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Publication 1321

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Accepted for publication July 24, 1979

July 27, 1981

Publication 1321

Library of Congress Catalog Card No.: 81-65226

ISSN 0096-2651

PRINTED IN THE UNITED STATES OF AMERICA

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INTRODUCTION

Mammal-bearing rocks of Late Tertiary age occur extensively in the precordilleran and piedmont zones of western Argentina, from Jujuy Province in the north to Mendoza Province in the south. Many studies have been made of the rocks throughout this region, but few include a description of characteristic mammalian faunas with their stratigraphic occurrences adequately recorded. Without these data neither the faunal history nor the stratigraphy of these beds can be properly unraveled (Simpson, 1940, p. 667). The important Tertiary mammal-bearing beds of this region all appear to be post-Friasian (post-medial Miocene) in age (Marshall et al., 1979).

Much the most interesting and important Late Tertiary stratigraphic sequence yet known is in the tri-province area of Catamarca, Tucumán, and Salta in northwestern Argentina. The most significant of these areas is in the Valle de Santa María (=Yocavil) and the adjacent Valle de Amaicha (figs. 1–3). A second area occurs about 100 km to the southwest in the region of San Fernando and Puerta de Corral Quemado along the Río Belén and its tributaries (figs. 1, 4).

These regions have been the subject of numerous geological and paleontological studies, among which may be mentioned those of C. Ameghino (1919a, b), F. Ameghino (1889, 1891a, b, 1906), Bordas (1935), Cabrera (1928, 1937, 1944), Caminos (1972), de Carles (1911), Castellanos (1927, 1932, 1937, 1939, 1940, 1946a, b, 1947, 1948a, b, 1954), Doering (1882), Frenguelli (1930a, b, 1937), Galván & Huidobro (1965), González Bonorino (1950), L. Kraglievich (1934), Lydekker (1893, 1894), Marshall (1976, 1978a, b, 1981), Marshall et al. (1979), Mercerat (1895), Moreno & Mercerat (1891a, b), O'Donnell (1938), Patterson (1937a, b), Patterson & Kraglievich (1960), Peirano (1943, 1945, 1946a, b, 1956), Reig (1952, 1958a), Riggs (1928, 1929, 1933, 1934, 1936), Riggs & Patterson (1939), Rovereto (1914), Schlagintweit (1937), Scillato Yané (1975a, b), Simpson (1940, 1970, 1974), Stahlecker (1935), Stelzner (1872), and Tapia (1941).

Superposition of extensive sequences of Late Tertiary sediments containing good mammalian faunas in South America are few. For this and other reasons, attention has long been directed to the sequence of mammal-bearing rocks in the Valle de Santa María and Puerta de Corral Quemado areas. In addition, these stratigraphic sequences contain numerous tuff beds that have recently been dated by radioisotope (potassium-argon) methods, and data on magnetostratigraphy are available for part of the sequence (Marshall et al., 1979).

This study includes the original, never before published field notes, maps, and stratigraphic sections of Rudolf Stahlecker on which some earlier geochronologic studies were based (Appendix II). In addition, some revision is made of the fossil faunas from these localities, and an attempt is made to synthesize

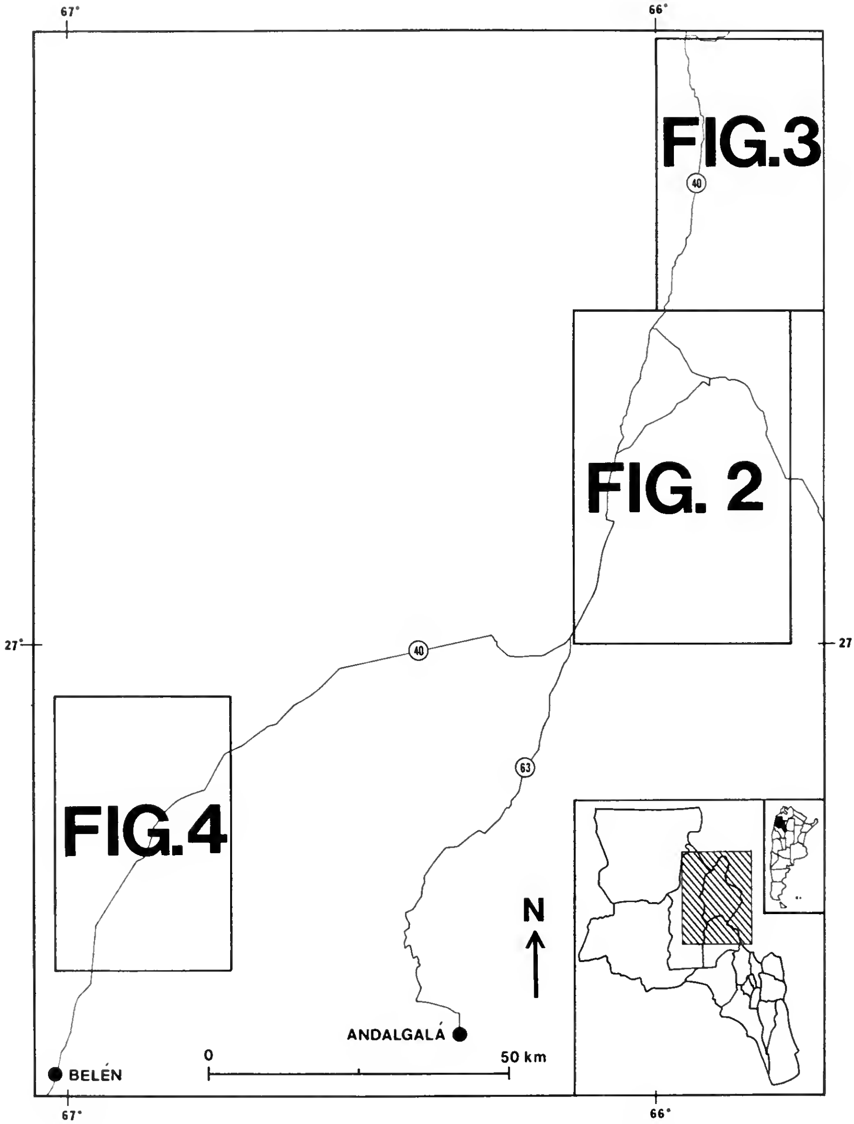

FIG. 1. Map of Catamarca Province, northwestern Argentina showing locations of maps in figures 2, 3, and 4.

these new data with previous findings. This study permits a unique opportunity to integrate paleontologic, radioisotopic, and magnetostratigraphic data and dictates reconsideration of the age, chronology, and correlation of these deposits and their contained faunas. Such an interdisciplinary approach further permits refinement of knowledge and standardization of South American Late Tertiary Land Mammal Ages.

PALEONTOLOGY

The first published record of Late Tertiary fossils in the Valle de Santa María (fig. 2) was apparently by Stelzner (1872, p. 635) who collected fresh-water mollusks from a sandy level low in the exposed section. These shells were later studied and discussed by Doering (1882) as "*Azara occidentalis*" and "*Corbicula*" *stelzneri*.[1]

During December, 1876, Sr. Inocencio Liberani, professor of natural history in the Colegio Nacional, Tucumán, visited the Valle de Santa María. There, along the eastern side of the valley, he encountered the remains of fossil vertebrates. Early in 1877 he returned with a colleague, Professor Rafael Hernández, and made a sizable collection of archaeological and paleontological material. Included among these were fragments of an extinct glyptodont that were presented to Dr. Francisco P. Moreno in 1882 and were said to have come from "una formación prepampeana del valle de Santa María en Catamarca" (see F. Ameghino, 1891a; C. Ameghino, 1919a). Moreno (1882, p. 126) regarded these fragments as a new species of *Hoplophorus* and proposed the name *Hoplophorus ameghinoi*. A description of this species was not given by Moreno, and the name must be regarded as a *nomen nudum* until formally described by F. Ameghino in 1889 (pp. 8, 25).

In January, 1885, Sr. don Manuel B. Zavaleta brought to Buenos Aires a complete glyptodont shell collected from the Valle de Tafí, Tucumán. This and other specimens collected by Zavaleta were later acquired by the Museo Nacional de Buenos Aires (now Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires) and described by F. Ameghino (1891a). The taxa included *Typotherium internum*, *Megamys formosus*, *Tetrastylus montanus*, and *Sphenotherus zavaletianus*. F. Ameghino also assigned *Hoplophorus ameghinoi* Moreno 1882 to *Plohophorus*.

In 1889, Sr. Adolfo Methfessel made a collection of fossil vertebrates from a meseta in "el bajo de Andalhualá" and adjacent areas in the Valle de Santa María (Moreno & Mercerat, 1891a, p. 223). This locality is apparently the same as Loma Rica[2] (fig. 2), about 2 km to the southwest of Chiquimil (=Xiquimil, Siquimil, Entre Ríos), of later workers. The fossils collected by Methfessel were given to the Museo de La Plata and were described by Moreno & Mercerat (1891a) and Mercerat (1895). However, none of the 17 species of mammal described by Moreno & Mercerat from Catamarca was figured, and this work was soon crit-

[1]Under the name "*Corbicula*" *stelzneri* Doering have been referred bivalves by various geologists working in the Valle de Santa María, Catamarca. This "species," however, was neither described nor figured by early workers and was thus a *nomen nudum*. In 1966 Parodiz obtained a sample of this bivalve, and he later (1969) formally described *stelzneri* as a new species of *Neocorbicula*. "Since a *nomen nudum* has no status and does not preoccupy (and in addition, as it was given originally as '*Corbicula*,' not *Neocorbicula*), that name is preserved, to avoid possible confusion in the geological literature" (Parodiz, 1969, p. 94).

Parodiz (1969, pp. 94–95) listed the type locality of *Neocorbicula stelzneri* as: "East of Santa María, in the Santa María Valley west of Sierra Aconquija (near the limit with Tucumán), province of Catamarca, Argentina; from 'Estratos Calchaqueños,' Calchaquian (Santamarian Frenguelli), Middle Miocene. Collected by R. Herbst. Type and 150 paratypes at IML [Instituto Lillo, Tucumán]; 30 paratypes, including those measured, at CM [Carnegie Museum, Pittsburgh] . . . ."

[2]This name, which means *rich hill*, was apparently given by previous collectors because of the abundance of fossils found there.

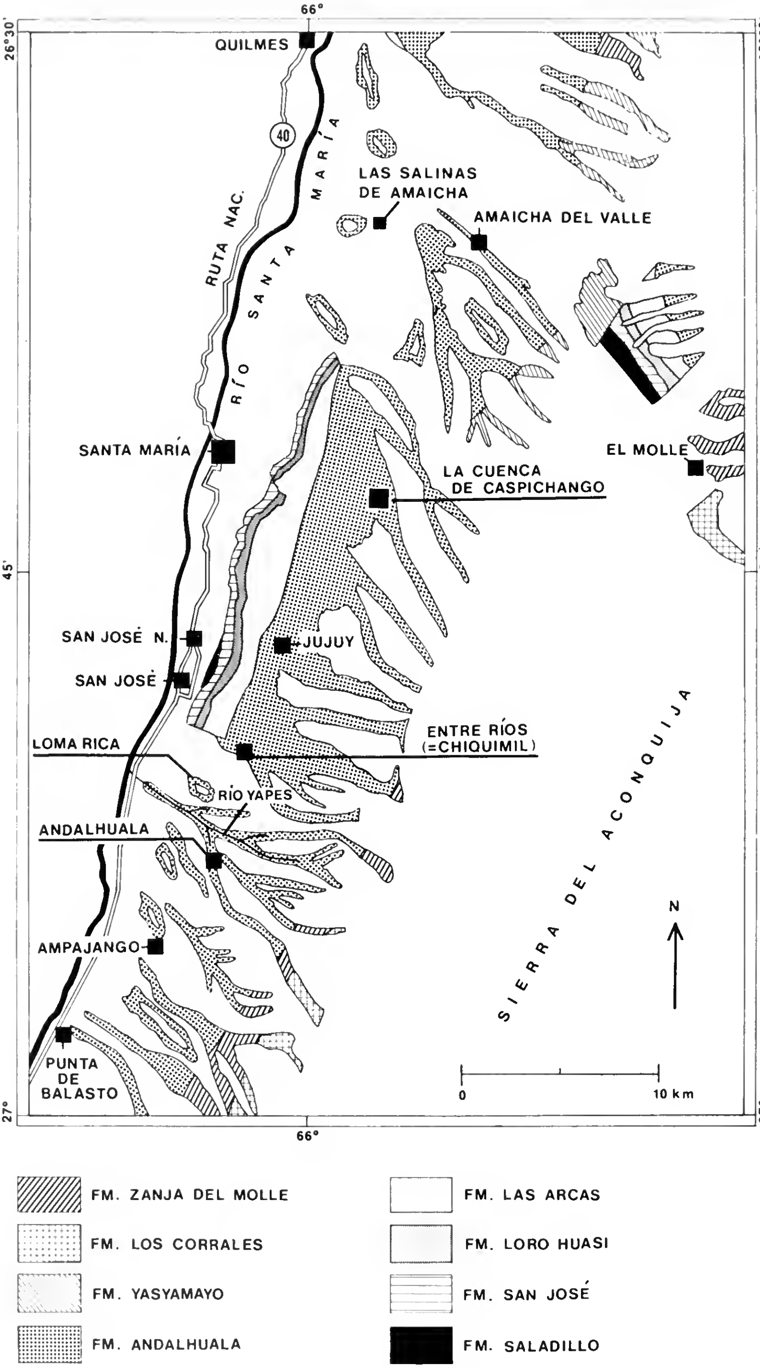

FIG. 2. Map of southern part of Valle de Santa María showing distribution of Late Tertiary beds of the Santa María Group and vertebrate fossil localities. Data from Hoja 11e, Santa María, 1:200000 in Huidobro (1972).

ically reviewed by F. Ameghino (1891b). Some of the species described by Moreno & Mercerat were later redescribed and figured by Lydekker (1893, 1894).

In 1906, F. Ameghino reviewed knowledge of the "Araucanense"[3] fauna from the Valle de Santa María and presented an updated list of the 32 genera recorded there.

In the years that followed, additional specimens were obtained by local collectors from the Valle de Santa María. Many of these were eventually acquired by the Museo Argentino de Ciencias Naturales and were described by Rovereto (1914). He recorded 41 genera for this fauna, assigning three more provisionally.

Between May and December, 1926, an expedition from Field Museum of Natural History, Chicago, under the direction of Elmer S. Riggs, made a large collection of fossil vertebrates from beds of Late Tertiary age in the Valle de Santa María (Appendix I). Another collection of similar age was made 100 km to the southwest of the Valle de Santa María in the vicinity of Puerta de Corral Quemado (fig. 4). A preliminary paper on the findings of this expedition, with two stratigraphic sections and a partial faunal list, was given by Riggs & Patterson (1939).

Between 1927 and 1930, the Museo de La Plata conducted three paleontological expeditions under the direction of Dr. Angel Cabrera to the province of Catamarca. These were carried out during November–December, 1927; February–April, 1929; and January–March, 1930. The area prospected by Cabrera included the "Araucanense" beds from La Ciénaga in the south, to six km to the north of Corral Quemado, encompassing a belt 15–20 km in breadth along the Río Belén (fig. 4). Camps of the first expedition were made at Puerta de Corral Quemado; the second at La Ciénaga, Las Juntas, and Puerta de Corral Quemado; and the third at Corral Quemado, and in the Loma Negra between Cerro Colorado de Hualfín and the Río San Fernando. These collections were partially described by Cabrera (1928, 1937, 1944).

Joaquín Frenguelli made a collection of fossil vertebrates from Tiopunco in the northern part of the Valle de Santa María and donated this to the Museo de La Plata. These specimens were listed, in part, by him in a paper in 1937.

In 1943, Peirano made a paleontological-geological survey of four fossil-bearing localities in the Valle de Santa María (figs. 2, 3): (1) la cuenca de Caspichango, (2) las Salinas de Amaicha, (3) Tiopunco, and (4) El Molle Grande (=Valle de El Cajón). The locality at Las Salinas was poorly fossiliferous, although some *"Corbicula" stelzneri*, glyptodonts, and turtles were collected (Peirano, 1943, p. 45). El Molle Grande, first worked by Peirano, yielded some bivalves (*cf. "Corbicula"*) and gastropods. Of the 250 specimens of fossil vertebrates collected from there, the best represented are small rodents and birds, along with a few turtles and macraucheniids.

Of all the fossiliferous localities in the northeast of Catamarca, that of Tiopunco is by far the richest in vertebrates and plants (Peirano, 1943; O'Donnell, 1938). Peirano (1943, p. 51) described the Tiopunco locality as follows:

> Podemos considerar en Tiopunco dos partes con fósiles: la que queda al NE. del puesto de Nucapa, sobre la margen derecha del arroyo, y la que está situada al SE. de dicho puesto, en la margen izquierda de la citada corriente; entre ellas se encuentra una faja angosta, pues el arroyo de Nucapa es la continuación de dos cauces que nacen al E. del lugar, faja ésa completamente estéril.

[3]For clarification of the origin and previous usage of this name see p. 13.

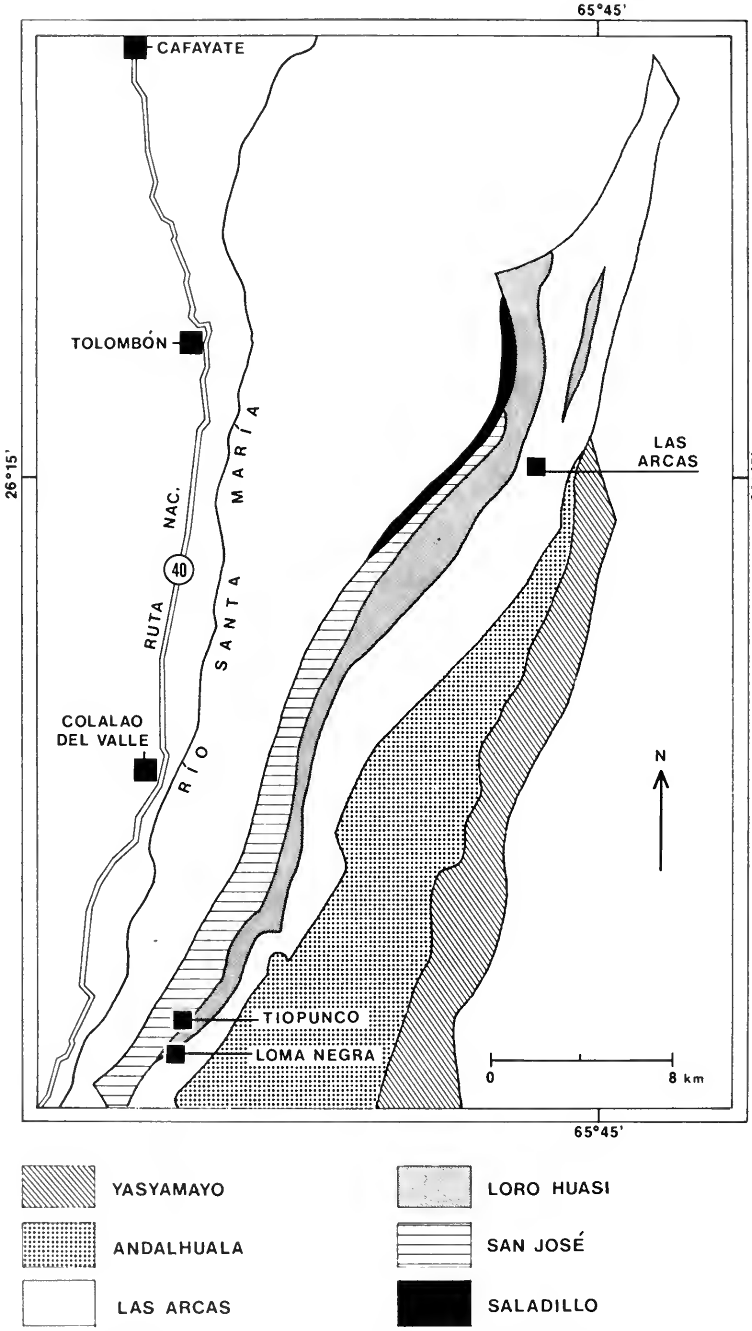

FIG. 3. Map of northern part of Valle de Santa María showing approximate distribution of Late Tertiary beds of the Santa María Group and fossil vertebrate localities. Base map—Cafayate, Hoja 10e, 1:200000. Distribution of geological formations is based on data supplied by the Instituto Nacional de Geología y Minería, Departamento de Geografía, Argentina.

