897), who was the first to record the presence of ichnofossils in the lower Paleozoic of the Tandil mountains of Buenos Aires Province (Valentin, 1895). It is thus observed that the material found was generally sent to overseas institutions and that they were also studied by foreigners. Participation of German paleontologists constituted more than 40% of the total number of authors in 1890–1930 and mostly carried out studies on Mesozoic faunas, which were the only existing source of information until the mid-twentieth century.

Equally important were the contributions to the Cenozoic megafauna (Ihering, 1896, 1897, 1899a, 1899b, 1902, 1903a, 1903b, 1903c, 1904, 1905, 1907, 1914, 1922; Cossmann, 1899; Doello Jurado, 1915, 1919, 1922, 1927). In these studies, the German-Brazilian Hermann von Ihering (1850–1930) played a fundamental role in 1896–1922 (Fig.1.11). Ihering settled in Brazil in 1880. After 1910, Doello Jurado was instrumental in these contributions. Ihering complemented the studies on fossil vertebrates undertaken by brothers Carlos and Florentino Ameghino from the Museo Nacional de Buenos Aires (since 1957, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia").

Knowledge on Meso–Cenozoic invertebrates—mostly mollusks, brachiopods, corals, echinoderms, and bryozoans—was expanded from the 1920s onwards. A series of studies on Triassic and Tertiary insects from the west and north of the country appeared, due mostly to Argentine or foreign authors residing in the country (Cabrera, 1928; Schlagintweit, 1936; Frenguelli, 1938a, 1938b, 1939; Viana & Haedo Rossi, 1957). It is worth noting the contributions by Dallas (1924) and Cockerell (1925, 1926a, 1926b, 1936). All these studies were later synthesized by Fossa Mancini (1941). In parallel, research conducted at the Museo de La Plata would lead to specific publications on Cenozoic echinoderms (Sáez, 1930) and Paleozoic nautiloids (Sáez, 1931).

Thus, between 1890 and 1920, almost half of the publications on fossil invertebrates were related to Cenozoic mollusks and between 1890 and 1936 was published a large proportion of all works on Cenozoic invertebrates known until the mid-twentieth century. Among them are studies of Bryozoa (Canu, 1904, 1909, 1911), Porifera (Principi, 1915), Cnidaria (De Angelis D'Ossat, 1908), Gastropoda (Borchert, 1901), and Echinodermata (Lahille, 1896, 1898; Lambert, 1903; Ruedemann, 1916) from the Paleozoic, Mesozoic, and Cenozoic of Patagonia. Most of them are still nowadays fundamental contributions on these subjects. Except those of Lahille and Lambert, all studies were conducted abroad with specimens that were sent from Argentina.

Between 1876 and 1935, only 30% of the publications were edited in the country and approximately 75% of these

were published equally by the Museo Argentino de Ciencias Naturales, the Museo de La Plata, and the Academia Nacional de Ciencias of Córdoba. Those of the latter included useful Spanish versions of a series of classic monographs originally published in other languages. Also during this period, a series of biostratigraphic studies were carried out by the División de Minas, Geología e Hidrología of the Ministerio de Agricultura and from Yacimientos Petrolíferos Fiscales (state oil company). These biostratigraphic studies were conducted, among others, by the German geologists Paul F. K. Groeber (1885–1964), Anselm Windhausen (1882–1932), Richard Wichmann (1881–1930), Gerth, Keidel, and Stappenbeck and the Italian paleontologist Cayetano Rovereto (1870–1952) and geologists Guido Bonarelli (1871–1951) (Fig. 2.1) Egidio Feruglio (1897–1954) (Fig. 2.2), Alejandro Matveievich Piatnitzky (1879–1959), and Remigio Rigal (1894–1990). Many of these contributions, even if not exclusively on paleontology, came to bear later a decisive influence on its development. The fossil invertebrates they collected were studied abroad, either by themselves (*e.g.*, Bonarelli, Gerth, Feruglio, Piatnitzky) or by specialists from institutions to which they were affiliated.