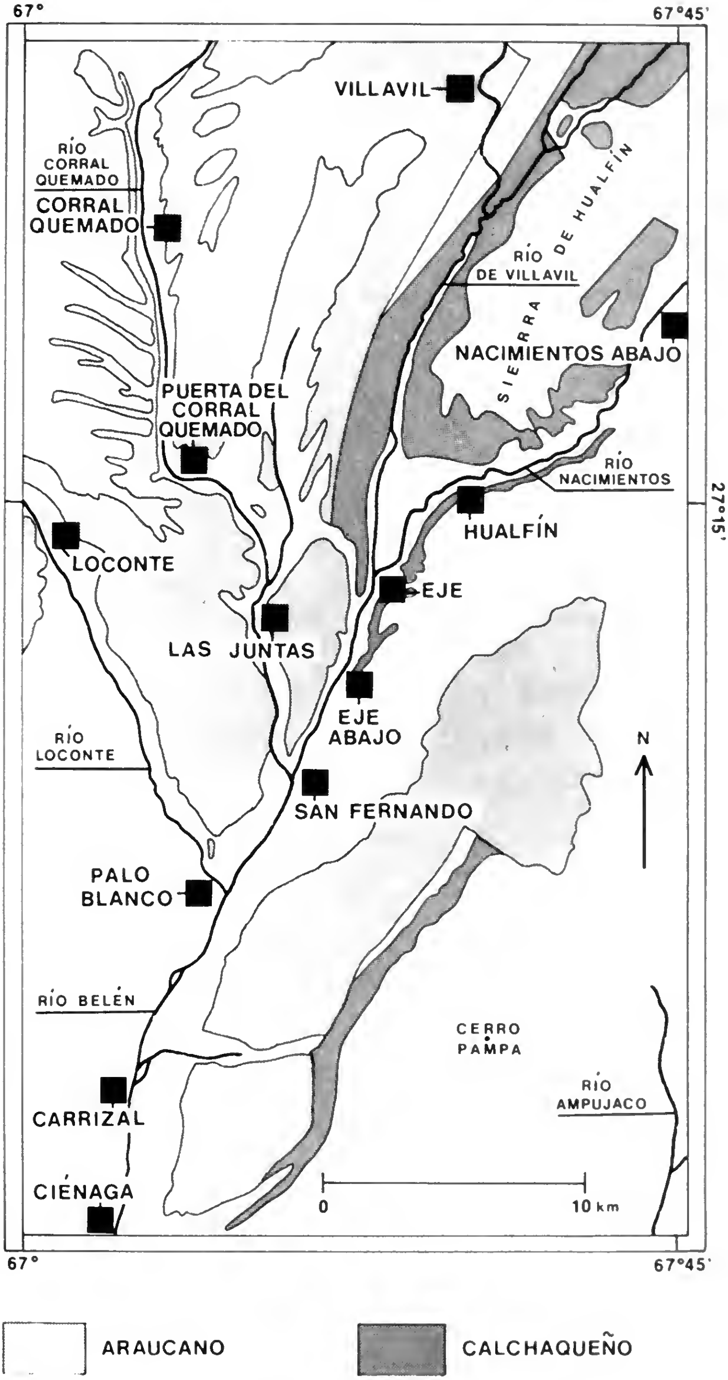

FIG. 4. Map of Puerta de Corral Quemado and vicinity showing distribution of Late Tertiary "Araucano" and "Calchaqueño" beds. Data from Hoja 12d, Capillitas, 1:200000 in González Bonorino (1950).

Peirano (1945, 1946a, b, 1956) later made a collection of fossil vertebrates from the Quebrada de Amaicha, province of Tucumán, located on the eastern side of the north edge of the Sierra de Aconquija and on the west side of the southern end of the Cumbres Calchaquies. He reported that these beds and faunas were similar to those in the Valle de Santa María.

Thus, over the years, Peirano made an important collection of fossil vertebrates from the Valle de Santa María, from approximately the same beds and horizons as did the Field Museum expedition, as well as from surrounding areas. Peirano made a detailed study of the stratigraphy in these areas and recorded the levels from which the fossils were collected. He concluded (1956, p. 92), as did Riggs & Patterson (1939, p. 144), that tuffs and fossils were generally abundant in the upper parts of these beds, but rare in the lower. The Peirano Collection, now in the Instituto Lillo, Tucumán, has not yet been fully described.

In summary, fossil vertebrates have been collected from the following localities in the Valle de Santa María and vicinity: Ampajango (=Ampahanco), El Arroyo, Andalhualá, El Vallecito, Colera, Río (or Arroyo) de Yapes, Loma Rica, Chiquimil, Jujuy (=Quebrada de Jujuy, Quebrada de los Cancino), La cuenca de Caspichango (=East of Santa María), Peneplain Basin, Las Salinas de Amaicha, Amaicha del Valle, El Molle Grande (=Valle de El Cajón), Tiopunco (=Theopunca, Teopunca, Nucapa), Quebrada de Las Arcas, and Quebrada de Zanja Honda.

GEOLOGY AND STRATIGRAPHY

Stratigraphic terminology for the thick series of Late Tertiary beds in the Valle de Santa María has had a long and confused history (fig. 5). Doering (1882) applied the name "Araucano" to strata above what is now called the Famatina Group on the primary basis of Tertiary beds in Río Negro Province, southern Argentina, but with extension to rocks of supposedly similar age elsewhere in Argentina. He placed his Araucano, which he considered Lower Miocene in age, between the "Patagoniano" and the "Pampiano."

In times when lithostratigraphic, chronostratigraphic, and geochronologic classifications were not distinguished, Doering's Araucano was applied to rocks and faunas, including those in Catamarca, believed to be synchronous. Such terms as Araucanense, Araucanéen, Araucanian, Estratos Araucanos, etc. (fig. 5) have been applied to varying parts of the rock sequence and faunas in the Valle de Santa María (F. Ameghino, 1906; Rovereto, 1914; L. Kraglievich, 1934). These Araucano beds appear in all the older works as if they were a unit, faunally and stratigraphically, with "*Corbicula*" *stelzneri*, a characteristic fossil. Thus, F. Ameghino (1889, p. 125) wrote:

> En la parte Norte y Occidental de la República el piso Araucano está bien desarrollado en el Valle de Santa María en la provincia de Catamarca, en donde está representado por capas de areniscas oscuras o verdosas, poco coherentes en unos puntos, pero muy compactas en otras; afectuando una estructura esquistosa que muestra numerosas impresiones de conchas de moluscas, entre los que se pueden distinguir una especie extinguida del género *Azara* llamada *Azara occidentalis* Doer. y la *Corbicula stelzneri* Doer. que pueden considerarse como los fósiles caracteristícos de esta formación. Los vertebrados fósiles tampoco son raros, siendo el más abundante el *Plohophorus Ameghini* Mor., especie de gliptodon peculiar a este horizonte.

Doering (1882)	F. Ameghino (1906), Rovereto (1914), L. Kraglievich (1934)	González Bonorino (1950)	Frenguelli (1930a, b, 1937)	Riggs & Patterson (1939)	J. L. Kraglievich (1952)	Peirano (1956)	Galvan & Huidobro (1965), Huidobro (1966, 1972)	Simpson (1974)
				Corral Quemado	Corral Quemado			Corral Quemado
	Araucanense (=Araucanéen, Araucanian, Estratos Araucanos)	Araucano (Araucanense)	Araucaniano: superior / medio	Araucanense	Andalhualá	Araucanense superior	Grupo Santa María: Andalhualá superior / Andalhualá inferior	Andalgalá
			Araucaniano: inferior	Chiquimil A / Chiquimil B	Chiquimil	Araucanense inferior	Grupo Santa María: Loro Huasi	Chiquimil A / Chiquimil B
Araucano (upper part only)		Calchaqueño (Calchaquense)	Santamariano (superior)	Calchaquí	Calchaquí	Calchaquense	Grupo Santa María: Las Arcas, San José, Saladillo	Calchaquí

FIG. 5. Historical development of time and rock nomenclature for the Late Tertiary mammal-bearing beds in the Valle de Santa María and in the vicinity of Puerta de Corral Quemado, Catamarca Province, Argentina. Correlations of rock boundaries are only approximate.

Rovereto (1914, p. 1) also regarded the Araucano faunas of Catamarca as a single unit and the fossil beds in the Valle de Santa María with "*Corbicula*" *stelzneri* as representing the "araucano tipíco." However, the rocks and faunas so called in the Valle de Santa María are later in age than those encompassed by Doering's original "Araucano" (Simpson, 1974, p. 4).

The Araucanian faunas from the Valle de Santa María on which the basic studies of C. Ameghino, F. Ameghino, Rovereto, L. Kraglievich, and others were based are all without precise stratigraphic data and have no reliable data as to levels of collection of the vertebrate fossils. They possibly represent a mixture from all the stratigraphic units recognized by Riggs & Patterson (1939), but primarily from their Araucanense (see below).

A lower member, containing a guide horizon with *Neocorbicula stelzneri* and included by Doering (1882) in his Araucano, was distinguished by Bodenbender (1924) who called it lower Calchaquí, a name based on a stratigraphic sequence of continental red beds in the vicinity of Famatina in the province of La Rioja. Frenguelli (1937) later restricted the name Calchaquí to this unit in the Valle de Santa María, and this usage was followed by Riggs & Patterson (1939).

Frenguelli (1930a, p. 115) divided the Tertiary strata in the Valle de Santa María into two lithologic units supposedly separated by a major unconformity (fig. 5). The thicker lower unit he named Santa María and divided into two horizons: the lowermost being the lower and upper Famatina of Bodenbender, and the uppermost, containing "*Corbicula*" *stelzneri*, he called Calchaquí. Frenguelli named the upper unit Araucaniano, which corresponded to the Araucanense of the Ameghinos and Rovereto minus Calchaquí. Frenguelli further divided his Araucaniano into three horizons: inferior, medio, and superior (fig. 5).

Riggs & Patterson (1939) reproduced two stratigraphic sections made by Rudolf Stahlecker (Appendix II), who accompanied Riggs on his expedition to Catamarca in 1926–1927 (fig. 6). One 1,525 m section was made in the vicinity of Chiquimil from the pueblo of San José to the pueblo of Chiquimil, Department of Santa María (fig. 6), and another 1,913 m section was made near Puerta de Corral Quemado, Department of Belén (fig. 4). On the basis of lithology, Stahlecker divided his stratigraphic sections into three major units of which the middle was divisible into three, making five units in all (figs. 5, 6). Upon study of the fauna, it became evident that the units distinguished by Stahlecker could, in part at least, be distinguished faunistically as well (Riggs & Patterson, 1939).

The basal horizon recognized by Stahlecker is mainly red in color and toward the top is composed predominantly of sandstones. Below these massive red sandstones in the Chiquimil section occurs a layer of hard, brownish calcareous sandstone containing abundant shells of *Neocorbicula stelzneri*. Near San José, Stahlecker noted a fairly even transition between this basal horizon and that following, whereas near Puerta de Corral Quemado the transition was abrupt and the upper red sandstone thinner than in the section near San José. These facts led him to suspect that a short period of erosion had intervened before deposition of sediments of the succeeding unit (Riggs & Patterson, 1939, p. 146). Riggs & Patterson used the name Calchaquí for this basal unit with *Neocorbicula*, which is Doering's Araucano in this area.

The only vertebrate yet found in the Calchaquí is a fragmentary glyptodont, tentatively identified by Riggs & Patterson (1939) as *Parahoplophorus?* sp. This

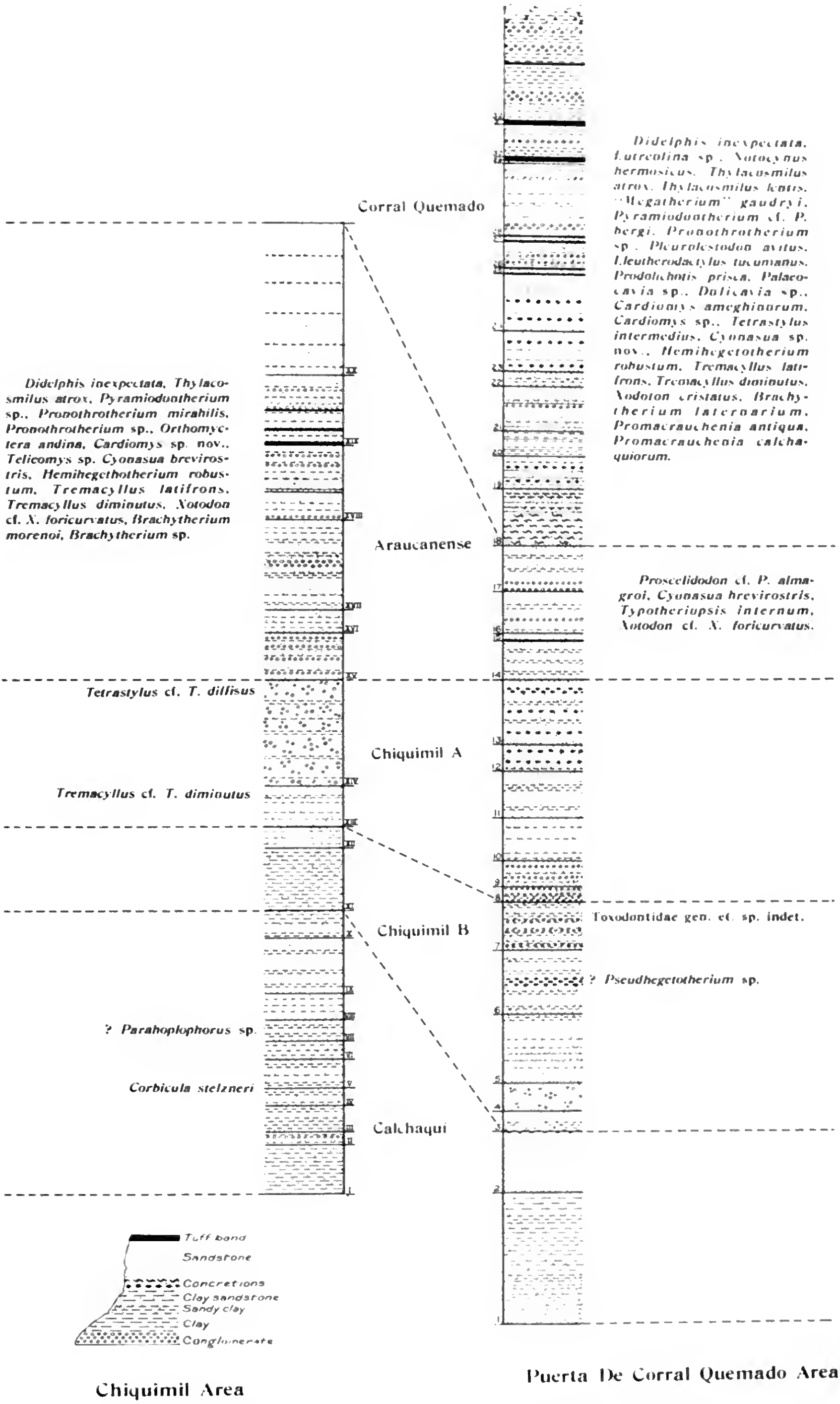

FIG. 6. Stahlecker's stratigraphic sections of Chiquimil and Puerta de Corral Quemado, as originally published by Riggs & Patterson (1939, fig. 1).

determination is highly questionable. *Parahoplophorus*, a "Mesopotamian"[4] genus, is presumably (Pascual et al., 1965; Pascual & Odreman Rivas, 1973) Montehermosan in age.

There had been debate as to whether or not the Calchaquí sediments are separated by an unconformity from those above it. Frenguelli (1937) and González Bonorino (1950) claimed that such an unconformity existed, although Stahlecker (as reported in Riggs & Patterson, 1939) and Peirano (1946b) were unable to detect any major break in sedimentation in the Tertiary beds in the Valle de Santa María. Most authors (*e.g.*, Frenguelli, 1937; Peirano, 1946b; Galván & Huidobro, 1965) now agree that Calchaquí is Miocene in age, and Pascual & Odreman Rivas (1973, p. 310) have suggested that it may be of the same age as the Chasicoan.

The second unit recognized by Stahlecker (fig. 6, Appendix II) is considerably thicker near Puerta de Corral Quemado than in the Valle de Santa María. It is composed predominantly of soft, fine-grained sandstones, although some concretionary layers are present at Puerta de Corral Quemado. The third unit is characterized by hard layers, sometimes conglomeratic, or gypsum-rich, yellowish sandstone. The names Chiquimil B and Chiquimil A were applied by Riggs & Patterson to the second and third units, respectively.

Few fossils are known from the Chiquimil. One of the two specimens found in Chiquimil A, *Tremacyllus* cf. *T. diminutus* (fig. 6, Appendix IV), is a species found also in the Araucanense and Corral Quemado. The other, *Tetrastylus* cf. *T. diffisus*, compares closely with a Mesopotamian species. Neither of the fossil mammals from Chiquimil B has been found in higher levels at either locality. The undetermined hoplodontheriine toxodontid is of minimal value as an index fossil, because members of that subfamily survived into the Montehermosan. The hegetotheriid is different from the forms found in the Araucanense or Corral Quemado, but identification of it is very uncertain; the specimen is much smaller than the type of the Chasicoan *Pseudohegetotherium torresi*. Pascual & Odreman Rivas (1973) have tentatively assigned the Chiquimil A and B to the Chasicoan. G. Simpson (1974, pp. 4–5) justly argued that the extremely inadequate fossil evidence does not suffice to permit separation of Chiquimil A from the Araucanense (=Andalhualá) fauna and suggests, but is entirely inadequate to demonstrate, that Chiquimil B might belong to the Chasicoan. Until more fossils are found, these uncertainties will remain unresolved.

The two upper units, consisting predominantly of clays, sandstones, and frequent tuff beds, yielded fossils in abundance (fig. 6, Appendix IV, V, VI). These units are separated at the Corral Quemado locality by a thick homogeneous bed of whitish sandstone containing abundant worm-shaped concretions. This marker bed[5] was noted by Stahlecker in the Chiquimil area above unit XX, but was not included in his section (Riggs & Patterson, 1939, p. 146). The fourth

[4]When the paper by Riggs & Patterson (1939) was written, it was generally believed that the "Mesopotamiense" was earlier than the "Araucanense," whereas the reverse is now believed to be the case (Pascual & Odreman Rivas, 1973). It is even possible that the "Araucanense" and "Mesopotamiense" of earlier workers are, at least in part, time equivalents.

[5]Peirano (1956, p. 75) doubts the usefulness of this as a marker bed—". . . es posible que se convenciese luego que esa capa no era tan constante en esas mismas condiciones, experiencia que hemos tenido repedidas veces nosotros con rocas ora calcáreas ora sin ese elemento."

unit is much thicker in the Chiquimil area, whereas the fifth was studied in the Puerta de Corral Quemado region only. Riggs & Patterson (1939, p. 146) restricted the name Araucanense to the fourth unit, which is well developed in the Valle de Santa María. The name Corral Quemado Fm was proposed for the uppermost unit, because it is extensively exposed at that locality. This formation was also reported to occur near Chiquimil, but collections were not made from it in that area (Riggs & Patterson, 1939, p. 147n).

The preliminary faunal lists presented by Riggs & Patterson (1939) were fairly extensive for the Corral Quemado and for their Araucanense. Based largely on these lists, and in accord with the conclusions of Riggs & Patterson (1939, p. 147), Pascual & Odreman Rivas (1973) assigned the mammalian fauna of the Corral Quemado an early Montehermosan age, and the fauna of the Araucanense a Huayquerian one. G. Simpson (1974, p. 5) did not feel that a significant difference in age had been demonstrated and elected to provisionally consider both faunas as Huayquerian in age.

Thus, on the basis of Stahlecker's work, combined with study of the mammalian faunas, Riggs & Patterson (1939) divided the Araucaniano of earlier authors (e.g., Frenguelli, 1930a, b, 1937) into three formations and one into two members. These are, from oldest to youngest, Chiquimil B (new in Riggs & Patterson), Chiquimil A (new in Riggs & Patterson), Araucanense (a restriction of the classic but invalid name), and Corral Quemado (new in Riggs & Patterson) (fig. 6).

Doering's (1882) original "Araucano" is derived from the name of an Indian tribe from southern Argentina and Chile (i.e., araucanos were originally from the Arauco region of Chile) and is thus not acceptable as a time or rock unit name in modern geological nomenclature. In realization of this, G. Simpson (1940), using L. Kraglievich's (1934) term Huayqueriaense, proposed Huayquerian as a time and time-rock (Age and Stage) designation for the Araucanense of Riggs & Patterson (1939), deriving the name from the Huayquería Formation (a rock unit named by de Carles, 1911) from the Huayquerías region in the Department of San Carlos, province of Mendoza. That usage has since been generally adopted (e.g., Pascual et al., 1966). The rocks of Huayquerian age in the Valle de Santa María of Catamarca, however, are clearly distinct from the Huayquería Formation of Mendoza (G. Simpson, 1974, p. 4).

Cabrera (1944, p. 7) noted that the results of his studies did not support the opinion of Riggs & Patterson (1939) that a significant difference exists in the faunas between their Araucanense and Corral Quemado. He recorded the same species of Glyptodontidae above and below the boundary between these formations, although he gave no stratigraphic data to support this claim. Cabrera also noted that the Araucanense and Corral Quemado of Riggs & Patterson are more or less equivalent to the Araucaniano medio and Araucaniano superior of Frenguelli (1937).

As early as 1919, Rassmus had proposed that the name Andalhualá be applied to all the so-called Araucanense of Catamarca, including rather less than Peirano's Araucanense, but distinctly more than that of Riggs & Patterson. J. L. Kraglievich (1952, plate opposite p. 30) used the name Andalhualá, which he confined to the restricted Araucanense of Riggs & Patterson and correlated with the Huayquería Formation of Mendoza. In a work published simultaneously in the same journal, Reig (1952, p. 123) evidently intended the same usage as J. L. Kraglievich, but specified a "Formación de Andalgalá." There is some added confusion because there is both an Andalgalá (also sometimes spelled Andagalá), Department of Belén (fig. 1), and an Andalhualá, Department of Santa María near Chiquimil (fig. 2), both in Catamarca. Despite Simpson's (1974, p. 4) statement to the contrary, Andalhualá is the more likely type locality, and that name is here retained for the formation in question. There are no Araucano beds known in the area of Andalgalá (see González Bonorino, 1950, Hoja 13d, Andalgalá).