Bonarelli, together with the Argentinean geologist Juan J. Nájera (1887–1966), published in 1921 an important study on the Cretaceous stratigraphy and paleontology from the Lake San Martin region. This study was later extended by Feruglio (1934a, 1934b, 1936) on Mesozoic and Cenozoic fossil invertebrates of different localities of Patagonia and by Piatnitzky (1938) on those of the region of Cardiel and San Martin lakes. Bonarelli (1921, 1927) also covered in his contributions invertebrates from units recognized in northern Argentina.

Piatnitzky discovered in the 1940s a series of levels with Upper Paleozoic invertebrates in the central and western area of Chubut Province, which would give rise to important collections by the Argentinean geologist Tomas Suero (1915–1963) and laid the basis, from the 1960s onwards, of important studies by researchers of the Museo de La Plata directed by Arturo J. Amos (1927–1999). Rovereto, on the other hand, collected bryozoans from the Paleogene/Neogene of Peninsula Valdes, which were studied in Italy by Conti (1949). A specific exception was Rigal, who, in December 1924, collected Lower Jurassic ammonites in the Cordillera del Espinacito, south of San Juan Province that were described shortly after (Rigal, 1930).

THE FIRST INVERTEBRATE ARGENTINE PALEONTOLOGISTS, 1937–1947

The second half of the 1930s and the following decade changed the development of Argentine fossil invertebrates studies. During those years, contributions by paleontologists based overseas were reduced and those made by Argentinean paleontologists began to prevail. This was mainly related to foreign researchers residing in the country, together with a small group of paleontologists born in Argentina. Hence, the first Argentinean group of invertebrate paleontologists arose. Despite their ups and downs, they showed a remarkable continuity over the following decades.

Apart from the contributions mentioned above by Doello Jurado (1915, 1919, 1922, 1927), the beginning of this new era of Invertebrate Paleontology in Argentina can be traced back to 1937, the year in which the first work on fossil invertebrates published by Horacio J. Harrington (1910–1973) appeared (Fig. 2.3). Not only was Harrington a pioneer of a national paleontological school, but with him, diverse studies initiated and their importance would be appreciated in the following decades. Harrington (1937) study on Ordovician fossils—perhaps because of the influence of Keidel—revitalized Kayser's research on Paleozoic invertebrates from the end of the nineteenth century, which except for some isolated contributions had languished until then.

Harrington's publications dealing with Paleozoic invertebrates (mainly trilobites and graptolites) from Argentina, with contributions from Japanese geologist Teiichi Kobayashi (1901–1996) (Fig. 2.4), Armando F. Leanza (1919–1975) (Fig. 2.5), and Carlos Rusconi (1898–1969) (Fig. 2.6), doubled all previous publications on the subject in approximately 15 years (*i.e.*, Harrington, 1937, 1938; Kobayashi, 1935, 1936, 1937a, 1937b; Leanza, 1941; Harrington & Leanza, 1942, 1943, 1952, 1957; Rusconi, 1946a, 1946b, 1948a, 1949b, 1950a, 1950b, 1951, 1952a, 1952b, 1953, 1954a, 1954b, 1955a, 1955b; Borrello & Gareca, 1951). Thus, not only was the knowledge of Lower Paleozoic faunas increased but also that of the Upper Paleozoic, which had been initiated by Reed (1927).

At the same time, contributions on Cenozoic mollusks from Mesopotamia and the Buenos Aires Province were published. The beginning of the 1930s had a fundamental protagonist: Joaquín Frenguelli (1883–1958) (Fig. 2.7). Although his contributions to the field of fossil invertebrates were few in comparison with those he made in other fields of the natural sciences, they were the only regional studies on Cenozoic insects (Frenguelli, 1938a, 1938b, 1939), Upper Paleozoic and Triassic continental mollusks (Frenguelli, 1945), and different types of siliceous microorganisms. But Frenguelli's decisive influence on the study of invertebrates began with him as Director of the Museo de La Plata and Head of the División de Paleozoología Invertebrados y Paleobotánica of the same institution. Under his direction, the Museo de La Plata acquired a renewed relevance, evidenced in the quantity and quality of the publications produced until almost the end of the 1940s. As a researcher, Frenguelli promoted numerous biostratigraphic studies, especially about the Mesozoic of Neuquén Province, which enriched the museum's well-organized collections. It was then that Harrington and the Italian geologist Enrico Fossa Mancini (1884–1950) also participated, where researchers such as A. Herrero Ducloux (1915–1965), Suero, Angel V. Borrello (1919–1971) (Fig. 2.8), and Leanza, among others, were formed, who in their works would also show the influences of Keidel and Groeber. It is worth mentioning the studies of Fossa Mancini (1938) on bivalves from the Cretaceous/Paleogene boundary; of Leanza (1940a, 1940b, 1942, 1943, 1944, 1945a, 1946, 1947, 1949) and Herrero Ducloux & Leanza (1943) on bivalves and, especially, ammonites from the Mesozoic. They were followed by the contributions from Carral Tolosa (1942b), Lambert (1944), Sokolov (1946), and Stipanicic (1951).

Between 1936 and 1947, the number of publications dedicated to fossil invertebrates doubled that of the previous decade and comprised half of all the publications until then. Of the 80% of fossils in Argentina published,

Figure 2. 1, Guido Bonarelli (1871–1951). **2,** Egidio Feruglio (1897–1954). **3,** Horacio J. Harrington (1910–1973). **4,** Teiichi Kobayashi (1901–1996). **5,** Armando F. Leanza (1919–1975). **6,** Carlos Rusconi (1898–1969). **7,** Joaquín Frenguelli (1883–1958). **8,** Ángel V. Borrello (1918–1971).

about 60% were known through the publications of the Museo de La Plata under the direction of Frenguelli. During that period, 90% of the authors resided in the country and important papers on the Paleozoic, Mesozoic, and Cenozoic faunas were published. For example, contributions of Parodiz (1944, 1946a, 1946b, 1948, 1949, 1951, 1962) and Carral Tolosa (1937, 1939, 1942a) dedicated mostly to Quaternary mollusks from Buenos Aires Province.

When Frenguelli left the Museo de La Plata, there was an abrupt end of that institution as an important center for the study of fossil invertebrates in the country. It would be almost 20 years before it regained some extent in the matter due to the presence of new researchers, although not equally important in its publications.

TOWARDS THE ARGENTINE PALEONTOLOGICAL ASSOCIATION AND AMEGHINIANA, 1947–1957

The following period, which extends from 1947 until the foundation of the Asociación Paleontológica Argentina and the subsequent appearance of the journal Ameghiniana in 1957, would show a 20% decrease in the total number of publications compared to the previous decade. An exception to this trend are the numerous contributions made by Rusconi, mostly in the Revista del Museo de Historia Natural of Mendoza, and referred mainly to Lower Paleozoic trilobites and graptolites. It is worth mentioning here the contributions by Cecioni (1953) to the knowledge of the Lower Paleozoic nautiloids. The total number of publications increased by 30% and although they focused on the study of the Lower Paleozoic faunas, equally proportional publications centered around Mesozoic and Cenozoic invertebrates.

Especially notable in this period was the diversity of studied phyla, reaching proportions never seen before. The articles included works on Tertiary gastropods (Camacho, 1953) and echinoderms (Bernasconi, 1954, 1959) and on Cretaceous invertebrates from Tierra del Fuego Province (Camacho, 1949; Furque & Camacho, 1949). Among these studies, it is worth mentioning those referring to foraminifera, which marked the beginning of a new era in the study of the Late Cretaceous and Tertiary invertebrates (Camacho, 1954; Boltovskoy, 1961; Bertels, 1964). The emphasis shifted from the mega to the microfauna. The first courses of micropaleontology taught in the country by the Argentinean paleontologist Horacio H. Camacho (1922–2015) (Fig. 3.1) also contributed, as they were taken by most of the main Argentinean paleontologists during the second half of the twentieth century.