In a detailed stratigraphic study (fig. 5) of the Valle de Santa María, Peirano (1956) rejected the subdivisions and nomenclature of Riggs & Patterson (1939), and retrogressively called all the beds here in question Araucanense, which he believed to be a single, conformable unit in that valley. However, he did indicate an Araucanense superior, approximately the Corral Quemado of Riggs & Patterson, and an Araucanense inferior, approximately their Araucanense and Chiquimil A, perhaps also including Chiquimil B (Simpson, 1974, p. 4).

Peirano (1956, p. 84) noted that subdivision of the Calchaquense and Araucanense should be based on paleontological data; however, his subdivision into levels has only lithologic value. He abstained from placing names on these lithologic levels, because to do so could, in his opinion, lead to greater nomenclatural confusion. For this reason he applied only numbers to the distinct levels. Peirano (1956, p. 78) also proposed a tentative correlation of beds between the Valle de Santa María and the Quebrada de Amaicha.

Galván & Huidobro (1965) and Huidobro (1972) essentially rejected previous stratigraphic terminology altogether and proposed a number of new formational names in place of Calchaquense and Araucanense of earlier workers, which they placed in a Santa María Group (only in very small part equivalent to the Santamariano of Frenguelli; see fig. 5). This included various continental formations of Late Tertiary age in the Valle de Santa María from Punta de Hualasto to Cerro Paranilla (fig. 2), separated by faults against the Precambrian basement of the Sierra de Aconquija and of the Cumbres Calchaquíes (Galván & Huidobro, 1965, p. 220). The total thickness of the Santa María Group is not possible to calculate due to these truncations, although the maximum known thickness is in excess of 3,000 meters (see below). Most of these Late Tertiary sediments are sandstones and clays, with much conglomerate above the Calchaquí and recurrent thin ash beds in the Andalhualá. Eight formations are recognized by Huidobro (1972) (from top to bottom):

Fm. Zanja del Molle[6]	600 m
Fm. Los Corrales[6]	120 m
Fm. Yasyamayo[7]	80 m
Fm. Andalhualá	1,200 m

[6]Dr. Gerardo E. Bossi (pers. comm.) regards these beds as facies of the Andalhualá Formation.

[7]The Yasyamayo conglomerates are roughly equivalent to the Puna Schotter of earlier authors. These beds are separated from the underlying Andalhualá by a large unconformity (G. E. Bossi, pers. comm.) and are not part of Huidobro's Santa María Group. Much of the area assigned by Huidobro (see fig. 2) to the Yasyamayo Fm. south of Amaicha del Valle (arroyo Las Salinas, Los Colorados, etc.) is actually San José Fm. with *"Corbicula."* This error is related to the Huidobro's mistaken claim that the Yasyamayo Fm. also has *"Corbicula"* (G. E. Bossi, pers. comm.).

Fm. Loro Huasi[8]	650 m
Fm. Las Arcas[8]	200 m
Fm. San José	200–230 m
Fm. Saladillo	40 m

Galván & Huidobro (1965, p. 225) divided the Andalhualá Formation into two members: (1) an upper (superior) member composed of sands and clays with conglomeratic levels and tuff beds near the top; and (2) a lower (inferior) member composed of fine-grained sands and clays with abundant intercalations of gypsum. An attempt is made in Figure 5 to correlate Huidobro's stratigraphic nomenclature with those employed by previous workers.[9]

GEOCHRONOLOGY

Mineral concentrates of tuffs from two of the stratigraphic units recognized by Riggs & Patterson (1939, fig. 1) at the Puerta de Corral Quemado locality and one from the Chiquimil locality have yielded reliable radioisotope dates (fig. 7). These are—3.54 mybp for unit 29, and 6.68 mybp for unit 8 of the Puerta de Corral Quemado section; and 6.02 mybp for unit XIX of the Chiquimil section. Magnetostratigraphic data for parts of these sections are shown in Figure 7, along with reasoned correlations with the polarity time scale.

These radioisotope dates and magnetostratigraphic data support the relative ages and correlations of these beds proposed by Riggs & Patterson (1939). In addition, these data permit correlation of these Late Tertiary Land Mammal Ages with those in North America (fig. 8). A more detailed treatment of these data is presented by Marshall et al. (1979).

PALEOPHYSIOGRAPHIC IMPLICATIONS

The majority of known South American Early and Middle Tertiary mammal-bearing beds occur in Patagonia, southern Argentina (Simpson, 1940). During the Late Miocene (post-Friasian—ca. 12.0 mybp—see fig. 8), the Argentine sedimentation center shifted from Patagonia to the Pampas[10] and northwestern re-

[8]According to G. E. Bossi (pers. comm.), the stratigraphic relationship of these beds was reversed by Huidobro.

[9]Dr. G. E. Bossi kindly read this paper in detail subsequent to its final completion. He feels that the exact equivalence between the named units in the Santa María Group and those units of Stahlecker from Chiquimil are as follows:

Unit XX to XV	Araucanense	Fm. Andalhualá
Unit XIV to XIII	Chiquimil A	Fm. Lorohuasi
Unit XII to XI	Chiquimil B	Fm. Lorohuasi
Unit X to VI	Calchaquense	Fm. Las Arcas
Unit V to I	Calchaquense	Fm. San José

Bossi noted that Stahlecker's division of the Lorohuasi Fm. was probably influenced by the vertebrate remains.

[10]*Pampa* is a Quechua Indian name, which to some authors has been interpreted to mean plain and others to mean sea. The Pampean region, an area of extensive flat grasslands, comprises the provinces of Buenos Aires and Santa Fé, part of La Pampa, the eastern part of Córdoba, the western parts of Entre Ríos and Corrientes, as well as parts of Chaco and Formosa. This is the area that first received the attention of early Argentine and foreign geologists and paleontologists, particularly because of the high frequency with which fossil mammals are encountered.

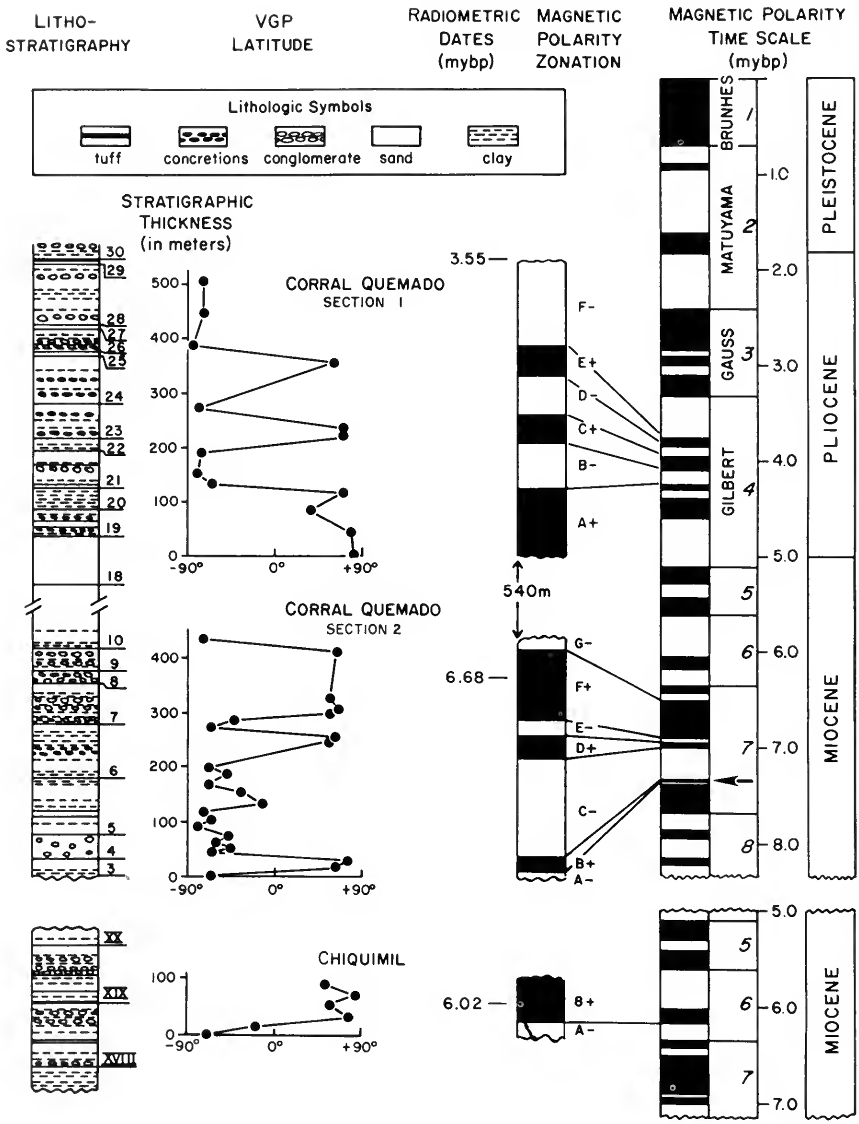

FIG. 7. Lithostratigraphy, magnetostratigraphy, and radioisotope dates. Lithostratigraphic columns are after Riggs & Patterson (1939, fig. 1) using their numberings for lithologic units. Corral Quemado sections are continuous, but the middle portion is not illustrated. Magnetozones in polarity zonation column are labeled + for normal polarity, − for reversed polarity. Magnetic polarity time scale follows LaBrecque *et al.* (1977) with the addition of the short normal polarity interval (arrow) found in Iceland by Watkins & Walker (1977). Numbers to the immediate right of the polarity time scale are epoch numbers. Geologic time scale follows Berggren & Van Couvering (1974). (After Marshall et al., 1979.)

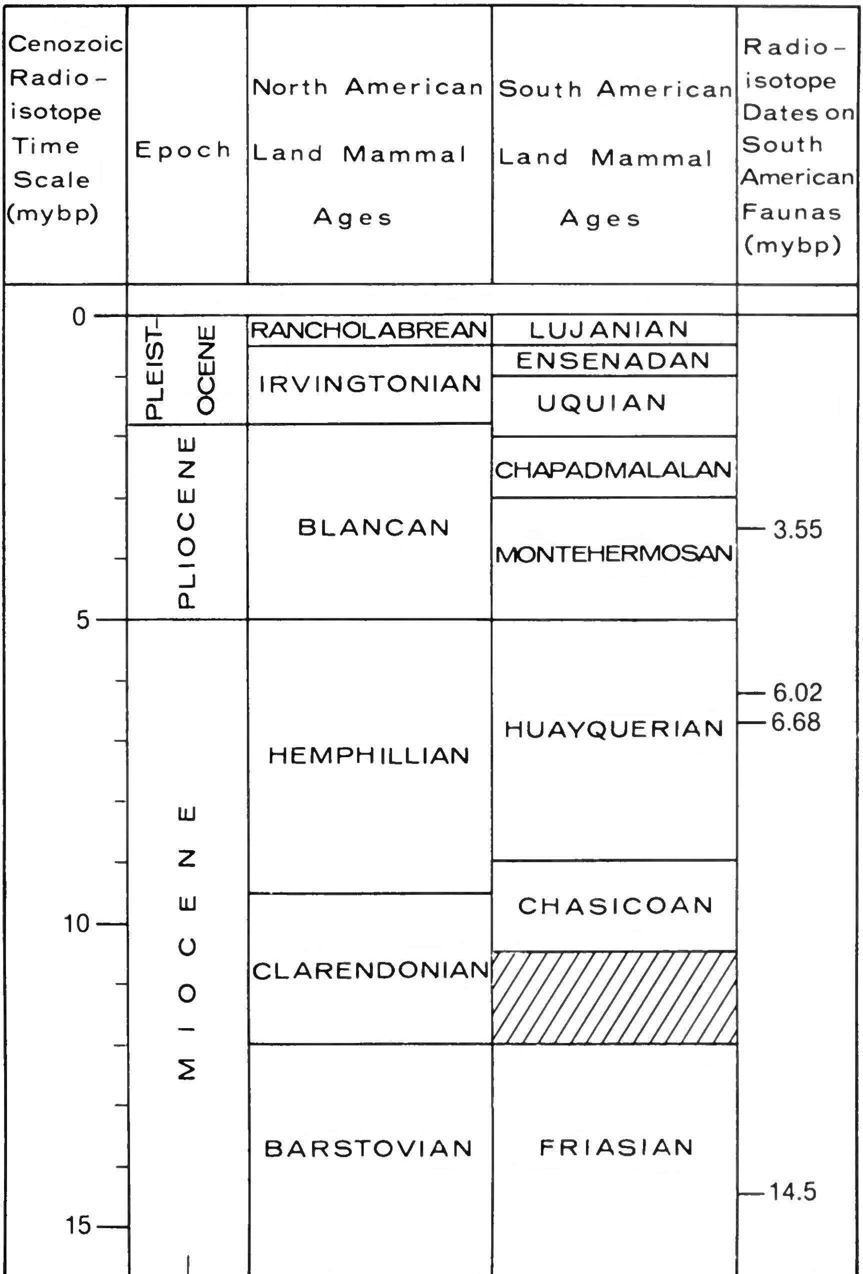

FIG. 8. Late Cenozoic radioisotope time scale and chronostratigraphy showing approximate correlations of North and South American Land Mammal Ages. Geologic time scale follows Berggren & Van Couvering (1974). (After Marshall et al., 1979.)

gions (Pascual, 1961, p. 64; Yrigoyen, 1969, p. 319; Patterson & Pascual, 1972). The sediments changed from predominantly pyroclastic (i.e., tuffs and bentonitic clays) that characterize pre-Chasicoan units, to predominantly clastic (i.e., silts, sands, and loess) that predominate post-Friasian units of the Pampean and northwestern regions (Pascual, 1961, 1965; Pascual & Odreman Rivas, 1971). This change of sediment type coincided with a post-Friasian phase of Andean orogeny that resulted in elevation of the main Cordillera (Herrero-Ducloux, 1963; Farrar & Noble, 1976).

Peirano (1956, p. 90) emphasized that during the Late Tertiary a single primary sedimentary basin existed in the Santa María area of northwestern Argentina. It was in this basin that the Late Tertiary sediments were deposited, and there is no clear evidence of local tectonic movements in this region during their deposition.

The last major phase of Andean orogeny occurred after Montehermosan time, because all of the Late Tertiary beds in this area are now folded, faulted and, in places, removed by erosion. This orogenic phase resulted in faulting and uplift of the Sierras del Aconquija, Las Cumbres Calchaquíes, and del Cajón (or Quilmes) and in formation of intermountain basins like the Valle de Santa María and Valle de Amaicha (González Bonorino, 1950, p. 73). These movements were delimited by NNE-SSW oriented fracture zones, clinal structures, and block faulting, which in places brought Late Tertiary beds into thrust contact with Precambrian basement (Huidobro, 1972). The presence of this last major orogenic phase has conventionally served to mark the Plio-Pleistocene boundary in Argentina (Pascual & Fidalgo, 1972). Uplift of the Andes continued and became accentuated during the Quaternary (Polanski, 1957; Peirano, 1956; Huidobro, 1965; Turner, 1970; Caminos, 1972), when they attained their present elevation.

Elevation of the Andean Cordillera in the Late Tertiary acted as a barrier to moisture-laden Pacific winds (Patterson & Pascual, 1972, p. 251). The rain shadow effect of the newly elevated Andes initiated the desertization of Patagonia. The southern South American habitat changed from primarily savanna-woodland (which predominated during the Early to Middle Tertiary-Paleocene through Miocene) to drier forests and pampas, ranging from forests in northern parts of the continent to grasslands in the south (Pascual & Odreman Rivas, 1971, p. 399). Pampas habitats similar to those prevailing today probably came into prominence at about this time. Many subtropical savanna-woodland forms retreated northward, and new opportunities arose for those mammals able to adapt to a plains environment (Patterson & Pascual, 1972, p. 251).

Gerth (1941), Just (1952), and Solbrig (1976) have shown that mesic forests that covered the southern part of the continent in the earlier Tertiary became progressively restricted as a result of these physiographic changes. Through the Miocene the fossil mammals of southern Patagonia suggest a climate sufficiently genial to permit such now mainly tropical animals as porcupines, echimyids, dasyproctids, anteaters, and primates to flourish there. The habitat suggested by these mammal faunas is a savanna-woodland that graded northward into rain forest, woodland, and savanna of the tropical zone, then no doubt more extensive than at present (Patterson & Pascual, 1972).

The character of Pliocene sediments and vertebrate faunas in the province of Buenos Aires (e.g., Monte Hermoso, Chapadmalalal, and Irené Formations) indicates that this region had a warm-temperate, humid climate, contrasting to the cool-temperate Pampean climate of today (Pascual & Odreman Rivas, 1971, p. 407). The evidence as gleaned from the vertebrate fossils indicates that during the Pliocene the documented climatic change was gradual and was related to, and correlated with, the last major period of Andean uplift.

The frequent presence of fossil trees (see Frenguelli, 1937, p. 405; O'Donnell, 1938) and anteaters (*e.g. Myrmecophaga* and *Palaeomyrmidion*, Rovereto, 1914) in the Late Tertiary sediments in the Valle de Santa María indicates that the climate and environment in this region was then different than it is today. It has been inferred that these western valleys, such as Santa María, served as corridors that permitted displacement of subtropical elements to the southwest (Pascual & Odreman Rivas, 1971). This view is supported by knowledge of the fossil vertebrates in these areas, and it explains the presence today of relic invertebrates of Brazilian affinity in some mountain areas of northern Patagonia (Ringuelet, 1959, 1961).

The climate of northwestern Argentina during the Pliocene was presumably much like that of the present day Chaco. The region became xerophytic only after the Sierras Pampeanas, which border this area to the east, were uplifted beginning in the Pliocene (Orians & Solbrig, 1977, p. 19). During the Pliocene, the region was lower than it is today, and the Sierras Pampeanas did not then act as effective barriers to humid winds from the northeast (Solbrig, 1976, p. 23). As a consequence, the latest Pliocene provides the first unmistakable evidence for extensive areas of semidesert in northwestern Argentina (Simpson, 1971; van der Hammen, 1972; Orians & Solbrig, 1977, p. 63), and coincident with the rise of the Andean Cordillera we find the first indication of high mountain flora (Simpson, 1971; van der Hammen, 1966). In point of fact, the Pliocene uplift of the Cordillera Central of Chile and the Pleistocene uplift of the Sierras Pampeanas of Argentina produced the rain shadow effect that makes the valleys of east-central Catamarca the semideserts they are today (Solbrig, 1976, p. 24).

ACKNOWLEDGMENTS

Funds for field work in Argentina were provided by grant 1698 from the National Geographic Society, Washington, D.C., to L.G.M. The ^{40}K-^{40}Ar dating was supported by NSF Grant EAR 73-00235 A01, formerly GA-40805, to G. H. Curtis, Department of Geology and Geophysics, University of California, Berkeley, and its publication was made possible by NSF Grant 7909515 to L.G.M. Processing of the paleomagnetic samples was supported by NSF grant EAR 75-13571 to R. F. Butler, Department of Geosciences, The University of Arizona, Tucson. Special thanks to Dr. G. E. Bossi, Facultad de Ciencias Naturales, Miguel Lillo, Tucumán, Argentina, for helpful discussions on the geology of the Valle de Santa María, and to Dr. R. Pascual, Museo de La Plata, for critically reading a final draft of the manuscript. Appendices IV, V, and VI were compiled by J. G. Armstrong-Ziegler, Custodian of Fossil Vertebrates, Department of Geology, Field Museum.

Field work in Catamarca during May, 1977, by L.G.M. was done in collaboration with R. F. Butler, R. Pascual, and G. J. Scaglia, Director, Museo Municipal de Ciencias Naturales de Mar del Plata "Lorenzo Scaglia," Mar del Plata, Argentina.

APPENDIX I

The Marshall Field Paleontological Expedition to Catamarca, Argentina

The Marshall Field paleontological expedition of 1926 to Catamarca Province in northwestern Argentina included Elmer S. Riggs of Field Museum as leader, Robert C. Thorne of Vernal, Utah, as collector, and Rudolf Stahlecker, a former student of F. von Huene of the University of Tübingen, as geologist (fig. 9).

Riggs and Thorne sailed from New York on April 10, for Buenos Aires. While Riggs dealt with logistics problems there, Thorne proceeded to the railway terminus at Andalgalá in the province of Catamarca (fig. 1). Riggs followed a week later.

In Andalgalá, Riggs met Colonel Wieser, an acquaintance he had made several years earlier, who had agreed to assist the present expedition. Two local residents, Juan and Felipe Méndez, both of San José (fig. 9), were employed as local collectors; both were to prove useful members of the expedition.

Two saddle horses and six pack mules were hired to convey the expedition's collecting and camping equipment from Andalgalá over a mountain pass to the pueblo of San José, a distance of 120 miles, requiring some four days' travel. Thorne was sent ahead with the packtrain to establish camp.

Meanwhile Riggs, employing a separate guide, made a reconnaissance trip to the valley of Ojo del Agua in the province of Tucumán, where he located bones of glyptodonts and a sloth (fig. 10). Returning hurriedly to Andalgalá on the third day, Riggs met Stahlecker upon his arrival from Buenos Aires. Three

Fig. 9. Expedition members in camp at Chiquimil. From left to right—Rudolph Stahlecker, Felipe Méndez, Elmer S. Riggs, Robert C. Thorne, an unidentified boy (standing), and Juan Méndez.