Besides the publications by the Museo de Historia Natural of Mendoza, about 35% of the remaining publications were edited abroad, following in quantity to those published by the Sociedad Argentina de Geología (founded in 1945). Although the number of Argentine authors doubled, most of them would not be actively participating in the study of fossil invertebrates. Added to the partial decrease in the total number of contributions, their dispersion in different publication media, the departure of several important researchers and an increase in foreign researchers, a growth crisis was evident.

The foundation of the Asociación Paleontológica Argentina in 1955 and the publication of its journal Ameghiniana from 1957 onwards were transcendent milestones in the history of the study of fossil invertebrates in the country. This auspicious event practically coincided with the creation of the Consejo Nacional de Investigaciones Científicas y Técnicas and of the Comisión Científica de la Provincia de Buenos Aires, organizations that would contribute to the continuity of scientific research and the publication of its results. Thus, the pursuit of common goals and with the support of two institutions created specifically to support scientific research, paleontologists and Argentine paleontology began, during the second half of the 1950s, a

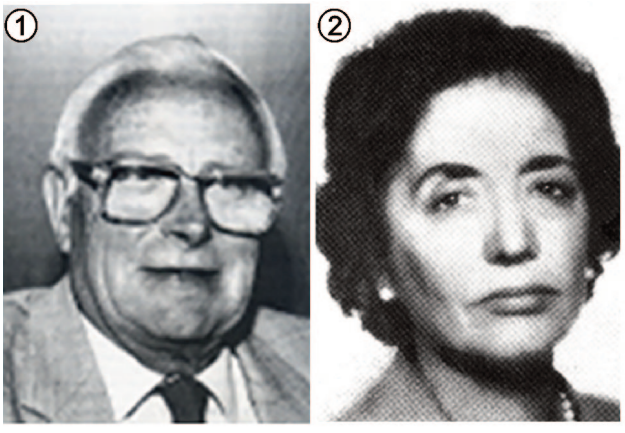

Figure 3. 1, Horacio H. Camacho (1922–2015). **2,** Hildebranda Á. Castellaro (1913–1995).

trend of sustained progress that would continue in the following decades.

Notable events of this period were also the publication, in the 1960s, of the Paleontographia Bonaerense by the initiative of Borrello and with the support of the Comisión Científica de la Provincia de Buenos Aires; the initial volumes of the Guia Paleontológica Argentina with the support of the Consejo Nacional de Investigaciones Científicas y Técnicas; and the first Congresos Paleontológicos Argentinos under the auspice of the Asociación Paleontológica Argentina. Only the Guias Argentinas del Paleozoico were published. The Argentinean Hildebranda Á. Castellaro (1913–1995) (Fig. 3.2) was the main author of the Cambrian–Ordovician (Castellaro, 1963) and the Silurian–Devonian (Castellaro, 1966) periods, in which she synthesized the existing knowledge. The Guia Paleontológica Argentina and the Paleontographia Bonaerense included issues/volumes on fossil invertebrates. They responded to the need for an updated synthesis of the knowledge obtained over more than 100 years of research and, until then, scattered in different publications, often difficult to access. Following this goal but in a wider field, Camacho published in 1966 the book "*Invertebrados Fósiles*", the first of its kind produced in the country (Camacho, 1966).

Finally, it should be noted that the study of Argentine fossil invertebrates was led by foreigners at the end of the nineteenth century and the beginning of the twentieth, mainly focussing on the publication of the faunas and their affinities, in addition to documenting their existence. At later stages, the interest of Argentinean paleontologists focus shifted to stratigraphic applications. The emphasis on the stratigraphic aspects of paleontology is probably derived from economic applications and the geological background of almost all Argentine invertebrate paleontologists. This was clearly evidenced by the fact that nearly all groups that supposedly had no stratigraphic importance were studied by foreign specialists or Argentine biologists in isolated publications, or they were even totally ignored. In many cases, such an approach to paleontological research also led to scarce attention to the basic morphological features and precluded studying poorly known faunas.

Finally, paleoecological, paleobiogeographic, and evolutionary studies were also marginalized, which are the natural corollary of morphological and taxonomical studies and the necessary basis for any well-founded correlation. It is a fact, however, that invertebrates' paleontology in Argentina during this period was affected by the lack of relationship between the number of active paleontologists and the questions to be solved. It is worth mentioning that micropaleontology started and developed about 30 years later than in other countries.