FIG. 10. Megathere locality at Ojo del Agua in the province of Tucumán.

days later Juan Méndez returned from San José with the pack mules to pick up Riggs, Stahlecker, and additional provisions. The party then proceeded to join Thorne, who had since moved camp to the little Indian village of Chiquimil (fig. 11) a few miles to the southeast of San José (fig. 2). On May 19, the expedition was united at Chiquimil.

The rainy season at Catamarca extends from December to April, and the months immediately following are most favorable for collecting. It was therefore highly desirable for the expedition to begin work there in May.

The mammal-bearing beds in this area consist of a large series of massive sands and indurated clays (figs. 12–15). Remains of mammals were locally abundant, especially on the hill called *Loma Rica*. The Chiquimil area was worked from May 20 until June 25. By the end of that time the fossil beds in this area were all but exhausted, and further reconnaissance for new collecting grounds was required.

In an attempt to prospect as much of the surrounding areas as possible, the party divided into two groups. One, consisting of Thorne and Stahlecker, explored northward along the east side of the valley to Las Arcas in the southernmost part of the province of Salta (fig. 3). They had little success. Riggs, with Juan and Felipe Méndez, proceeded down the valley as far as Punta Belasto, investigating localities reported to lie in that direction. Specimens were collected from Andalhualá, Ampahanco, Vallecito, and Río de Yapis (fig. 2).

After 10 days (June 29 through July 8), the two groups returned to Chiquimil and collected a few more specimens from Loma Rica before moving camp to San José. The expedition worked out of San José from July 12 to August 8 and made several short collecting trips north and south. The locality of Jujuy, about 4 km east of San José, was collected between July 12–14; Tio Punco (Theopunca, Teopunco, Nacimiento de Agua) was collected between July 27–29; and Ampajango (Ampahanco) to the south was visited August 7–8. Specimens were also collected from an unspecified locality to the "East of Santa María" during July 21–22, and from "Peneplain Basin" on July 17.

By the end of July the expedition had prospected and collected for a distance of more than 50 miles along the east side of the Valle de Santa María. Having found no additional promising localities in this area they decided to move camp. The collections made up to that time were packed and temporarily stored in a warehouse in San José.

Colonel Wieser reported that he had seen bones similar to those excavated by Field Museum while excavating Indian graves near the small pueblo of Puerto de Corral Quemado some 100 miles to the southwest of San José. A former physician of Belén had volunteered similar information two months earlier. Fossil mammals had not previously been recorded from that area, and Riggs was eager to investigate. So, during the second week of August the pack mules were loaded, and the expedition moved to Puerta de Corral Quemado (figs. 17–22). There, residence was established in a new adobe building on the property of Sr. Don Carmen Aibar, a provincial senator and town resident (fig. 17). Considering that it was now mid-winter and that the party had just encountered a sizable snow storm on their southward journey, the use of this new building was most appreciated.

Collecting in the Corral Quemado area was carried out from mid-August through mid-November. Most collections were made from along the Río Corral

FIG. 11. Camp, in trees in center of picture, at Chiquimil. View looking south; westernmost slope of Loma Rica is visible in extreme right of picture.

Fig. 12. Looking almost due north from saddle on hill just east of Loma Rica (see fig. 24) at the village of Chiquimil and the east side of the Valle de Santa María. The beds at the right of the picture which form the escarpment represent unit XX of Stahlecker's Chiquimil section.

Fig. 13. Looking almost due east from hill formed by Calchaquí just east of San José, with the Sierra del Aconquija in the background. The pueblo of Chiquimil is in the trees on the meseta to the right. The beds mapped by Stahlecker as Calchaquí are the dark ones at the base of the photo, those mapped as Chiquimil A and B are in the large valley in the foreground, and those of the Araucanense form the large escarpment and its base in the center of the photo.

FIG. 14. Close-up of unit XIX, a white tuff dated at 6.02 mybp. View looking due east; beds dip to ESE. Photo taken in large canyon just north of Chiquimil.

FIG. 15. Robert C. Thorne (left) and Felipe Méndez (right) excavating the skull of the type (FMNH P14357) of the giant predaceous ground bird *Andalgalornis ferox* from unit XVIIIb at Chiquimil (see fig. 16).

FIG. 16. Type specimen (FMNH P14357) of the giant predaceous ground bird *Andalgalornis ferox* (left), which stood about five feet in height, collected from unit XVIIIb at Chiquimil, compared with the skeleton of a golden eagle (right) (also see fig. 15).

Quemado and its immediate tributaries, although prospecting was done to the west of this area and some collections were made as far away as La Conte. More specimens were obtained from Corral Quemado than from the Valle de Santa María. These widely exposed beds had never before been prospected by paleontologists, whereas those near Chiquimil had been visited frequently. Summer began in November, and with it came the rains. These periodical showers interfered with collecting activities and made it necessary to discontinue work.

Difficulties were encountered in finding wood to make shipping crates for the collection. Some drift logs were rescued from the Río Corral Quemado by Don Carmen's workers, and these were placed at the expedition's disposal. A slipsaw, improvised by breaking off alternate teeth of an ordinary crosscut saw, was used

FIG. 17. Looking almost due north from camp (left foreground) across the río Corral Quemado to the pueblo of Puerta de Corral Quemado in the trees at the base of the escarpment.

FIG. 18. Looking north across the río Corral Quemado into the valley of El Jarillal. Puerta de Corral Quemado is in the trees in the left center of the picture, and the small hogbacks just right of center represent unit 8 of Stahlecker's Puerta de Corral Quemado section. Unit 8 yielded a reliable radioisotope date of 6.68 mybp; the beds strike 40–45° NNE and dip 18–26° WNW.

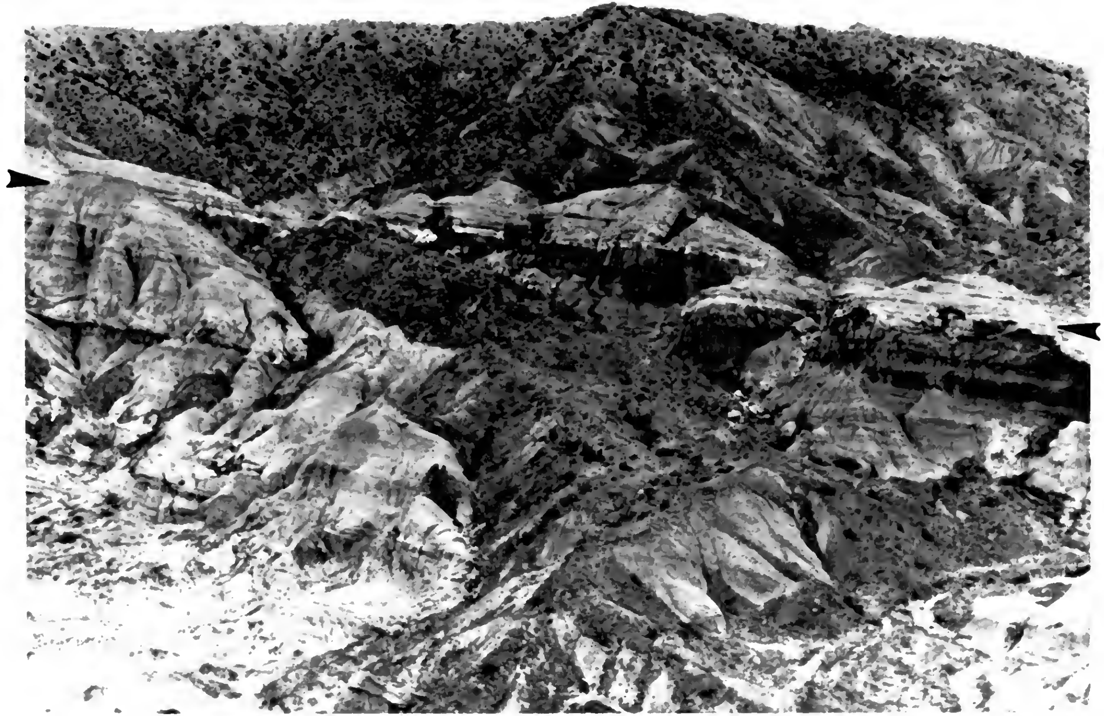

FIG. 19. Looking west into large canyon just south and on opposite side of hill from camp at Puerta de Corral Quemado. The prominent white tuff marked by arrows represents unit 8 of Stahlecker's Puerta de Corral Quemado section.

FIG. 20. Escarpment showing weathering pattern of beds near Puerta de Corral Quemado. Note horse and rider in foreground for scale.

FIG. 21. Robert C. Thorne (on rope ladder) and Rudolph Stahlecker (on ledge) excavating the skeleton of a glyptodont; beds dip to WNW.

Fig. 22. Robert C. Thorne at camp at Puerta de Corral Quemado with mule carrying empty boxes for packing fossils.

to cut the logs into boards, which in turn were made into shipping crates. The collection was then packed and ready for transport to the railway depot at Andalgalá. The smaller boxes were conveyed by pack mules (fig. 22), and a horse cart was used for the heavier ones. These were taken to the pueblo of Belén, some 40 miles south of Puerto de Corral Quemado. Striking camp at Puerto de Corral Quemado on November 19, Riggs and Stahlecker proceeded to Belén where they secured a truck and transported the collection to Andalgalá.

The problem then arose of claiming the collection stored at San José and getting it to Andalgalá. The rains had caused a landslide that entirely blocked the road from San José to Tucumán, making the route impassable. Further, because of a shortage of horse feed, wagon freighters refused to make the journey from San José to Belén. With no alternatives, resort to pack mules became necessary. The collections, however, had been packed in boxes too heavy for mules. Thorne, therefore, was sent back to San José with the Méndez brothers and instructed to unpack the collection, cut the boxes into smaller units, and repack these for transportation by mule. By this means the collection from San José was conveyed by mountain and desert trails to Andalgalá and from there, along with the collection from Corral Quemado, was shipped by rail to Buenos Aires.

From Andalgalá Riggs returned to Ojo del Agua to secure a megathere that he had located during his trip there in May. The regular members of the expedition then proceeded to Buenos Aires, arriving in late December.

APPENDIX II

Stahlecker's Maps and Sections

Rudolf Stahlecker's detailed study of the stratigraphy of the Chiquimil and Puerta de Corral Quemado areas, "To appear in Geol. Ser. Field Mus. Nat. Hist." (Riggs & Patterson, 1939, p. 162) was never published. However, Stahlecker's manuscript entitled, "Geological Observations in the Tertiary of the Province of Catamarca, Argentina," with stratigraphic sections and geological maps, was available to Riggs & Patterson during preparation of their paper. Fortunately, copies of Stahlecker's manuscript, stratigraphic sections (figs. 23, 26), and the maps upon which these sections were based (figs. 24, 25) are still available and, except for the sections and maps being redrafted and minor editorial changes to the manuscript, are here reproduced in their original form. The available text was clearly written by Stahlecker as evidenced by the awkward syntax; he was German and did not write fluent English. We have reworded some of the more cumbersome phrases, but thought it best to leave most as they were originally written. The same geologic symbols are used in the sections and maps, and Stahlecker's interpretations of the geological features are readily obvious. The fossil taxa collected by Riggs in the Valle de río Santa María are listed in Appendix IV and those from Puerta de Corral Quemado in Appendix V; the number of specimens and their levels of collection in each area are listed in Tables 1 and 2, on pages 40 and 42, respectively. Specimens without data are listed in Appendix VI. It must be stressed that the majority of identifications in Appendices IV–VI are tentative.

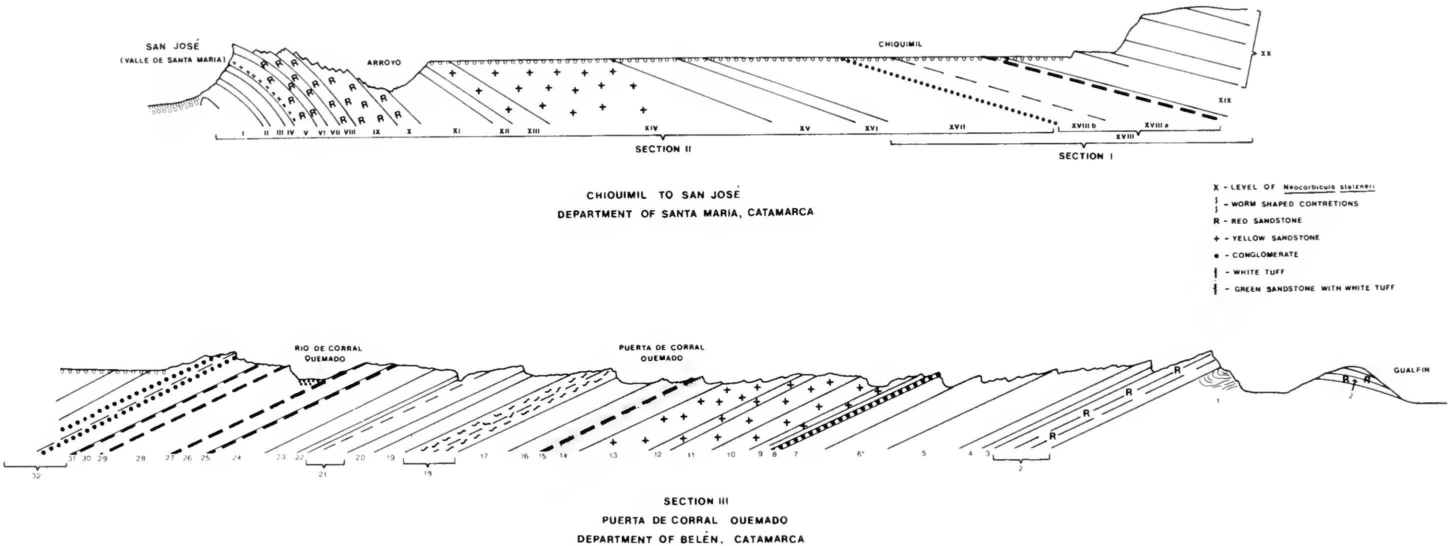

FIG. 23. Top—stratigraphic section of Chiquimil region (see fig. 24); strike 40–45° NNE, dip 18–45° ESE. Bottom—stratigraphic section of Puerta de Corral Quemado region (see fig. 25); strike 40–45° NNE, dip 18–26° WNW. Stratigraphic sections are not to same scale.

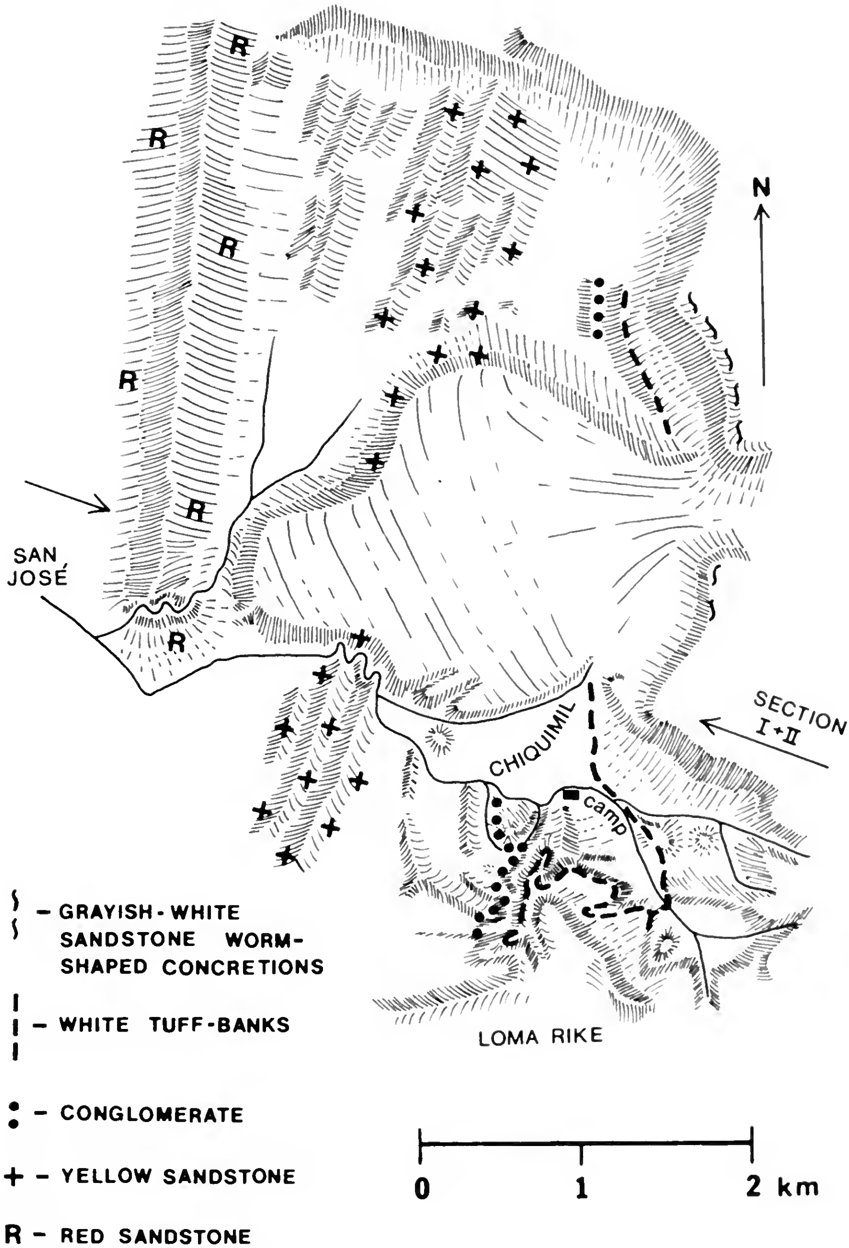

FIG. 24. Field map I of R. Stahlecker; region of Chiquimil (=Entre Ríos) and Loma Rica (=Loma Rike), district of San José. Stratigraphic sections I+II are shown in Figure 23 (top).

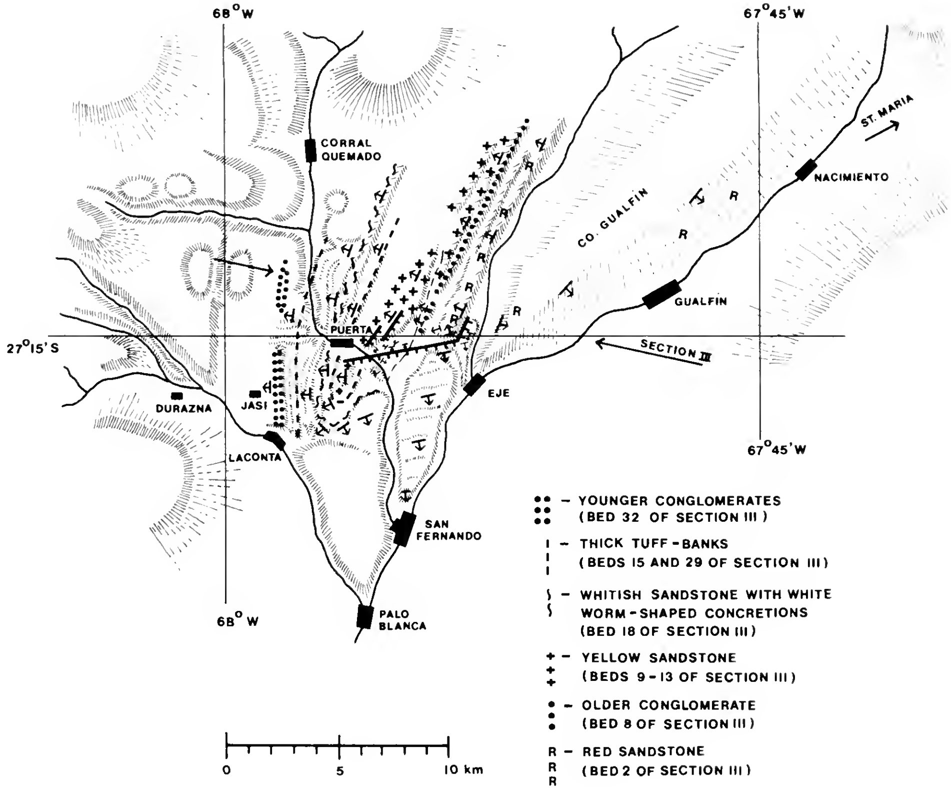

FIG. 25. Field map II of R. Stahlecker; region of Puerta de Corral Quemado. Stratigraphic section III is shown in Figure 23 (bottom).

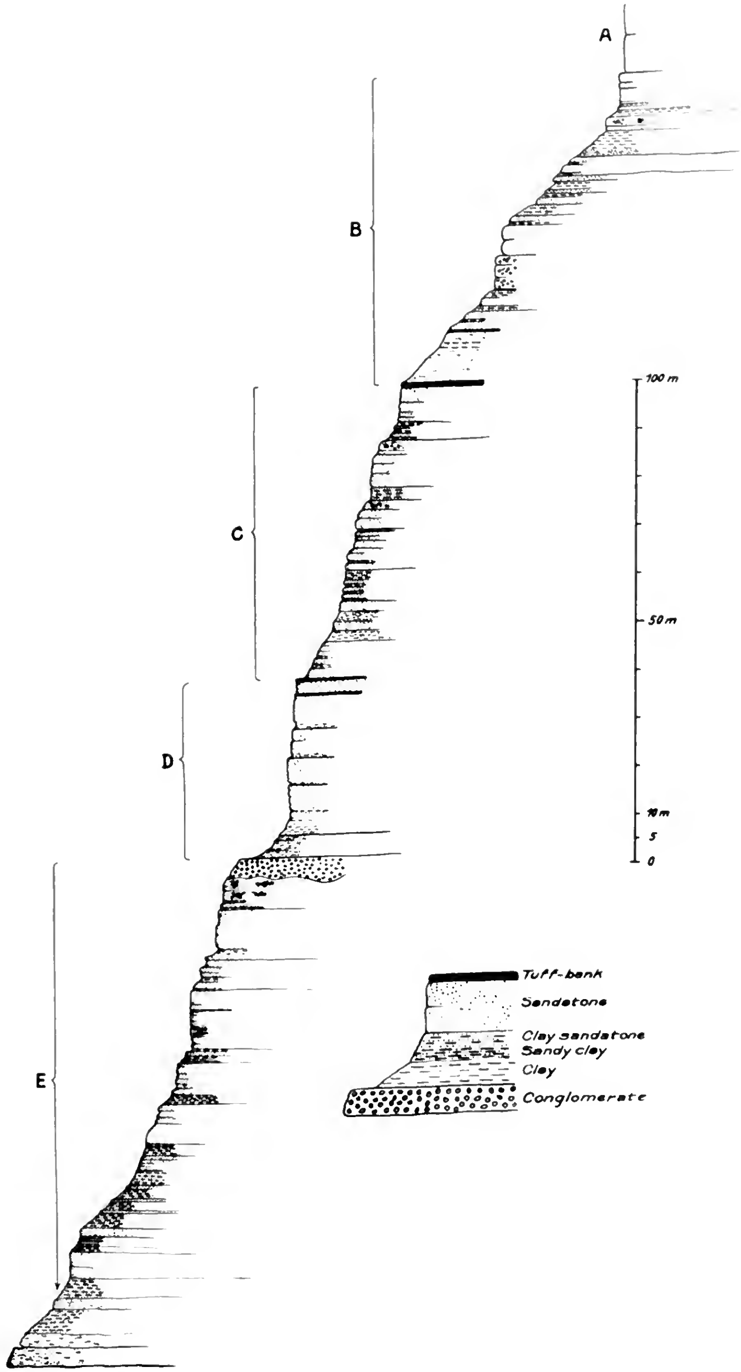

FIG. 26. Detailed section of units XX (A), XIX (B), XVIIIa (C), XVIIIb (D) from Chiquimil. Geological sections I + II (A–D)—designations of all divisions are same as in map I (fig. 24). Geological section III (E)—designations of all divisions are same as in map II (fig. 25).

Table 1. Summary of Appendix IV. Mammalian biostratigraphy of the Chiquimil section. Units VII–XX correspond with those in the stratigraphic section in Figure 23, top. No vertebrate fossils were collected from units I–VI. The numbers in the matrix represent number of specimens per taxon per unit.

VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIIIb	XVIIIa	XIX	XX	
														1	*Geochelone gallardoi*
				1											*Geochelone* sp.
											1	1			*Procariama simplex*
											1				*Andalgalornis ferox*
										1				1	*Paradidelphys pattersoni*
														1	*Thylatheridium dolgopolae*
														1	*Sparassocynus* sp.
													1		*Thylacosmilus atrox*
										1	1		1	1	*Pronothrotherium typicum*
										1				2	*Chorobates scalabrinii*
										1				2	*Paraeuphractus prominens*
										4	4	3			*Phtoramys pulcher*
										1				1	*Protabrocoma antiqua*
												1		1	*Lagostomopsis pretrichodactyla*
							1			1				1	*Tetrastylus* sp.
												1			*Neophanomys biplicatus*

TABLE 1. (*Continued*).

VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIIIb	XVIIIa	XIX	XX	
														1	*Carlesia* sp.
											1			1	*Cardiomys ameghinorum*
										4	2	1			*Orthomyctera andina*
										1					*Palaeocavia* sp.
										1		1			*Prodolichotis prisca*
												1	1		*Cyonasua* cf. *C. brevirostris*
											1				*Brachytherium morenoi*
												1		2	*Brachytherium intermedium*
											2				*Xotodon* sp.
										1					*Hemihegetotherium robustum*
										3	4	1		6	*Tremacyllus latifrons*
						1					4				*Tremacyllus diminutus*
										1		1			*Tremacyllus* sp.
1															?*Parahoplophorus* sp.
										1					*Eosclaerocalyptus planus*
				1											*Stromaphorus?* sp.

Table 2. Summary of Appendix V. Mammalian biostratigraphy of Puerta de Corral Quemado section. Units 6–32 correspond with those in the stratigraphic section in Figure 23, bottom. No fossils were collected from units 1–5. The numbers in the matrix represent numbers of specimens per taxon per unit.

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	27	28	29	30	31	32	
															1												*Ceratophrys* sp.
											1																*Hermosiornis incertus*
														2													*Procariama simplex*
														?1	?1												*Paradidelphys pattersoni*
																								1			*Lutreolina* sp.
																										1	*Borhyaenidium* sp.
														2													*Thylacosmilus atrox*
															1											1	*Pronothrotherium typicum*
																	1										*Pleurolestodon acutidens*
								1																			"*Scelidotherium*" *pendolai*
												1														2	*Paleuphractus argentinus*
																		1									*Chorobates scalabrinii*
																	1										*Paraeuphractus prominens*
									1?					1												1	*Eleutherocercus solidus*
											1						1										*Stromaphorus* sp.
																										1	*Phtoramys pulcher*
															1							1					*Pithanotomys columnaris mendocinus*
																										1	*Paramyocastor diligens*

Table 2. (*Continued*).

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	27	28	29	30	31	32	
															2												*Tetrastylus intermedius*
														1			1										*Cardiomys ameghinorum*
															1												*Palaeocavia* sp.
								1		?1	?1																*Cyonasua* sp.
																								1		1	*Promacrauchenia antigua*
														1			6			2		2					*Promacrauchenia* sp.
																	1							1			*Brachytherium laternarium*
											1			1										1			*Xotodon* sp.
	2																										*Toxodontotherium* sp.
								8		?1	?1																*Typotheriopsis internum*
														2												1	*Hemihegetotherium robustum*
																										1	*Hemihegetotherium* sp.
1																											*Pseudohegetotherium* sp.
																1	1			1							*Tremacyllus latifrons*
															1												*Chapalmalania* cf. *C. altaefrontis*
											1						1	1									*Hoplophractus proximus*
																	1										*Stromaphorus compressidens*
																				1							*Phlyctaenopyga ameghini*

"Geological Observations in the Tertiary of the Province of Catamarca, Argentina"

by Rudolf Stahlecker

Introduction

Our main task was the collecting of fossils, and geological observations were made as a supplement to this purpose. Excursions were not made outside the collecting areas. Nevertheless, our detailed observations of these areas will hopefully give an accurate picture of the regional geology.

Chiquimil

Stratigraphic Section I.—This section was taken south of Chiquimil, where we found most of the fossils. Letters A–E (fig. 26) indicate the portions of the beds that were divided into units for the purpose of recording fossils. Compare the map in Figure 24 with sections I and II (fig. 23, top). Units XVII–XX in Figure 26 correspond with those in section I (fig. 25, top).

Unit	Thickness and Lithology		Composite Thickness and Lithology	
XX (A)	ca. 200 m	light, mostly fine ss. with thin intercalations of loess, which follow hanging wall and form steep slope east of Chiquimil, above which were found light greyish white ss. with worm-shaped concretions		
XIX (B)	6 m	fine, light grey ss.	ca. 60 m	light grey, mostly fine ss. alternating with brownish, clayey layers of loess; numerous intercalations of white tuff and coarsely grained parts with boulders
	1 m	ss. and clay		
	1 m	sandy, green clay		
	2 m	ss. with boulders and clay fragments		
	1 m	ss., whitish tuff		
	5 m	brown loess clay (sandy in lower parts)		
	1.5 m	fine, light grey ss.		
	1.5 m	coarse ss. with tuff fragments		
	0.5 m	soft, brown clay		
	1 m	ss., coarsely grained, much tuff		
	1.5 m	clay, dark brown to green		
	1 m	ss., coarse, dark green		
	6 m	ss. alternating with loess		
	6 m	fine, light grey ss.		
	7 m	ss. with many boulders		
	0.5 m	tuffaceous ss.		
	5 m	fine, light grey ss. alternating with brownish loess-ss.		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
XIX (B)	1.5 m	fine, light ss. with much tuff		
	0.5 m	white tuff		
	6 m	soft, fine, light grey ss.		
	4 m	fine ss., very light with much tuff		
XVIIIa (C)	0.5–3 m	white tuff	ca. 100 m	fine, light grey ss. with intercalations of brown loess and single layers of tuff; in upper part occur two layers of coarser-grained ss. with boulders
	7 m	fine, light grey ss.		
	3.5 m	fine ss. alternating with loess		
	2 m	coarse ss., many boulders		
	8 m	fine, light grey ss.		
	2.5 m	light grey ss. alternating with brownish loess in thin layers		
	2 m	grey ss., coarse-grained, many boulders		
	13 m	fine, light grey ss. with thin layers of brown, soft loess		
	15 m	fine loess; brown, clayey, sandy layers alternating with light grey, fine ss.		
	8 m	light grey, mostly soft, fine ss.		
XVIIIb (D)	0.3–0.5 m	brilliant white tuff, locally removed by erosion		
	25 m	fine ss., light yellowish to grey		
	3 m	ss. and clay, green to brown		
	4.5 m	light greyish, clayey, soft ss. with thin, hard, calcareous layers		
XVII (E)	3–5 m	conglomerate, often weakly cemented	ca. 100 m	light greyish ss. (more in upper parts) and brown, more clayey, fine, loess layers, especially in lower parts
	END OF SECTION II TAKEN NORTH OF CHIQUIMIL			
	35 m	fine-grained, light grey ss.; upper and lower parts with boulders; soft, clayey layers in middle part; some thin layers of brown loess		
	3 m	fine, laminated, light grey ss. alternating with brown loess		
	6 m	light ss.; in junctures of stratification occur brown, sandy clay; lower parts greenish and coarsely grained		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
XVII (E)	2 m	brown, clayey ss. and loess		
	8 m	light grey ss.		
	2 m	soft, brown, clayey ss. and loess		
	3 m	fine ss. with thin layers of brown clay in junctures of stratification		
	11 m	brown, fine loess clay and soft, brown, clayey ss. of fine grain and three layers of coarse, greenish ss., each 0.5 m thick		
	2 m	ss.		
	3 m	coarse, greenish ss. in thin layers alternating with brown, sandy, fine loess		
	5 m	hard, greenish white ss.		
	4 m	brown, sandy clay		
	2 m	light, soft, clayey ss.		
	5 m	sandy, clayey, fine, brown loess		
	8 m	light, greenish white, clayey ss.		

Stratigraphic Section II.—This section was taken from San José, across the red sandstone to the conglomerate in the basin north of Chiquimil. Compare map in Figure 24 with sections I and II (fig. 23, top).

Unit	Thickness and Lithology		Composite Thickness and Lithology	
XVII	3–5 m	conglomerate	ca. 105 m	light grey ss.; partly fine, partly coarse, especially below and above in thick layers, alternating with red, sandy clay layers
	3 m	coarse ss. with boulders		
	1 m	tuffaceous ss.		
	1 m	red, clayey ss.		
	10 m	light, fine ss.		
	2 m	sandy, clayey, dark green ss.		
	3 m	coarse ss.		
	18 m	light, fine-grained ss. alternating with red, sandy clay		
	2 m	conglomerate		
	4 m	light greyish ss.		
	10 m	red, sandy clay and light ss. alternating in thin layers		
	5 m	light ss.		
	7 m	red, sandy clay and light ss. alternating in thin layers		
	4 m	coarse ss.		
	1 m	red, sandy clay		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
XVII	7 m	light ss.		
	7 m	red, sandy clay		
	15 m	white-greenish to light greyish ss.		
	5 m	red-brown, sandy clay		
XVI	30 m	light, greenish white ss. forming cliffs of 1–7 m; alternating with equally light, more clayey layers		
XV	10 m	reddish brown sandy clay	ca. 70 m	light, white, coarse, often conglomerate ss. alternating with red-brown, softer, clayey layers
	4 m	light, white ss.; coarse, with small boulders		
	10 m	light, soft ss.		
	4 m	red and green clayey sand		
	3 m	light, coarse ss.		
	6 m	red to green clayey sand		
	10 m	light, coarse ss.		
	5 m	reddish brown, clayey ss.		
	2 m	fine ss.		
	10 m	light, white ss.; very coarsely grained, with many small boulders		
	1.5 m	brown, clayey ss.		
	7 m	light, soft ss.		
XIV	285 m	yellow ss.; 10–30-m massive layers of coarse-grained, often conglomeratic with many small layers of more clayey ss. and thinner ledges of sandy, yellow clay, some with much gypsum; coarser ss., especially above	ca. 340 m	yellow ss.
XIII	55 m	yellow, hard ss., some coarse grained, with 1–3-m thick, softer, light greyish white clay layers		
XII	30 m	light greyish ss., not very hard, alternating with red-brown clayey layers 1–2 m thick	ca. 140 m	light greyish, mostly soft, clayey ss. alternating with red-brown or light clayey layers.
XI	95 m	light greyish to light yellow-brownish, very clayey and soft ss. with many 1–3-m layers of fine ss. or red-green clay		
	15 m	light grey to greenish white, sandy clay		
X	45 m	red, sandy clay alternating with clayey ss. and thin ss.; clayey layers become more massive and sand diminishes upward	ca. 215 m	red ss.

Unit	Thickness and Lithology		Composite Thickness and Lithology	
IX	80 m	dark red-brown ss. in 10–20-m thick compact layers of different grain (biotite, muscovite) divided through 5–10-m massive layers of softer, more clayey ss.		
VIII	35 m	dark red-brown ss., fine and coarse grains alternating with ripple marks, in 5-m thick layers separated through 1-m softer clayey ss.; much biotite and muscovite		
VII	30 m	grey-greenish or reddish ss. alternating with equally massive, more clayey, red ss.		
VI	25 m	ss., essentially dark red, fine-grained		
V	50 m	harder layers of mostly grey-green ss. alternating with more massive, softer layers of red, more clayey ss. and this with layers of red, sandy clay; only rare boulders.		
IV	1 m	brownish, hard, calcareous ss., with "*Corbicula*"	ca. 115 m	mostly sandy clay, green, yellow, brown, red, purple, part also pure clay, part ss. (especially upper) and boulders (in upper part); many thin, hard layers of marl or lime or calcareous ss.; much gypsum
	20 m	hard, sandy clay and clayey ss, mainly red, though alternating with green parts; ss. predominate; sparse gypsum		
III	25 m	green, yellow, brownish, clayey ss.; gypsum above with hard, thin layers of calcareous ss. and boulders		
	5 m	sandy clay, red alternating with green		
II	15 m	purple, san-clay with layers of boulders and thin layers of white ss.		
	0.5 m	conglomeratic ss.		
I	2 m	green, sandy clay	ca. 50 m	sandy clay, primarily green, but with yellow, red and brown; layers of light ss. (especially above) and brownish hard layers with much gypsum
	0.5 m	white tuffaceous ss.		
	2 m	very sandy clay, light, tuff mixture		
	2 m	yellow or brown clay with much gypsum		
	7 m	green, sandy clay with thin layers ss.		
	4 m	brown clay with much gypsum		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
I	3 m	green, sandy clay		
	3 m	hard marl with thin, reddish layers of calcareous matter		
	25 m	green to yellow clay, partly sandy, with many thin, hard layers of marl or lime; much gypsum		
	3 m	reddish, sandy clay		

The section published by Penk (1920) is not in every detail identical with ours. Penk apparently made his sections at a somewhat different place which, because of the rapid change of facies, would explain the differences.

On the whole, the sections described here and those of Penk can be compared. Penk's (p. 168) units 1–2, 3–9, 10–14, 15, 16 correspond with units I–IV, V, VI–IX, X, XI in section II (fig. 23, top); and his (p. 190) units 3, 4, 5–8, 9, 10 correspond with units XIII–XIV, XV, XVI–XVIII, XIX, XX in section I (fig. 23, top).

Puerta de Corral Quemado

Stratigraphic Section III.—This section was taken near Puerta de Corral Quemado; units 32–28 were taken in the hills north of Laconta, units 27–18 in the hills north of Puerta de Corral Quemado, units 17–14 in the hills south of Puerta de Corral Quemado, and units 13–1 east of Puerta de Corral Quemado. Compare map in Figure 25 with section III (fig. 23, bottom).

Unit	Thickness and Lithology		Composite Thickness and Lithology	
32	ca. 200 m	little indurated, coarse, brownish sandy, clayey layers with boulders alternating with massive, very coarse, loosely cemented conglomerates; some streaks of white tuff		
31	3 m	hard, whitish, tuffaceous ss.		
30	45 m	little-indurated, fine, light brownish ss. with loess-fine, clayey layers each 1–3 m thick; upper part more loosely cemented, coarse conglomerates		
29	2 m	light greyish white, fine ss. with worm-shaped concretions	ca. 18 m	hard, mostly white, tuffaceous ss.
	2 m	soft, fine, light brownish ss.		
	10 m	white, hard, tuffaceous ss.		
	3 m	hard, greenish, conglomeratic ss.		

Unit	Thickness	and Lithology	Composite Thickness	and Lithology
29	1 m	hard, white, tuffaceous ss.		
28	85 m	soft, light brownish, fine ss. alternating with brown loess conglomerates (partly light brown, partly dark green, partly soft, partly harder, cemented by concretions); single tuffaceous layers 1–3 m thick	ca. 105 m	soft, loess-fine, light brownish, clayey ss. alternating with brown loess and conglomerate (often dark green)
	7 m	dark greenish conglomerate		
	10 m	loess-fine, light brownish, clayey ss.		
	2 m	conglomerate		
27	5 m	white, cross-bedded, tuffaceous ss.; dark greenish layers between		
26	45 m	soft, light brownish, fine ss. and thinner layers of loess in lower part alternating with some fine, coarse, or conglomeratic layers of dark greenish ss.	ca. 260 m	predominately fine, light brownish ss. alternating with coarser to conglomerate (partly dark green) layers; single layers of loess or light greyish, fine ss.; single streaks, hardened by concretionary matter (in upper part), or whitish tuff (in uppermost and lowermost portions)
25	2 m	white, cross-bedded, tuffaceous ss.		
24	80 m	light brownish, fine ss. alternating with dark greenish ss. (fine to conglomeratic) with single layers of loess or fine, harder, light greyish ss.; single streaks hardened by concretionary matter		
23	55 m	fine, brown, or light brownish ss. in massive strata; thin, concretionary hard streaks; single layers of loess or light greyish ss.		
22	15 m	fine, soft, clayey, brown ss. with streaks of loess alternating with light brown, harder ss.		
21	65 m	fine, light brown, in part light greyish, ss. alternating with coarse, brown or dark green conglomerate (in upper part); ss. in middle and lower part also more clayey, softer layers; single thin streaks of white tuff		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
20	30 m	essentially brown loess alternating with thinner 1–3-m thick layers of brownish loess-ss.; single, thin, white to green streaks, hardened by concretionary matter		
19	60 m	light brownish ss.; fine, with many layers full of pea-shaped, dark brown concretions; single thin layers of loess or white tuff		
18	80 m	light, whitish, fine ss. with many worm-shaped concretions; single thin layers of brownish loess or white tuff		
17	25 m	light grey to light greenish, coarse ss. alternating with light brown, fine loess-ss. or brown loess	ca. 175 m	light brownish loess-ss. and brown loess with intercalations of light greyish, fine ss. and brownish green, coarse, conglomeratic ss.
	55 m	light brownish loess-ss. and massive layers of loess (up to 10 m thick) with single layers of 1–2-m thick light greenish to greyish, coarse, conglomeratic ss. or fine, light greyish ss.		
16	85 m	mainly fine, light brownish, often clayey, soft ss. with intercalations of brown, sandy loess and single layers of light greyish color, alternating in 10–30-m thick series of strata with four layers of greenish brownish, coarse, conglomeratic ss. in 3–7-m thick layers		
15	3 m	soft ss., white to greenish white to green	ca. 15 m	brilliant white and dark green layers; much tuff and coarse conglomeratic ss.
	2 m	brown, sandy loess		
	2–3 m	dark green, hard, coarse ss.		
	1 m	coarse, white, tuffaceous ss.		
	4 m	light brownish loess-ss.		
	1 m	loess		
	2 m	greenish yellow, hard, coarse, conglomeratic ss.		
	1 m	dark green, coarse ss.		