CONTRIBUTIONS TO THE KNOWLEDGE OF DIFFERENT GROUPS OF FOSSIL INVERTEBRATES

Foraminiferida

Leaving aside the studies of Pleistocene and Holocene faunas mainly by Boltovskoy (1961), the first studies of fossil foraminifera were carried out by Camacho in the late 1940s and early 1950s, focused on material from the Late Cretaceous (Camacho, 1954). These studies would be continued in the 1960s by Bertels (1964), among others, focusing on benthic and planktonic foraminifera of the Cretaceous–Paleogene and Paleogene–Neogene of Patagonia.

Radiolaria

Richter's (1925) study on Cretaceous material from Isla de los Estados is the only study of radiolarians in this period.

Porifera

Fossil Porifera in Argentina were scarcely studied. Demospongea from the Ordovician and Cenozoic of Patagonia and the Quaternary of Buenos Aires Province were published by Kayser (1876) and Principi (1915), respectively. The presence of dubious Hexactinellida in the Middle Cambrian of Mendoza Province was recorded by Rusconi (1952a, 1954a).

Bryozoa

Bryozoa in Argentina was documented with the discovery of Trepostomata in the Devonian Precordillera by Kayser (1876) and Cyclostomata and Cheilostomata from the Tertiary of Patagonia by Ortmann (1902) and, fundamentally, in the classic contributions made by Canu (1904, 1911). Subsequently, Conti (1949) made only one more contribution of Bryozoans from the Tertiary of Chubut during this time interval.

Cnidaria

The knowledge of the Cnidaria of Argentina was based on the study of some Conulata and Tabulata from the Silurian and, fundamentally, from the Devonian by Thomas (1905), Gerth (1926, 1928), and Weaver (1931), and on the study of Scleractinia from the Lower–Middle Jurassic and Lower Cretaceous of the Neuquén Basin.

Brachiopoda

The study of brachiopods in Argentina was based on the contributions from Kayser (1897), Thomas (1905), and Clarke (1912) from the Lower and Mid–Paleozoic of western and northern Argentina, to which those of Harrington (1938) and Leanza (1945b, 1948) would be added. The monograph by Behrendsen (1892) on the Mesozoic faunas of western Argentina included a few Jurassic brachiopods as well.

Also from the first half of the twentieth century were the studies of Jaworski (1926), Feruglio (1936), and Weaver (1931) on Jurassic and Cretaceous faunas and those of Ihering (1903b) and Doello Jurado (1922) on Tertiary faunas, all of them including brachiopods from Patagonia.

During the second half of the 1950s, a new era began with the publications of Castellaro (1959) and Amos (1958a, 1958b) on brachiopods from the Silurian of the Precordillera and the Upper Paleozoic of San Juan and Chubut provinces, respectively.

Mollusca

The Phylum Mollusca was one of the most studied and publications throughout this period represented approximately 46% of Argentina's total articles published dedicated to fossil invertebrates. The groups that received the most attention were, in decreasing order, Gastropoda (49%), Cephalopoda (34%), and Bivalvia (17%).

There were no studies on Polyplacophora, a class that extends from the Cambrian to the present. Likewise, Scaphopoda, recorded worldwide from the Ordovician to the Holocene, were barely mentioned by Wilckens (1907b) based on some specimens from the Late Cretaceous of southern Patagonia.

The Hyolitha—either considered as a Class within Mollusca or as an independent Phylum—constitute a group restricted to the Paleozoic, whose presence in Argentina was not recorded in the period. Similarly, the Tentaculitoidea, known from the Ordovician to the Devonian, remained virtually ignored in Argentinean studies on Paleozoic invertebrates.

Gastropoda. The Gastropoda group of Mollusca was the subject of numerous publications. Gastropod material was described mostly in monographic works during the last part of the nineteenth century and first half of the twentieth century. For example, Gottsche (1878), Behrendsen (1891, 1892), Haupt (1907), Jaworski (1926), Carral Tolosa (1942b) for the Jurassic of western Argentina and Patagonia, Stanton (1901), Paulcke (1903), Wilckens (1907b), Bonarelli (1921, 1927, 1945), Weaver (1931), Feruglio (1934a, 1934b, 1936) for the Cretaceous of Patagonia and north of the country, Sowerby (1846), Borchert (1901), Ortmann (1902), Ihering (1907), and Camacho (1949, 1953) for the Tertiary of Patagonia and Mesopotamia. The studies by Parodiz (1944, 1946a, 1946b, 1949, 1951) deserve a special mention here. Older Gastropoda were published by Kayser (1876) for the Ordovician and by Reed (1927) for the Upper Paleozoic.

Bivalvia. The Bivalvia were the mollusks that had the lowest number of publications in the period, representing 17% of the total. The material of bivalves was described, mostly in some of the monographic works mentioned above in the section corresponding to the Gastropoda, and referred mainly to the Jurassic of western Argentina (Behrendsen, 1892; Jaworski, 1915; Groeber, 1924) and the Cretaceous (Forbes, 1846) and Tertiary (Ihering, 1902; Ortmann, 1902) from Patagonia. The works on faunas of the Upper Paleozoic and Triassic (Frenguelli, 1945), Upper Cretaceous, and Tertiary (Fossa Mancini, 1938) are from the second half of this period. Lower Jurassic Bivalvia were studied from western Chubut by Feruglio (1934b) and Carral Tolosa (1942b), from Piedra Pintada, Neuquén by Leanza (Leanza, 1940a, 1940b, 1942). Mesozoic trigonids from Neuquén were described by Lambert (1944). Ordovician bivalves from northern Argentina were also studied by Harrington (1938).

By the end of the 1950s, studies on bivalves were restricted to specific descriptions of material from the Tertiary of Patagonia (Camacho & Fernández, 1956; Camacho, 1957), except for the description, by Harrington (1955), of the *Eurydesma* fauna of the Upper Paleozoic of the Sierras Australes.

Cephalopoda. The Cephalopoda constitute, after the Gastropoda, the mollusks that have been the subject of the largest number of publications in the period considered, representing 34% of the total number of publications referring to Mollusca. More than 90% of these publications were dedicated to Jurassic and Cretaceous ammonoids.

Like Bivalvia, this trend gave continuity to a situation observed from the very beginning of the studies of fossil invertebrates in the country. Between the late nineteenth and early twentieth centuries, foreign researchers made a series of contributions, mostly monographic, on ammonoids. Authors of these studies were Behrendsen (1891, 1892), Steuer (1897), Tornquist (1898), Burckhardt (1900a, 1900b, 1903), Haupt (1907), Douville (1910), Jaworski (1914, 1915), Stehn (1923), Gerth (1925), Krantz (1928), and Weaver (1931) for the Jurassic and Cretaceous of west-central Argentina. The ammonoids from the Mesozoic, mainly Cretaceous, of the southern region of the country were studied by Stanton (1901), Paulcke (1907), Favre (1908), Stolley (1912), Bonarelli & Nágera (1921), Feruglio (1936), and Piatnitzky (1938).

In the 1940s, the studies of the first Argentine ammonitologist A. F. Leanza began. He studied ammonites from the Upper Jurassic and Lower Cretaceous of the Neuquén Basin (Leanza, 1944, 1945a, 1946, 1947, 1949, 1958; Leanza & Giovine, 1949) and in the following decade he would focus mainly on the Cretaceous of the Austral Basin. Marginally, there were some specific publications by other Argentinian authors on *aptychi* (Rusconi, 1948b) and ammonites from the Lower Cretaceous of the Neuquén Basin (Giovine, 1950, 1952), as well as studies from some foreign authors (Maubeuge & Lambert, 1955) on Middle Jurassic faunas.