Unit	Thickness	and Lithology	Composite Thickness	and Lithology
14	6 m	light brownish loess-ss.	ca. 45 m	light brownish and red-brown, fine ss.; two layers of light greenish yellow color
	2 m	greenish yellow, sandy clay		
	10 m	light brownish loess-ss. with loess		
	5 m	soft, fine, light green to yellow ss.		
	22 m	red-brown, fine ss.; soft, with single layers of loess		
13	3 m	coarse ss.; yellowish, hard with boulders	ca. 105 m	yellowish, hard, coarse ss. (in upper part) alternating with fine, light grey ss. or brown loess (especially in lower part); also light greenish yellowish clay (with white, concretionary streaks)
	11 m	fine, light grey ss. alternating with brown loess		
	3 m	coarse, yellowish, hard ss.		
	3 m	greyish to yellowish or brown clay		
	7 m	light grey or light brown, fine ss.		
	6 m	brown loess		
	4 m	coarse, yellowish, hard ss. with boulders		
	10 m	light grey, fine ss. alternating with loess		
	3 m	coarse, yellowish, hard ss.		
	11 m	light grey, fine ss. alternating with brown loess		
	1 m	coarse, yellowish, hard ss.		
	11 m	fine, light ss. with loess		
	30 m	brown loess alternating with fine, light grey ss. and with layers of light greenish yellow clay (with white concretionary streaks) each layer 1–4 m thick		
12	35 m	fine, yellowish ss. with thinner, brown streaks; hard with concretionary matter		
11	65 m	mostly fine, light grey-brown ss. in 1–8-m thick layers alternating with 1–3-m thick layers of mostly brownish, sandy clay; rare intercalations of thin, yellow, coarse-conglomeratic layers	ca. 125 m	mostly fine, light brownish (part light greyish) ss. with intercalations of brown clay; rare, thin layers of coarse, conglomerate ss. with partly yellow color
10	50 m	light brownish, fine ss. with thin layers of loess and rare layers of light greyish ss. (in lower part); single, thin streaks of coarse grain with boulders		
	1 m	light greyish ss.		
	1 m	brown clay		

Unit	Thickness	and Lithology	Composite Thickness	and Lithology
10	1 m	yellow ss.		
	2 m	brown clay		
	1 m	brownish, conglomeratic ss.		
	3 m	brown clay		
9	20 m	yellowish, hard, very coarse ss. with conglomerates and single layers of greenish clay	ca. 35 m	yellow, hard, coarse ss. in upper part; brown or greenish yellow, clayey layers below
	7 m	loess and loess-ss.		
	5 m	green, yellow, whitish clay		
	1 m	conglomerate		
	3 m	brownish and greenish yellow clay		
8	5 m	very coarse, brownish conglomerate	ca. 18 m	coarse, brownish conglomerates
	5 m	fine, light grey ss.		
	2 m	conglomerate		
	3 m	brown-red clay		
	3 m	coarse conglomerate		
7	7 m	light brownish, fine ss.	ca. 80 m	several layers of brown-red, sandy clay alternating with fine, light brown or grey ss., coarse ss., or conglomerate
	20 m	mostly brownish red, sandy clay with 1–2-m thick intercalations of fine, light ss.		
	2 m	conglomerate		
	10 m	light brown, fine ss. and brown loess		
	1 m	conglomerate		
	5 m	light brownish, fine ss.		
	20 m	mostly brownish red, sandy clay with 1–2-m thick intercalations of fine ss. or conglomerate		
	15 m	light grey to greenish ss. of coarse grain, partly conglomeratic, alternating with fine ss. and rare layers of brownish red clay		
6	15 m	fine, light greyish or light brownish ss. with 1–2-m thick layers of brown loess	ca. 110 m	very fine, very light brown, compact ss.; "Woolsack" weathering; intercalations of 3–10-m layers of brown loess
	75 m	very fine, light brownish compact ss.; "Woolsack" weathering (roundish globular decomposition) in 5–25-m layers with 3–10-m intercalations of brown loess; in middle part 5 m with many, darker brown streaks, hardened by concretionary matter		
	3 m	brown loess with thin layers of ss.		

Unit	Thickness and Lithology		Composite Thickness and Lithology	
6	17 m	very fine, light brownish ss.		
5	12 m	light grey to light greenish, coarser ss. with thin, brownish, hard, concretionary streaks and single layers of clay	ca. 125 m	mostly light brownish, partly grey, fine ss. with rare, thin layers of loess; upper part coarser, light grey ss.; concretionary, brown, hard streaks and layers whitened by tuff; 1 m dark red ss. in lower part
	8 m	light brownish, fine ss. with concretionary streaks		
	10 m	light grey, soft ss. with concretionary streaks		
	1 m	soft, clayey ss., whitish tuff		
	2 m	brown, concretionary ss.		
	6 m	greyish ss. alternating with loess		
	8 m	light brownish, fine ss.		
	1 m	white, soft, tuffaceous ss.		
	1 m	greenish, hard, sandy clay		
	75 m	brown, fine ss. with rare streaks of loess; in middle part 1 m dark red ss.; in lower part layers of light grey ss.		
4	35 m	light grey ss.; mostly coarse, partly conglomeratic; single layers with concretionary matter		
3	20 m	light brownish or red ss. and light red clay		
2	ca. 100 m	dark red ss. with single layers of bright clay		
1	ca. 100 + m	exposed—mostly bright-colored layers of sandy clay with intercalations of soft, clayey ss. (especially in lower part); red, yellow, green, brown, purple; all sharply dipping		

Remarks on Regional Tectonics

The "red ss." and the colored, clayey layers below it are poorly exposed. They appear only where the Sierras have pressed up the inside of the Bolson like an eccema by lateral pressure. Both profiles (fig. 23), show that the red sandstone is overthrust over the more clayey beds below. This suggests a great deal of lateral pressure in these areas. Both valleys show the upwarping of these tertiary beds into an anticline. In the valley of Santa María, the red sandstone occurs only near San José and north of it for a distance of 10–15 km. The inclination of the strata increases toward the top of the anticline, and reaches a sharp degree north and south of San José. This does not occur elsewhere in the territory we examined. It is remarkable that the exposure of the red sandstone is found in that part of the valley where the Sierra del Cajón and the Cerros de las Animas nearest approach each other—that was the place where the pressure was strongest and the anticline steepest; the red sandstone was elevated and was affected by the erosion that rent the top of the anticline, the top-point of which is only just exposed.

Cerro Gualfín tore up this arch in rising through the strata in the vicinity of Puerto de Corral Quemado (fig. 25); the red sandstone there lies on both sides of Co. Gualfín. A transverse fault accompanied by considerably smaller faults explains the disappearance of the Co. Gualfín and with it the red sandstone toward the south under the sediments in the valley of San Fernando. In the elongation of the red sandstone toward the south beyond the transverse fault, there appear strata that might begin with about units 17–18 of section III (fig. 23, bottom). It is remarkable that they are not inclined toward the Sierra in the west, but toward the south. The strata visibly increase in steepness toward the top in the short anticline south of Puerta as well as in the valley of Santa María. The pressure from the west reveals itself in the more vertical position of the beds on the east flank of the Sierra. East of Eje and Gualfín, the light beds above the red sandstone reappear as they do on the west side near Puerta.

Description and Comparison of Stratigraphic Sections

The clayey beds at the base of the red sandstone could be mapped only near San José. The sand portion and red color increase toward the top; the transition into the red sandstone takes place gradually and without a proper parting; marls, calcareous beds, and the proportion of gypsum, significant in the lower parts, disappear toward the top of the section. The "*Corbicula*" horizon is one of the uppermost calcareous streaks and lies in the lower part of the transition zone.

In a fine reddish sandstone 40 m above the "*Corbicula*" horizon was found the transverse section of a carapace of a medium-sized glyptodont. This specimen was not collected. The very slight overthrust, lying higher up, has not stifled any sediments. The lowest strata are well exposed about 5 km north, with numerous thin marl, gypsum, and calcareous bands of a clayey-slatey character—yellowish and greenish colors predominate.

Between Puerta and Gualfín, we could catch but a glimpse of these strata. There too, the lower parts contain more yellow and greenish beds, whereas intense red-clayey layers dominate the upper part. The lower part will likely be the one with more sand. Very calcareous and marly, thin layers are frequently intercalated here as well (especially below). These beds are folded, and the relationship to the red sandstone that is pushed on top of them is not certain. Particularly, there is no transition zone recognizable. Still, I do not suppose that the tectonics destroyed any important parts; the lower, more normally deposited strata correspond to those at San José. Besides, the overthrust seems to disappear toward the north; nor do transition beds to the red sandstone seem to be developed there as they were at San José.

The dark red sandstone is strikingly visible at a distance, and it stands out morphologically owing to its hardness—it is the hardest part of the whole series. Near Puerta we could not examine it, because it precipitates vertically. Near San José it proved to be poorly fossiliferous. By reason of the condition on the whole and the situation in the section (and particularly of its hanging wall) I equate the red sandstone in both localities. Its thickness near Puerta is less than at Chiquimil.

The Parting Beds in the Hanging Wall of the Red Sandstone.—Something of a transition zone is developed near San José, in which the red sandstone becomes more clayey and soft, the color fading somewhat, and light greyish intercalations begin; near Puerta de Corral Quemado the parting is rather distinct. The hard, massive, dark red sandstone in the Valley of Santa María is overlain by 10 m of rather pure, light red clay with thin red sandstone which in turn is followed by brown and light grey, fine sandstone. A 1-m band of dark red sandstone occurs 70 m above this.

This distinct break in lithology, together with the lesser thickness of the red sandstone in Puerta, suggests that a short period of erosion occurred after deposition of this sandstone.

The Strata Between Red and Yellow Sandstone.—While 350 m thick near Puerta, this portion occupies only 140 m near San José. In the valley of Santa María, it consists of rather soft layers that are eroded, forming V-shaped depressions between the two sandstones that offer resistance. Red-brown, loess-fine, sandy clay alternates with fine, light grey, very clayey and soft sandstone. Near Jujuy, occur some poorly fossiliferous layers hardened by calcareous concretions. The only fossils, a glyptodont and a large tortoise, were found near Ampahango in an especially thick loess-intercalation.

At Puerta these beds are thicker and are partly of different composition. Several intercalations of coarse to conglomeratic sandstone found here are lacking near Santa María. Here are numerous streaks hardened by concretionary processes, whereas in the valley of Santa María they are rare or lacking. Apparently water played a greater part in deposition of these beds near Puerta than it did near Santa María. But in the whole series, those layers deposited by water are intercalations only. At Puerta, too, the loess-like, brown, clayey layers and the fine-grained sandstones that are supposed to be mostly wind deposits are predominant. The very fine and compact sandstones with "Woolsack" weathering (unit 6 of section III) may also be loess. As near Santa María, these beds are rather soft and easily eroded. They are here likewise poorly fossiliferous, but some fossils, including a toxodont, were found here (especially in unit 7).

The similar lithology of the two sandstones (i.e., they are fine grained and soft) and the similarity of the fossils found in them cause me to equate the two.

The yellow sandstone, with 320 m at Puerta and 340 m at Santa María, is of similar thickness at the two localities. It is marked by considerable hardness, mainly caused by numerous coarse-grained to conglomeratic intercalations. These hard layers are yellowish in color and, as they are always morphologically well marked, the whole series is characterized by this color as seen from a distance. In the valley of Santa María, these strata are well developed—loess plays a minor part in it.

Often the richness of gypsum is striking. Water that runs through the yellow sandstone contains distinctly more salt than that above it and is often undrinkable. On the whole, it may be concluded that here water had a greater part in deposition as evidenced by the coarse grain, the stratification, and the presence of boulder beds.

Fossils are very rare, mostly crushed, and occur only as isolated bones, from which fact conclusions may be drawn as to the genetic conditions of the sediment.

Near Puerta, a little more fine-grained sandstone and loess are intercalated. In stratigraphic sections 5 km and more apart, the coarse, yellow layers go through uniformly, whereas the fine sandstones and loesses vary greatly in thickness and quality.

Near Puerta, this series begins with the striking conglomerate that indicates a considerable transport of detritus, caused either by tectonic or by increasing precipitations. The fine-grained intercalations in the middle part of the yellow sandstone near Puerta show by these concretionary streaks that water participated in its deposition. Fossils occur in the same manner as at Santa María.

The Beds Between the Yellow Sandstone and Whitish Sandstone with Worm-Shaped Concretions.—Their thickness near Puerta amounts to 235 m; at Santa María, it may exceed 400 m. The section there ceases without reaching the upper limit of the series, but the sandstone could be observed on an excursion and was later recognized at Puerta.

The appearance of numerous tuff intercalations is characteristic of this series. Such tuffs may occur over a large area, and their appearance at about the same stratigraphic horizon in the two areas studied suggest that they may be contemporaneous.

Further, these beds at both localities show frequent intercalations of loess-fine clays and sandstone that offer comparatively little resistance to erosion and therefore form mostly long depressions along strike. Coarse to conglomeratic intercalations occur repeatedly, though they are not as frequent or of the importance as in the yellow sandstone. They are softer and not yellow in color.

Particularly, the upper part of these beds at Santa María is rather sandy and forms a wall-like step of light grey, mostly fine sandstone upon which lies the whitish sandstone with the worm-shaped concretions. Near Puerta, the latter forms a step, of which only the foot consists of the above characterized strata. The greater thickness at Santa María is mainly due to these upper fine sandstones, which at Puerta are not as well developed.

The following refers to the conditions near Puerta:

The Whitish Sandstone with Worm-Shaped Concretions.—This is distinctly harder and contains abundant tuffaceous material. Loess plays quite a minor part, whereas brown, thin streaks, hardened by concretionary matter are more frequent. I have not seen any fossils in this part.

The strata in the hanging wall begin with plainly brown sandstone with characteristic dark-brown, pea-shaped concretions. I saw these concretions near Santa María in a corresponding level. This sandstone contains fossils. The upper following loess-horizon of 30 m (unit 20) was particularly fossiliferous. Fragments of fossil tortoise were found in both units.

Faunistically, the whitish sandstone seems to form an important boundary. Above it we found the first remains of large glyptodonts in considerable numbers. There was no sign of them in the lower parts in spite of numerous other fossils. In the same way, the first remnants of megatheriids and *Promacrauchenia* appear in this level. Northeast of Santa María, I found fragments of a large glyptodont in a horizon that corresponds to the sediments near Puerta.

Above this loess horizon, which usually forms a depression or terrace, there follow 380 m of mainly light brown, fine-grained sandstone with intercalations of coarse-grained layers and conglomerates. Tuff streaks appear repeatedly, particularly the two horizons with the cross-bedded, white tuffaceous sandstone (units 25, 27) are fairly good guide horizons in the vicinity of Puerta. (Tuff material and coarse grain and pebbles occur frequently in close association in all the examined strata.) The hardening of the sandstone and conglomerates in the uppermost part of this section visibly begins to decrease. Fossils are found throughout.

A hard, white, tuffaceous sandstone, 10–15 m thick, is morphologically and stratigraphically quite remarkable. Immediately above it, there begin about 50 m of strikingly soft, only little hardened sediments.

Higher up follow brown, scarcely consolidated beds, with remarkably coarse and thick conglomerates, that illustrate the beginning of a tectonic phase. Coarse sand, clay, and pebbles are deposited without any sorting of size. On the other hand, a clear bedding is seen, and white tuffaceous streaks are intercalated. These youngest beds of our section (unit 32) are, in the same manner as the lying wall, dipping. I could not find any fossils in it. They are exposed in a thickness of about 200 m, and toward the top become even more loose and soft. They dip under a horizontally lying, younger cover of detritus of a plain that extends in a breadth of a few kilometers in front of the Sierra in the west.

Near Condorguasi at Ojo del Agua, province of Tucumán (about 100 km east of Puerta), we collected the remains of a megathere. Mr. Riggs wrote me: "The *Megatherium* from Ojo del Agua is much larger and apparently later than any specimen collected by our party in Catamarca." (All these specimens were found at Puerta between 70 m and about 200 m above the whitish sandstone—unit 18.) "The two glyptodont carapaces which I saw there were also larger and apparently more like *Glyptodon* and *Panochthus* of the Pleistocene in Tarija. The *Megatherium* [specimens] collected near Puerta are all quite small. However, we found a small species of *Megatherium* relatively common in the Pleistocene at Tarija." Besides, the *Megatherium* from Ojo del Agua is much smaller than the species from the Pampa Formation. The matrix was only little indurated. Coarse, light grey sand was abundantly represented along with thick conglomerates and clayey layers; all were dipping. I should equate these strata with the uppermost part of the section at Puerta, but everything was here better sorted and bedded.

These beds here too were dipping and eroded; they are cut discordantly by the present plain. They are superposed by coarse-grained detritus and on the top by young loess in such a manner that there are but few exposures existing of the lower strata.

Better exposures occur northwest in the Campo de Pucara where obliquely standing, light grey, fine sandstone occurs in each valley [Rassmus (1918) described them also from here]. They seem to form the lying wall of this whole plateau that shows a concave surface, covered with young loess.

The altitude of this plateau is 1,800 m. It is not overtopped and accompanied on the side by high sierras, but cuts off rather abruptly in a steep slope, considerably cut by erosion, 800 m to the Bolson of Andalgalá. In the eastern part, there are similar conditions. The abrasion of these strata to the discordantly cutting plain must have taken place at a time when they already stood obliquely but did not have this relative altitude. The spreading out of the body of detritus on this plain may have largely taken place before elevation.

We accordingly recognize the consequences of great tectonic transactions that occurred after deposition of these beds as the section at Puerta shows: the occurrence of large conglomerates in the uppermost part, oblique situation, erosion to the discordantly cutting plateau that was afterwards covered by coarse gravel.

The loess of the plateau of Condorguasi is probably quite young. It is still being formed today under similar conditions as described by Penk (1920, pp. 237–238). The whole territory is barren of trees, but has a fairly dense growth of grass.

Comparison with Other Regions

The "*Corbicula*" horizon has often been discussed in the literature, although the red sandstone that lies above it has not always been fully taken into consideration. The sandstone is about half as thick at Puerta (100 m) as at Santa María (215 m). The next region examined is the Sierra del Atajo-Capillitas, north of Andalgalá, studied by Bodenbender (1924). It is situated about 40 km east of Puerta and about 80 km south of Santa María.

Bodenbender says about the Cuesta Colorado (NW of the Cerro Atajo): On top of not more than 50 m of red sandstone there are brown sandstones alternating with more coarse-grained, grey sandstones; calcareous concretions and thin layers of limestone and dolomite are characteristic. The color becomes lighter (light grey) toward the upper part. All the sandstones, including the red, are more or less calcareous. Bodenbender then concludes that these calcareous-dolomitic strata correspond to the "*Corbicula*" beds near Santa María and that the red sandstone occurs below them. This I want to contradict.

Comparing the section of Puerta with the preceding one, we find again that such small layers, consolidated by limestone or dolomite (units 5–6 of section III) occur above the red sandstone, as on the whole the part played by water in the depositing is more distinct. According to Bodenbender, these influences seem to be greater in his district. Groeber (1929) is probably correct in regarding the "*Corbicula*" horizon of Santa María as a most western branch of the marine invasion in the "Entrerriano." These invasions come from the east, and it seems easily conceivable that a little later the part played by water is greater farther east. We may thus explain the occurrence of these calcareous-dolomitic layers above the red sandstone.

I should like to equate all three occurrences of red sandstone. The inconsiderable thickness of 50 m in the Cerro Colorado fits into the image harmoniously; likewise the description of the higher strata. The red sandstone, according to Bodenbender, lies in the Co. Colorado in places directly on the granite, while farther east there is an intercalation of grey-yellow grit with conglomerates, increasing toward the east. Farther south, there occur coarse conglomerates under the grey sandstone. At Capillitas, the red sandstone, according to Bodenbender, partly superposes the old underground, in part they lie on grey sandstone. South of Atajo, again, the red sandstone lies directly on the granite and is here and there overlain by very fine, clayey, brown sandstone, with intercalations of grey layers and calcareous concretions.

The conditions in the hanging wall of the red sandstone can be correlated with those of Puerta, though they are different in the lying wall. The whole manner of deposition shows that differences in the facies and deficiency of strata are rather to be expected in the lying wall than in the hanging wall. The clayey and marly strata at Puerta and Santa María indicate a situation much nearer to the center of the basin of sedimentation than in the district of Atajo, where the red sandstone lies directly on the granite or on grit and coarse conglomerates.

Besides, the exposures at Puerta and Santa María show only the upper part of these strata; we may suppose considerable parts below them.

Bodenbender mentions the occurrence at Menchaca (west of Andalgalá) of clayey, little-hardened beds of different color. He supposes them to be higher in the section and that he cannot determine their connection with the above-described beds. Possibly these layers are a facies of the lying wall of the red sandstone, corresponding to the one at Puerta.

From Ampujacu (southwest of Atajo), Bodenbender mentions the red sandstone lying on older beds and says the transgression of the red sandstone over the Sierra de Belén is almost certain. Penk (1920) mentions brilliant red sandstone under grey layers, as erosion remnants on a granite-peneplain in the depression between Belén and San Fernando. In the southern part of the depression of Lampacillo (that takes us to the district of Puerta), Penk mentions red sandstone, again on granite; possibly his observations concern places lying farther northwest than ours near Puerta-Gualfín. Between Gualfín and Nacimiento, the red sandstone seems to lie directly on the sides of the rising Co. Gualfín. The colored, clayey beds that we found on their southern border are probably oppressed farther north by tectonics. Moreover, the red sandstone near Puerta, as mentioned above, makes the supposition of acting erosive forces possible, such as Penk states from the region of Belén-San Fernando.

We see from this survey how the red sandstone of the district of Atajo can be followed to the region of Puerta. According to our observations, we equate the red sandstone of Puerta to that of Santa María, where it occurs in the hanging wall of the "*Corbicula*" horizon.

Rassmus (1918) states that southeast of Atajo in the Campo de Pucara (near Condorguasi) there occurs a lying wall of the light-grey sandstone, etc., a red conglomerate, lying on an old plain of crystalline rock. This might be the representative of the red sandstone that thins out in that direction.