The studies on Mesozoic Nautiloidea were included in several monographs dedicated to the ammonoids (see above) and those on Cenozoic nautiloids in a paper by Ihering (1922). Knowledge of lower Paleozoic nautiloids was based on a specific contribution by Rusconi (1951) and on one study by Cecioni (1953) on specimens from northern Argentina.

Annelida

Contributions to the knowledge of the Annelida of Argentina were based on a few records from the marine Lower Jurassic of Mendoza Province (Behrendsen, 1892) and from the marine Lower Cretaceous of Patagonia (Weaver, 1931; Camacho, 1949).

Arthropoda

As already noted, contributions to Arthropoda knowledge accounted for 22% of the total contributions made on fossil invertebrates, most of them belonging to trilobites.

Trilobita. Kayser (1876, 1897, 1898) studies of the Ordovician faunas conducted in the late nineteenth century were followed, during the 1930s, by those of Kobayashi (1935, 1936, 1937a, 1937b). Only Thomas (1905) and Clarke (1912) contributions to Devonian faunas were known in the early twentieth century.

The situation changed in the 1930s, when a series of contributions were published based on the Ordovician record from the north of the country. These were started by Harrington in 1937 and continued partly in collaboration with Leanza (Leanza, 1941; Harrington & Leanza, 1942, 1943, 1957), culminating in the 1950s with the important work "Ordovician Trilobites of Argentina" (Harrington & Leanza, 1957). During the late 1940s and 1950s, several contributions were also made by Rusconi (1946a, 1950b, 1952a, 1952b, 1955a, 1955b).

Crustacea. In the case of fossil Crustacea, specific references to representatives of the Class Cirripedia were found in Ortmann (1902) and Feruglio (1949, 1950) for the Tertiary of Patagonia. The presence of Ostracoda was documented during the Paleozoic (Thomas, 1905). Conchostraca was fundamentally restricted to the Cenozoic (Rusconi, 1946a, 1946b, 1947, 1948c, 1948d, 1948e) and only a few Decapoda were recorded in the Jurassic of Mendoza Province (Rusconi, 1948a) and the Late Cretaceous and Cenozoic of Patagonia (Wilckens, 1907b, 1921).

Insecta. Main studies on Insecta were carried out in the 1920s and 1930s by Cabrera (1928) and Wieland (1926) on material from the Triassic of Mendoza Province and, fundamentally, by Cockerell (1925, 1926a, 1926b, 1936) and Schlagintweit (1936) on representatives from the Paleocene of the northwest of the country. Viana & Haedo Rossi (1957) studied formicides from the Miocene of Santa Cruz Province. Other records included fossil nests from the Tertiary of Patagonia, mainly described by Frenguelli (1938a, 1938b, 1939).

Echinodermata

Fossil Echinodermata from Argentina were inadequately studied. The first contribution was made by Desor (1846) in the mid-nineteenth century, referring to Echinoidea from the Tertiary of Patagonia. Afterwards, only specific contributions were produced (Lahille, 1896, 1898; Ortmann, 1902; Lambert, 1903), with a few additions from the Devonian (Ruedemann, 1916) and the Mesozoic of Neuquén Province (Weaver, 1931; Frenguelli, 1944) and Southern Patagonia (Wilckens, 1907b; Melinossi, 1935). Finally, in the late 1950s, Bernasconi (1954, 1959) published a revision of the Echinoidea from the Late Cretaceous and Tertiary, based on the existing collections in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia".

Graptolithina

Except for some isolated references dating back to the late nineteenth century (Kayser, 1876) and those produced in 1949–1950 describing Ordovician material from the north and west of the country (Rusconi, 1949a, 1949b, 1949c, 1949d, 1949e, 1950c; Borrello & Gareca, 1951), contributions to the study of graptolithina had to wait until 1960, the year in which J. C. M. Turner's work entitled "Graptolithic faunas of South America" was published (Turner, 1960).This was an important contribution to the knowledge of Graptoloidea and Dendroidea, mainly from the Ordovician of western and northern Argentina.

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doi: 10.5710/PEAPA.15.10.2024.441

Recibido: 01 de septiembre 2022
Aceptado: 15 de octubre 2024
Publicado: 25 de Junio 2025