Going southwest from Puerta, we come to the depressions of Lajas and Pailas. From there, Penk records very thick sandstone and conglomerates (particularly in the upper part) of red or brown color, conformably overlain by grey layers on the granite body. A far-going parallelism with our region is impossible. We must leave these two depressions out of consideration, as particulars are lacking; there must have occurred special conditions (thickness of more than 3,000 m between the granite and the hanging grey beds).

Near Los Angulos, Bodenbender states that above an older erosion plain (here formed by Paganzo II), there are yellow-reddish conglomerates (400–600 m), above it follow grey-greenish sandstones (300 m). Toward the south, these sandstones become partly coarser, partly clayey, brown-yellow, and red colors occur. Above there are brown calcareous sandstones. They are more clayey, well bedded, thickly banked, and hard: Marl-limestone banks are intercalated; one of them, near the lower boundary of the division, contains "*Corbicula*," etc. Grey beds (andesite and dacite tuffs) follow the brown sandstones.

We think these brown sandstones to be the equivalent of our red sandstones. At their bases occur the mollusks near Santa María. Bodenbender described another occurrence of mollusks from Los Angulos, the lying wall of which is formed by sandstones, conglomerates, clays, and marls of different color and consistency. Clays and marls of different colors we found also in the lying wall of the "*Corbicula*" horizon from Santa María. In the Atajo district, there are, at places, grey sandstones and conglomerates below the red sandstones.

According to Bodenbender, "Calchaqueño superior" follows above the brown sandstones near Los Angulos. A tuff conglomerate in compact banks, above it more or less fine, mostly tuffaceous, grey sandstone, above it tuff and ashes between sandstone, conglomerates, and sand, above it conglomerates (conformably or discordantly) with rare layers of tuff. A detailed parallelism of these upper divisions with our observations is impossible. On the whole, the tuff seems to play a part earlier and more abundant in the region of Los Angulos than farther north.

Between Tinogasta and Fiambala, Bodenbender reports a reddish yellow, partly oolitic sandstone, which in the east (i.e., in the lying wall; the beds dip west) is accompanied by greenish sandstone with sandy concretions and by brown sandstone with calcareous concretions. He followed these layers in the lying wall toward the south (i.e., toward Los Angulos) as a complex of only a few hundred meters of thickness (reddish yellow conglomerates in the east, i.e., the lying wall, and grey or greyish yellow sandstones in the west, i.e., the hanging wall). The reddish yellow, oolitic sandstone mentioned by Bodenbender above the latter near Tinogasta-Fiambala would accordingly be the equivalent of our red sandstone. It seems remarkable that the whole lower part (conglomerate, mostly brown or red sandstone) apparently diminishes in thickness toward the north (i.e., toward Fiambala-Belén).

Summary

The examined beds may be divided into three main complexes: (1) below the red sandstone, (2) respectively its equivalents, and (3) its lying wall, above it mainly light beds, that can be divided into a middle and an upper part of the whole series by the occurrence of *Promacrauchenia*, megatheres, and big glyptodons only above the whitish sandstone with worm-shaped concretions. The termination of this section is given by coarse conglomerates with tectonic dislocation and rare-unconformity.

The lower part makes special consideration worthwhile. Everywhere it lies discordantly on an older erosion plain. Thereby it becomes evident that the deposition of these strata took place in two basins. They are, at least in the observed territory, divided by a swell or at least restricted in their connection. This swell stretched from Atajo to the region of San Fernando-Belén. Only the red sandstone could superimpose it (it lies here directly on the old erosion plain). North and south of the swell there were thicker layers deposited between this plain and the red sandstone, particularly so the "*Corbicula*" horizon on its lower boundary. In the northern basin (Santa María-Puerta), colored, more clayey layers are deposited; in the southern basin (Tinogasta-Los Angulos), more sandy, mostly grey-green sediments, below them reddish yellow conglomerates, lying on the old peneplain. Toward the north (i.e., toward the swell) these beds seem to diminish in thickness. In the northern basin, the exposures are not deep enough to show the lack or existence of these conglomerates.

After the depositing of the red sandstone, there followed a period of erosion, which apparently shows hardly any effect in the north (near Santa María). There we find the maximum thickness of the red sandstone, its transition-zone to the hanging wall shows no signs of erosion. Although such signs are reported from Puerta, the thickness too is considerably lessened. It is still less in the region of Atajo. In the Campo del Pucara, there is only a red conglomerate. Between Belén and San Fernando, Penk mentions only the remnants of erosion. In the southern basin, the red sandstone is not formed in the same formation. Possibly it was there deposited and afterward eroded away. It is possible that there the marine transgression lasted longer. Bodenbender tells of calcareous marl banks in the brown sandstone in the hanging wall of the "*Corbicula*" horizon. The red-yellow sandstone from Fiambala is oolitic. It is natural that under these conditions the colors significant for the north do not recur. Bodenbender reports near Los Angulos conglomerates in the hanging wall of the brown sandstone; possibly they are the signs of the erosion that become much clearer in the part of the swell.

After this erosion period, it is striking that no more red deposits occur; evidently the conditions in the corresponding erosion districts had meanwhile thoroughly changed.

In the middle and upper part of the examined region, the essential facts have been stated in the description of the sections. A more exact comparison with neighboring districts is impossible, because details are lacking there.

Our observations are entirely in accord with the divisions by Groeber (1929) and Windhausen (1931). In the lying wall of the lower part a decided erosional discordance corresponding to the second tectonic phase, above follow as "Piso Entrerriano" the lower part of our section including the red sandstone. The prephase of the third tectonic phase is marked in the erosional effect in the swell region. A discordance did not occur, but the conditions in the erosion districts are different ones, so that no more red sediments occur. There follow the mainly grey beds of the "Piso Araucano." The influences of the determining third tectonic phase can also be mentioned.

[Throughout the text Stahlecker refers to and cites statements from Bodenbender, although except for one instance he does not give the year or page number. In his bibliography Stahlecker lists three works of Bodenbender (1911, 1916, 1924), and presumably these represent the sources of his data. Stahlecker also included Stappenbeck (1921) and Stelzner (1885) in the bibliography, although he makes no specific references to these works in the text.]

APPENDIX III

List of Fossil Vertebrates Recorded from the Late Tertiary of Catamarca

Class Amphibia
- Order Anura
  - Fam. Leptodactylidae
    - *Ceratophrys* sp.

Class Reptilia
- Order Chelonia
  - Fam. Testudinidae
    - *Geochelone gallardoi* (Rovereto, 1914, p. 115)

Class Aves
- Order Rheiformes
  - Fam. Rheidae
    - *Heterorhea* sp.
- Order Gruiformes
  - Superfam. Phororhacoidea

Fam. Psilopteridae

Hermosiornis incertus (Rovereto, 1914, p. 114) see Patterson & Kraglievich, 1960, p. 19

Procariama simplex Rovereto, 1914, p. 110

Fam. Phororhacidae

Andalgalornis ferox Patterson & Kraglievich, 1960, p. 34

Order Strigiformes

gen. et sp. indet.

Class Mammalia

Order Marsupialia

Superfam. Didelphoidea

Fam. Didelphidae

Subfam. Didelphinae

Paradidelphys pattersoni Reig, 1952, p. 123 (also see Simpson, 1974, p. 5)

Lutreolina cf. L. crassicaudata see Simpson, 1974, p. 10

Thylatheridium dolgopolae Reig, 1958a, p. 93

Subfam. Sparassocyninae

Sparassocynus sp. (referred—see Simpson, 1974, p. 11)

Superfam. Borhyaenoidea

Fam. Borhyaenidae

Subfam. Borhyaeninae

Eutemnodus? acutidens (Rovereto, 1914, p. 83) see Marshall, 1978a, p. 65

Subfam. Hathlyacyninae

Borhyaenidium riggsi Marshall, 1981, p. 37 (*Notocynus* sp. of Riggs & Patterson, 1939)

Fam. Thylacosmilidae

Thylacosmilus atrox Riggs, 1933, p. 62 (including *T. lentis* Riggs, 1933, p. 62—see Marshall, 1976, p. 18)

Superfam. Argyrolagoidea

Fam. Argyrolagidae

Microtragulus catamarcensis (L. Kraglievich, 1931b, p. 254) see Simpson, 1970, p. 8.

Order Edentata

Fam. Megatheriidae

Subfam. Megatheriinae

Pyramiodontherium bergi (Moreno & Mercerat, 1891a, p. 231) (including *Megatherium burmeisteri* Moreno & Mercerat, 1891a, p. 229; and *Pyramiodontherium dubium* Rovereto, 1914, p. 89—see Cabrera, 1928, p. 344)

Subfam. Nothrotheriinae

Pronothrotherium parvulum (Moreno & Mercerat, 1891a, p. 229)—see L. Kraglievich, 1934, p. 48

Pronothrotherium typicum F. Ameghino, 1907, p. 118

Fam. Mylodontidae

Elassotherium almagroi (Rovereto, 1914, p. 91) see Ortega, 1967, p. 117n

Pleurolestodon acutidens Rovereto, 1914, p. 92

Pleurolestodon avitus Rovereto, 1914, p. 95
Pleurolestodon macrodon Rovereto, 1914, p. 96
"Scelidotherium" laevidens Moreno & Mercerat, 1891a, p. 228 (see L. Kraglievich, 1934, p. 48; Bordas, 1935, p. 484; Ortega, 1967, p. 117n).
"Scelidotherium" pendolai (referred specimens—type species named by Rovereto, 1914, p. 152 on specimen from Monte Hermoso)
Sphenotherus zavaletianus F. Ameghino, 1891a, p. 95

Fam. Myrmecophagidae
Myrmecophaga conspicua (Rovereto, 1914, p. 98)
Nuñezia magna (C. Ameghino, 1919b, p. 152)—see L. Kraglievich, 1934, p. 48
Palaeomyrmidon incomtus Rovereto, 1914, p. 100

Fam. Dasypodidae
Chorobates scalabrinii (Moreno & Mercerat, 1891a, p. 226)—see Reig, 1958b, p. 250n
Chorobates villosissimus (Rovereto, 1914, p. 107) see Reig, 1958b, p. 250n
Macroeuphractus morenoi Lydekker, 1894, p. 58
Paleuphractus argentinus (Moreno & Mercerat, 1891a, p. 227)—see L. Kraglievich, 1934, p. 57
Paraeuphractus prominens (Moreno & Mercerat, 1891a, p. 226)—see Scillato Yané, 1975a, p. 451
Proeuphractus spicata (Rovereto, 1914, p. 108)—see L. Kraglievich, 1934, p. 60
Vassallia maxima Castellanos, 1946a, p. 8
Vassallia minuta (Moreno & Mercerat, 1891a, p. 228)—see Castellanos, 1937, p. 13
Plaina sp.

Fam. Glyptodontidae
Eleutherocercus solidus (Rovereto, 1914, p. 104) (including *Eleutherocercus tucumanus* Castellanos, 1927, p. 282; see Cabrera, 1944, p. 62)
Eosclerocalyptus planus (Rovereto, 1914, p. 103) (including *Eosclerocalyptus lilloi* C. Ameghino, 1919b, p. 150; see Cabrera, 1944, p. 9)
Glyptodontidium tuberifer Cabrera, 1944, p. 71
Hoplophractus proximus (Moreno & Mercerat, 1891a, p. 224)—see Cabrera, 1944, p. 21
Lomaphorus corallinus Rovereto, 1914, p. 103—(see Castellanos, 1948a)
Peiranoa bullifera Castellanos, 1946b, p. 5
Phlyctaenopyga ameghini (Moreno, 1882, p. 120 *nomen nudum;* F. Ameghino, 1889, p. 825—see Cabrera, 1944, p. 42)
Stromaphorus compressidens (Moreno & Mercerat, 1891a, p. 224) (including *Plohophorus philippii* Moreno & Mercerat, 1891a, p. 225—see Cabrera, 1944, p. 30)
Stromaphorus cuneiformis (referred specimens—species erected by F. Ameghino, 1904, p. 138, on specimens from Chapadmalal Fm.)
Urotherium simile Castellanos, 1948b, p. 6

Order Rodentia
Fam. Octodontidae
Phtoramys pulcher Rovereto, 1914, p. 61

Pithanotomys columnaris mendocinus (referred specimens—species erected by Rovereto, 1914, p. 221 on specimens from Huayquerías Fm., Mendoza)

Pseudoplataeomys brevis (Rovereto, 1914, p. 64)—see L. Kraglievich, 1934, p. 79

Pseudoplataeomys elongatus (Rovereto, 1914, p. 62)—see L. Kraglievich, 1934, p. 79

Pseudoplataeomys innominatus (Rovereto, 1914, p. 65)—see L. Kraglievich, 1934, p. 79

Neophanomys biplicatus Rovereto, 1914, p. 60

Fam. Echimyidae

Trichomys intermedius (Rovereto, 1914, p. 67)—see Bond, 1977, p. 312

Carterodon? parvulus (Rovereto, 1914, p. 68)—see Bond, 1977, p. 312

Proechimys ponderosus (Rovereto, 1914, p. 67)—see J. Kraglievich, 1957, p. 38; Bond, 1977, p. 312

Paramyocastor (= *Isomyopotamus*) *diligens* (Ameghino, 1888)—see Wood & Patterson, 1959, p. 325n

Fam. Abrocomidae

Protabrocoma antiqua (Rovereto, 1914, p. 66)—see L. Kraglievich, 1927, p. 591

Fam. Chinchillidae

Lagostomopsis pretrichodactyla (Rovereto, 1914, p. 73)—see L. Kraglievich, 1926, 1934 (= *Viscaccia angulata* Rovereto, 1914, p. 74; *Viscaccia insolita* Rovereto, 1914, p. 74)

Fam. Dinomyidae

Carlesia sp.

Tetrastylus? atrophiatus Rovereto, 1914, p. 72

Tetrastylus intermedius Rovereto, 1914, p. 69

Tetrastylus montanus F. Ameghino, 1891a, p. 94

Fam. Caviidae

Cardiomys ameghinorum latidens (Rovereto, 1914, p. 56)

Orthomyctera andina (Rovereto, 1914, p. 58)—see L. Kraglievich, 1934, p. 81

Orthomyctera rigens (Ameghino 1889, p. 218—referred specimens, type from Monte Hermoso)

Palaeocavia sp.

Prodolichotis prisca (Rovereto, 1914, p. 60)—see L. Kraglievich, 1934, p. 81

Fam. Erethizontidae

Neosteiromys bombifrons Rovereto, 1914, p. 75

Order Carnivora

Fam. Procyonidae

Cyonasua cf. *C. argentina* (referred material—see J. L. Kraglievich & Olazábal, 1959, pp. 10, 52; Marshall et al., 1979, p. 276)

Cyonasua brevirostris (Moreno & Mercerat, 1891a, p. 235) (including *Amphinasua longirostris* Rovereto, 1914, p. 81; and *Pachynasua? robusta* Rovereto, 1914, p. 82—see J. L. Kraglievich & Reig, 1954, p. 213; Marshall et al., 1979, p. 275)

Chapalmalania cf. *C. altaefrontis* (referred material—see J. L. Kraglievich & Olazábal, 1959, pp. 9, 28; Marshall et al., 1979, p. 276)

Order Litopterna
Fam. Macraucheniidae
"*Macrauchenia*" *calceolata* Moreno & Mercerat, 1891a, p. 234
"*Macrauchenia*" *lydekkeri* Moreno & Mercerat, 1891a, p. 233
Promacrauchenia antiqua (referred specimens—species erected by F. Ameghino, 1889, p. 530 on specimens from Monte Hermoso)
Promacrauchenia calchaquiorum Rovereto, 1914, p. 53
Fam. Proterotheriidae
"*Licaphrium*" *intermedium* (Moreno & Mercerat, 1891a, p. 234) *nomen vanum*—see Riggs & Patterson, 1939, p. 155)
Brachytherium morenoi Rovereto, 1914, p. 51 (=?*Proterotherium simplicidens* Rovereto, 1914, p. 50; see Riggs & Patterson, 1939, p. 155)
Brachytherium laternarium F. Ameghino, 1904, p. 485 (see Riggs & Patterson, 1939, p. 156)
Order Notoungulata
Fam. Toxodontidae
Toxodontherium andinum L. Kraglievich, 1931a, p. 93
Xotodon catamarcensis Lydekker, 1893, p. 22
Xotodon cristatus Moreno & Mercerat, 1891a, p. 232
Fam. Interatheriidae
gen. et sp. indet.
Fam. Mesotheriidae
Typotheriopsis internum (F. Ameghino, 1891a, p. 92) see Cabrera, 1937, p. 26
Typotheriopsis studeri (Moreno & Mercerat, 1891a, p. 232) see L. Kraglievich, 1934, p. 34
Fam. Hegetotheriidae
Hemihegetotherium achathaleptum Rovereto, 1914, p. 41
Hemihegetotherium affine Rovereto, 1914, p. 44
Hemihegetotherium gracile Rovereto, 1914, p. 43
Hemihegetotherium robustum Rovereto, 1914, p. 42
Pseudohegetotherium? sp.
Tremacyllus diminutus (referred specimens—species erected by F. Ameghino, 1889, p. 117 on specimens from Monte Hermoso)
Tremacyllus incipiens Rovereto, 1914, p. 46
Tremacyllus latifrons Rovereto, 1914, p. 47

APPENDIX IV

Valle de Río Santa María

Key: *Specimen missing; n.h. = no horizon.

FMNH No.	Taxa	Description	Unit
		Locality 1: Entre Rios (=Chiquimil)	
*P 14381	*Geochelone gallardoi*	plastron	XX
P 14375	*Procariama simplex*	partial upper break and one vertebra	XVIIIb
P 14357	*Andalgalornis ferox*	skull, mandibles, pelvis, and vertebrae (type)	XVIIIb

FMNH No.	Taxa	Description	Unit
P 14469	*Thylatheridium dolgopolae*	fragment of right mandibular ramus with P_2–M_3 (type)	XX
P 15225	*Sparassocynus* sp.	cranium lacking face	XX
P 14344	*Thylacosmilus atrox*	associated cranium, mandibular ramus, hind legs, and tarsals	XIX
*P 14453	marsupial	skull minus teeth	XVIIIb
*P 14454	marsupial	skull	XVIIIb
*P 14348	Megatheriinae *indet.*	cheek tooth	XVIIIb
P 14350	*Pronothrotherium typicum*	mandible	XVIIIb
P 14467	*Pronothrotherium typicum*	skull, pelvis, ribs, and vertebrae	XVII
P 14382	*Pronothrotherium typicum*	ulna and radius	XIX
P 14468	gravigrade *indet.*	femur, tibia, fibula, and astragalus	XVII
P 14471	gravigrade *indet.*	partial pelvis	X
P 15435	*Chorobates scalabrinii*	posterior two-thirds of skull	XX
P 14360	*Chorobates scalabrinii*	skull	XVII
PM 880	*Chorobates scalabrinii*	carapace	XX
P 14358	*Paraeuphractus prominens*	posterior two-thirds of skull, carapace, and pelvis	XVII
P 14351	*Paraeuphractus prominens*	skull	XX
*P 14347	Dasypodidae *indet.*	mandible	XVIIIa
*P 15226	Dasypodidae *indet.*	cranium and long bones	XX
P 14364	Dasypodidae *indet.*	rib	XVII
P 14376	Dasypodidae *indet.*	caudal vertebrae	XVII
P 14472	Dasypodidae *indet.*	fragmentary skull, mandible, humerus, and partial carapace	n.h.
PM 1089	Dasypodidae *indet.*	mandible fragment	XVIIIa
P 14345	Glyptodontidae *indet.*	caudal vertebrae	XVII
*P 14346	Glyptodontidae *indet.*	mandible	XVIIIa
P 14363	Glyptodontidae *indet.*	caudal ring	XVII
P 14461	Glyptodontidae *indet.*	right mandible	XVII
*P 14470	Glyptodontidae *indet.*	mandible, leg bones, part of carapace, and vertebrae	VII
P 14349	*Phtoramys pulcher*	anterior part of skull	XVIIIb
P 15313	*Phtoramys pulcher*	right ramus with P_4–M_3, broken incisor	XVII
P 15316	*Phtoramys pulcher*	right ramus with P_4–M_2	XVII
P 15314	*Phtoramys pulcher*	right ramus with P_4–M_3, broken incisor	XVII
P 15315	*Phtoramys pulcher*	left ramus with P_4–M_3, incisor, right maxilla with P^2–M^2	XVII
P 14373	*Phtoramys pulcher*	anterior part of skull, mandibles, femur, fragment of pelvis, tibia, and fibula	XVIIIb
PM 1091	*Phtoramys pulcher*	left mandible	XVIIIa
PM 1092	*Phtoramys pulcher*	left mandible	XVIIIa
PM 1093	*Phtoramys pulcher*	right mandible	XVIIIa
P 14339	*Protabrocoma antiqua*	fragment of palate with P^4-M^3	XVII
*P 14366	*Tetrastylus* sp.	right mandible with one cheek tooth	XVII
P 14466	*Tetrastylus* sp.	three molars and partial incisor	XIV
P 14347	*Neophanomys biplicatus*	right mandible with broken I–M_3	XVIIIa
P 14372	*Cardiomys ameghinorum*	lower right dentition with P_4–M_3 and broken incisor	XVIIIb
P 14343	*Orthomyctera andina*	right ramus with incisor, and P_4–M_3	XVII
P 14534	*Orthomyctera andina*	skull	XVIIIb
P 14370	*Orthomyctera andina*	skull	XVIIIb
P 14463	*Orthomyctera andina*	skull	XVII

FMNH No.	Taxa	Description	Unit
P 14337	*Orthomyctera andina*	fragment of palate and cheek region	XVII
PM 1094	*Orthomyctera andina*	left mandible	XVIIIa
P 14336	*Palaeocavia* sp.	right mandible fragment with incisor and P_4–M_2	XVII
P 14335	*Prodolichotis prisca*	mandible fragment with one tooth	XVII
PM 1095	*Prodolichotis prisca*	left mandible with four teeth	XVIIIa
*P 14371	rodent	part of left mandible with molars	XVIIIb
P 14385	rodent	humerus, femur, tibia, ribs, and foot bones	XIX
P 15317	rodent	five miscellaneous leg bones	XVII
P 14340	rodent	skull and mandibular rami	XVII
P 14338	rodent	palatal fragment	XVII
P 14342	*Cyonasua* cf. *C. brevirostris*	vertebrae, leg, and foot bones	XVIIIa
P 14341	*Brachytherium morenoi*	skull minus premaxillaries and condyles, and lower jaws	XVIIIb
P 14361	*Brachytherium intermedium*	skull	XVIIIa
P 15138	*Xotodon* sp.	maxillaries with right and left P^4–M^3; pre-sacral series complete except for atlas; sixth costal complete; first, third, and fourth complete; the rest, with exception of second and eight, represented by proximal part; pelvis and sacrum	XVIIIb
P 14369	*Xotodon* sp.	parts of skull and mandible	XVIIIb
P 152312	*Tremacyllus latifrons*	right mandible with P_4–M_1	XVII
P 15311	*Tremacyllus latifrons*	right fragmentary mandible with P_4–M_1	XVII
P 14456	*Tremacyllus latifrons*	skull with articulating mandible with complete dentition and complete post-cranial skeleton	XVIIIb
P 14536	*Tremacyllus latifrons*	skull	XX
P 14362	*Tremacyllus diminutus*	right mandibular ramus with P_3–M_3	XVIIIb
P 14374	*Tremacyllus diminutus*	skull with nine maxillary teeth	XVIIIb
P 14368	*Tremacyllus* sp.	right mandible with I_{1-2}, P_{2-4}, M_{2-3}	XVII
PM 1090	*Tremacyllus* sp.	left and right mandibular fragments	XVIIIa
		Locality 2: Loma Rica	
P 14353	*Procariama simplex*	skull, endocast, and vertebrae	XVIIIa
P 14455	*Paradidelphys pattersoni*	partial right dentary with C–M_4 all incomplete and fragments of left dentary with part of crown of M_2 and roots of M_3–M_4 (type)	XVII
P 14367	*Eosclaerocalyptus planus*	carapace	XVII
P 14355	*Phtoramys pulcher*	right mandible with M_{1-3}	XVIIIb
P 15271	*Phtoramys pulcher*	right mandible fragment with M_{1-2}	XVIIIb
P 14352	*Lagostomopsis pretrichodactyla*	skull minus premaxillaries	XVIIIa
P 14464	*Orthomyctera andina*	skull	XVII
P 14462	*Hemihegetotherium robustum*	skull fragments and left mandibular ramus	XVII
P 14354	*Tremacyllus latifrons*	left mandible with five teeth and fragment of symphysis; maxilla with M^{2-3}	XVIIIb
P 15269	*Tremacyllus latifrons*	partial left ramus with P_3–M_3	XVIIIb
P 14359	*Tremacyllus latifrons*	left mandibular ramus with P_3–M_3	XVIIIa

FMNH No.	Taxa	Description	Unit
P 14377	*Tremacyllus latifrons*	paired maxillae, palate, and part of frontals	XVIIIb
P 15270	*Tremacyllus diminutus*	left mandibular ramus with P_4–M_1	XVIIIb
P 14465	*Tremacyllus* cf. *T. diminutus*	skull, distal end of tibia, and miscellaneous bone fragments	XIII
		Locality 3: Peneplane Basin	
P 14392	*Protabrocoma antiqua*	skull and crushed articulating right mandible	XX
*P 14393	*Tetrastylus* sp.	mandibles	XX
P 14394	*Tremacyllus latifrons*	right ramus with P_3–M_3; left ramus with P_4–M_3	XX
		Locality 4: Arroyo (=Río) de Yapes	
P 14458	*Paradidelphys pattersoni*	partial right dentary with P_{1-3}, M_1, and M_{3-4}, all worn and broken	XX
P 14386	*Pronothrotherium typicum*	one half pelvis, vertebra, scapulae and ribs	XX
P 14387	*Paraeuphractus prominens*	fragment of skull with head plate	XX
P 15268	*Lagostomopsis pretrichodactyla*	palate with teeth; right and left P^4–M^2	XX
P 14388	*Carlesia* sp.	mandibular fragments with teeth	XX
P 14457	*Cardiomys ameghinorum*	skull, atlas-axis, three cervicals	XX
P 14389	*Brachytherium intermedium*	tibia and foot bones	XX
P 14380	*Brachytherium intermedium*	left mandibular ramus	XX
P 14390	*Tremacyllus latifrons*	right and left mandibular rami and isolated fragmentary teeth	XX
P 14538	*Tremacyllus latifrons*	skull	XX
P 15266	*Tremacyllus latifrons*	right mandibular ramus with P_2–M_2 and symphysis	XX
P 15267	*Tremacyllus latifrons*	right ramus with P_4 and M_3	XX
		Locality 5: Andalhualá	
P 14378	*Tremacyllus diminutus*	dorsally crushed skull with 10 upper teeth	XVIIIb
		Locality 6: Vallecito	
P 14379	*Tremacyllus latifrons*	badly broken skull and articulated mandibles	XVII
		Locality 7: Ampajango	
*P 14473	*Geochelone* sp.	carapace and plastron	XI
P 14396	*Stromaphorus?* sp.	skull with four maxillary and four premaxillary teeth	XI
		Locality 8: Unnamed	
*P 14356	Hegetotheriidae? *indet.*	paired mandibles	XX
		Locality 9: Jujuy	
P 14383	Megatheriinae *indet.*	large atlas	XIX
P 14384	gravigrade *indet.*	caudal vertebra	XIX
P 14537	*Cyonasua* cf. *C. brevirostris*	skull and mandibles	XIX
		Locality 10: East of Santa María	
*P 14460	*Paradidelphys* sp.	mandibles	n.h.
P 14395	*Xotodon* sp.	skull, paired mandibles, atlas, and foot bones	n.h.

FMNH No.	Taxa	Description	Unit
		Locality 11: Tiopunco	
P 14505	Megatheriinae *indet.*	pelvis	n.h.
P 15222	gravigrade *indet.*	patella and toe bone	n.h.
P 15223	gravigrade *indet.*	foot bones	n.h.
P 14507	*Eleutherocercus solidus*	caudal sheath	n.h.
P 15771	Glyptodontidae *indet.*	scutes	n.h.
P 14509	rodent	posterior two-thirds of skull	n.h.
P 14504	*Promacrauchenia* sp.	radius and ulna	n.h.
P 14508	*Promacrauchenia* sp.	calcaneum and ectocuneiform	n.h.
P 15431	Toxodontidae *indet.*	distal end of ulna	n.h.
P 14506	*Xotodon* sp.	skull with articulating mandibles	n.h.

APPENDIX V

Puerta de Corral Quemado

Key: *Specimen missing; n.h. = no horizon.

FMNH No.	Taxa	Description	Unit
P 14402	*Ceratophrys* sp.	partial skull	21
P 14422	*Hermosiornis incertus*	proximal part of right tibio-tarsus, right tarso-metatarsus; metarsal I and digits I and II complete	17
P 14525	*Procariama simplex*	cranium, wing, legs, and foot bones	20
P 14535	*Procariama simplex*	cast of femur (type ceded to Museo Argentino de Ciencas Naturales "Bernardino Rivadavia", Buenos Aires)	20
P 15303	*Procariama simplex*	ungual phalanx	n.h.
P 14403	strigiformid?	cranium	21
P 14519	*Paradidelphys pattersoni*	partial left dentary with C, P_{1-2}, dP_4, and M_{1-3}	20 or 21
P 14487	*Lutreolina* sp.	mandibles; fragment of palate with right P^3–M^4 and left C–P^2	30
P 14409	*Borhyaenidium riggsi*	mandibles; with left P_3–M_3; fragment of left maxillary with P^3–M^2 and isolated C 32	32
P 14407	*Eutemnodus? acutidens*	mandible fragment with roots of M_3 and M_4 complete	15–32 (probably 30)
P 14474 (=MLP 35-X-41-1)	*Thylacosmilus atrox* (type of *T. lentis*)	partial skull with dentition (ceded to Museo de La Plata)	20
P 14531	*Thylacosmilus atrox* (holotype)	nearly complete skull and associated skeleton	20
*P 14398	marsupial carnivore	two femora, phalanges, and mandible fragments	23
P 14404	Megatheriinae *indet.*	molar	21
P 14438	Megatheriinae *indet.*	paired mandibular rami with six molars	32
P 14499	Megatheriinae *indet.*	six caudals, one chevron, ribs, pelvis, tibia, femur, fibula, and foot bones	23

FMNH No.	Taxa	Description	Unit
P 14528	Megatheriinae *indet.*	left mandibular ramus with four molars, five isolated teeth, and foot bones	23
P 14530	Megatheriinae *indet.*	tibia and foot bones	19
P 14511	Megatheriinae *indet.*	two humeri, five unguals, six cervicals, vertebra, teeth, ribs, and mandible fragment	21
P 14503	*Pronothrotherium typicum*	articulated skeleton with skull, mandibles, and fragmentary caudals (on exhibition)	n.h.
P 14445	*Pronothrotherium typicum*	badly crushed posterior two-thirds of skull and fragmentary left mandibular ramus	32
P 14515	*Pronothrotherium typicum*	femora, part of pelvis, fibula, humerus, and foot bones	21
P 14495	*Pleurolestodon acutidens*	skull, paired mandibles, atlas, axis, and vertebrae	23
P 14521	?*Pleurolestodon* sp.	right mandible	20
P 14450	"*Scelidotherium*" *pendolai*	skull, humeri, fragments of pelvis, and vertebrae	14
P 15262	sloth	navicular and miscellaneous bones	n.h.
*P 14419	Myrmecophagiidae *indet.*	leg bones, vertebrae, carpals, ulna, radius, and skull	15–23 (probably 15)
P 14424	*Plaina* sp.	skull, paired mandibles, cast and mold of brain, leg scutes, and foot bones	15–23 (probably 15)
P 15302	*Plaina* sp.	three scutes	n.h.
P 14411	*Paleuphractus argentinus*	carapace	32
P 14412	*Paleuphractus argentinus*	skull and right mandible	32
P 14442	*Paleuphractus argentinus*	skull, mandible, and head shield	18
P 14510	*Chorobates scalabrinii*	carapace	24
P 14493	?*Macroeuphractus* sp.	paired fragmentary mandibular rami	23
P 15330	*Paraeuphractus prominens*	carapace fragments	n.h.
P 14526	*Paraeuphractus prominens*	skull, right mandible, pelvis, parts of carapace	23
P 15260	Dasypodidae *indet.*	ungual	n.h.
P 14449	Dasypodidae *indet.*	fragment of skull and ulna	32
P 14446	*Eleutherocercus solidus*	section of carapace, mandible, skull, tail sheath, vertebra, femora, tibiae, fibulae, scapulae, foot bones	32
P 14437	*Eleutherocercus solidus*	skull, mandibles, almost complete post-cranial skeleton, and fragment of carapace	23–28
P 14417	*Eleutherocercus solidus*	mandibles and carapace fragment	15–23 (probably 15)
P 14475	*Eleutherocercus solidus*	skull, rib, fragment of humerus, vertebrae, foot bones, scutes	20
P 14501	*Hoplophractus proximus*	skull, pelvis, sheath, caudals, tube, part of tail rings and carapace, humerus, femur, tibia, fibula, and foot bones	24

FMNH No.	Taxa	Description	Unit
P 14522	*Hoplophractus proximus*	caudal sheath	23
P 14405	*Hoplophractus proximus*	partial carapace, three caudal rings, caudal sheath, one femur, and incomplete pelvis	17
P 14414	*Stromaphorus* sp.	one half carapace, two caudal rings, one half tail sheath, femur, skull: facial region with right cheek teeth	17
P 14405	Glyptodontidae *indet.*	carapace (ceded to Museo de La Plata)	17
P 14406	Glyptodontidae *indet.*	three caudal rings	20
P 14410	Glyptodontidae *indet.*	caudal sheath with vertebrae [This specimen is very similar to the caudal tube doubtfully referred by Cabrera to *Hoplophractus proximus*. Specimen P 14501 shows that Cabrera's referred tube does not belong to this species.]	32
P 14494	*Stromaphorus* sp.	lumbar tube, sacrum, fragment of pelvis, tail	23
P 14520	*Stromaphorus compressidens*	four caudal rings, caudal sheath, fragments of carapace	23
P 14439	*Phlyctaenopyga ameghini*	carapace	26
*P 14532	*Phlyctaenopyga ameghini*	proximal portion of caudal tube	15–32
P 14447	Glyptodontidae *indet.*	carapace, lacking part of dome	32
P 14502	Glyptodontidae *indet.*	right mandible and carapace scutes	26
P 15258	Glyptodontidae *indet.*	tooth and palate	n.h.
P 15259	Glyptodontidae *indet.*	palate	n.h.
P 15299	*Phtoramys pulcher*	right mandible fragment with P_4–M_2	n.h.
P 15292	*Phtoramys pulcher*	right mandible with M_1	n.h.
P 14444	*Phtoramys pulcher*	skull: anterior part with incisors femur, tibia, and foot bones	32
P 15248	*Phtoramys pulcher*	right mandible with I, M_{1-2}, and part of P_4	n.h.
P 14431	*Pithanotomys columnaris mendocinus*	anterior portion of skull	21
P 15296	*Pithanotomys columnaris mendocinus*	right mandible fragment with P_4–M_3	n.h.
P 15290	*Pithanotomys columnaris mendocinus*	left mandible fragment with I, M_{1-3}	n.h.
P 15291	*Pithanotomys columnaris mendocinus*	right mandible fragment with M_{1-3}	n.h.
P 14484	*Pithanotomys columnaris mendocinus*	skull and mandibles	28
P 14533	*Pithanotomys columnaris mendocinus*	anterior two-thirds of skull	15–32
P 15249	*Pithanotomys columnaris mendocinus*	facial region of skull with right and left I–M^3	n.h.
P 14418	*Paramyocastor* (=*Isomyopotamus*) diligens	anterior portion of skull and right mandible	32
P 14432	*Paramyocastor* (=*Isomyopotamus*) sp. "but different"	anterior portion of skull	21
P 15253	*Lagostomopsis pretrichodactyla*	mandibular fragments with teeth	n.h.

FMNH No.	Taxa	Description	Unit
P 15252	*Lagostomopsis pretrichodactyla*	maxillary and mandibular fragments with teeth	n.h.
P 14540	*Lagostomopsis pretrichodactyla*	incomplete left and right mandibles	n.h.
P 14421a	*Tetrastylus intermedius*	right mandible, scapula, fragmentary leg bones (ceded to Museo de La Plata)	21
*P 14514	*Tetrastylus intermedius*	skull (missing), seven cervical vertebrae, one trunk vertebra	21
P 14434	*Cardiomys ameghinorum*	right mandible fragment with P_4–M_2	15–32
P 15287	*Cardiomys ameghinorum*	left mandible fragment with P_4	n.h.
P 15298	*Cardiomys ameghinorum*	left mandible fragment with symphysis	n.h.
P 14491	*Cardiomys ameghinorum*	right mandible with P_4–M_3, left mandible with M_{1-3}, femur, atlas, axis, and rib fragments	23
P 14513	*Cardiomys ameghinorum*	partial skull with molars	20
P 15251	*Cardiomys ameghinorum*	left mandibular fragment with P_4–M_2	n.h.
P 15300	*Orthomyctera rigens*	palate with right M^{1-3}, left P^4–M^2	n.h.
P 15289	*Orthomyctera rigens*	right mandible fragment with M_{1-3}	n.h.
P 15250	*Orthomyctera rigens*	facial region of skull with right M^{1-3}, left P^4–M^3	n.h.
P 15288	*Prodolichotis prisca*	right mandible fragment with M_{1-3}	n.h.
P 14426	*Palaeocavia* sp.	skull	15–32
P 14430	*Palaeocavia* sp.	skull	21
P 14421b	rodent	anterior portion of skull	21
*P 14427	rodent	skull, atlas, axis, and one cervical vertebra	15–32
*P 14429	rodent	skull	15–32
*P 14433	rodent	skull	21
P 15295	rodent	left mandible fragment with M_{1-2}	n.h.
P 15294	rodent	palate with right P^4, left P^4–M^2	n.h.
P 15293	rodent	facial region of skull with right and left I, P^4–M^1	n.h.
P 15297	rodent	right mandible fragment with I	n.h.
P 15247	rodent	cranium	n.h.
P 14397	*Cyonasua* sp.	mandible and partial femur	16 or 17
P 14451	*Cyonasua* sp.	right mandible of a juvenile	14
P 14401	*Chapalmalania* sp.	left mandible	15–32 (probably 21)
P 14448	*Promacrauchenia antigua*	skull, left mandible, and vertebra	32
P 14490	*Promacrauchenia antigua*	skull, mandible, scapulae, and fragments of ulna and metatarsus	30
P 14428	*Promacrauchenia* sp.	carpals and metacarpals	15–32
P 15304	*Promacrauchenia* sp.	pisiform	n.h.
P 14440	*Promacrauchenia* sp.	pelvis, sacrum, and vertebrae	26
P 14476	*Promacrauchenia* sp.	phalanges	20
P 14485	*Promacrauchenia* sp.	atlas	28
P 14486	*Promacrauchenia* sp.	proximal end of femur and humerus	28

FMNH No.	Taxa	Description	Unit
P 14488	*Promacrauchenia* sp.	two metapodials	23
P 14489	*Promacrauchenia* sp.	metatarsus and foot bones	23
P 14496	*Promacrauchenia* sp.	calcaneum	23
P 14497	*Promacrauchenia* sp.	fragmentary mandibles	23
P 14517	*Promacrauchenia* sp.	skull with cranium	26
P 14518	*Promacrauchenia* sp.	humerus, two ulnae, radii, four metatarsals, phalanges, and scapula	23
P 14529	*Promacrauchenia* sp.	scapulae, femur, tibia, and fibula	23
P 15256	*Promacrauchenia* sp.	astragalus and incomplete navicular	n.h.
P 15257	*Promacrauchenia* sp.	navicular	n.h.
P 14483	*Brachytherium laternarium*	mandibular fragments, miscellaneous long and foot bones	30
P 14500	*Brachytherium laternarium*	skull, mandibles, pelvis, and foot bones	23
P 15301	*Xotodon* sp.	five teeth	n.h.
P 14492	*Xotodon* sp.	skull	30
P 14512	*Xotodon* sp.	paired maxillaries	17
P 14516	*Xotodon* sp.	weathered skull and paired mandibles	20
P 14480	*Toxodontotherium* sp.	tibia, fibula, scapula, vertebra ribs, isolated teeth, and foot bones	7
P 14481	*Toxodontotherium* sp.	femur, tibia, and foot bones	7
P 14477	*Typotheriopsis internum*	skull and calcaneum	14
P 14452	*Typotheriopsis internum*	skull, articulating paired mandibles, and postcranial skeleton	14
P 14420	*Typotheriopsis internum*	cranium and posterior two-thirds of skull	14
P 15244	*Typotheriopsis internum*	right maxilla fragment with M^{2-3}	14
P 14408	*Typotheriopsis internum*	fragmentary mandibular rami	14
P 14415	*Typotheriopsis internum*	skull, paired mandibles, and complete forelegs	14
P 14423	*Typotheriopsis internum*	incisors	16 or 17
P 14482	*Typotheriopsis internum*	ulna, radius, foot bones, vertebra, and ribs	14
P 15246	*Typotheriopsis internum*	lunar	14
P 14416	*Hemihegetotherium robustum*	right mandibular ramus	32
P 14523	*Hemihegetotherium robustum*	skull	20
P 14527	*Hemihegetotherium robustum*	skull	20
P 14413	*Hemihegetotherium* sp.	skull, scapula, sacrum, phalanges, humerus, vertebra, ribs, tibia, and fibula	32
P 14478	*Pseudohegetotherium?* sp.	skull with eight maxillary and two premaxillary teeth	6
P 14498	*Tremacyllus latifrons*	facial region of skull	26
P 14399	*Tremacyllus latifrons*	skull and paired mandibles	22
P 14400	*Tremacyllus latifrons*	mandibles	23
P 15255	*Tremacyllus diminutus*	right mandible fragment with P_3–M_3	n.h.
P 15254	*Tremacyllus diminutus*	fragment of a right maxilla with P^2–M^3	n.h.
P 15263	hegetothere	left mandibular ramus with P_4–M_3	n.h.

APPENDIX VI

Specimens Without Locality Data

FMNH No.	Taxa	Description
P 14784	*Proeuphractus scalabrinii*	mandibular fragment with three teeth
P 15230	*Borhyaenidium?* sp.	facial region lacking teeth
P 15231	*Procariama simplex*	distal end of tibio-tarsus and tarsometatarsus
P 15229	*Cyonasua* sp.	right maxillary fragment with M^{1-2}

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