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VERTEBRATE PALEONTOLOGY AND BIOCHRONOLOGY OF THE LOWER CHINLE GROUP (UPPER TRIASSIC), SANTA FE COUNTY, NORTH-CENTRAL NEW MEXICO

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Abstract—Three Upper Triassic stratigraphic units in southeastern Santa Fe County, the Los Esteros and Tres Lagunas Members of the Santa Rosa Formation and the Garita Creek Formation, produce abundant fossil vertebrates. The Lamy amphibian quarry (Gunter bonebed) is in the Garita Creek Formation. The Los Esteros fauna is Adamanian in age based on the presence of *Rutiodon*, *Desmatosuchus* and *Stagonolepis*, and the Garita Creek fauna is Revueltian in age based on the presence of *Typhothorax*. The Tres Lagunas fauna may be Adamanian or Revueltian.

INTRODUCTION

The Lamy amphibian quarry in southeastern Santa Fe County is one of the most famous Late Triassic vertebrate localities in North America, with specimens from it on display at the National Museum of Natural History (Smithsonian) and the Museum of Comparative Zoology at Harvard University. However, until the mid-1980s, this one locality was all we knew of the Triassic vertebrate paleontology of Santa Fe County. Since then, Phil Bircheff has collected abundant Late Triassic fossils from this area, including rich faunas from the Santa Rosa Formation, which previously had yielded only fossil plants (Lucas and Hunt, 1987, 1989). The purpose of this paper is to give a preliminary description of these fossil vertebrates. MCZ refers to the Museum of Comparative Zoology (Harvard University) and NMMNH to the New Mexico Museum of Natural History and Science.

STRATIGRAPHIC CONTEXT

The Upper Triassic Chinle Group crops out in an elongate north-south strip in the southeastern corner of Santa Fe County (Fig. 1). Here, the

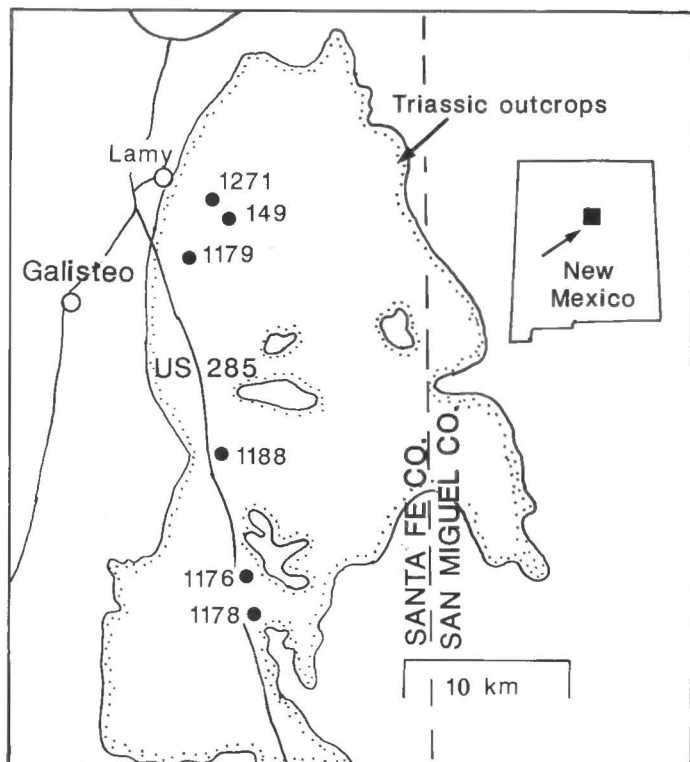


FIGURE 1. Location of Upper Triassic outcrops and NMMNH fossil localities in southeastern Santa Fe County, New Mexico.

Chinle Group disconformably overlies the Middle Triassic (Anisian) Anton Chico Member of the Moenkopi Formation and is in turn overlain by the Middle Jurassic Entrada Sandstone (Lucas, 1991). The lowest two Chinle Group formations, which are the subject of this report, are the Santa Rosa Formation and the overlying Garita Creek Formation. The Santa Rosa is divided into (in ascending order) the Tecolotito, Los Esteros and Tres Lagunas Members. The last two of these members have yielded diverse vertebrate faunas (Table 1). Recent reports (e. g., Hunt and Lucas, 1993) listed vertebrate specimens only from the Los Esteros Member, but several localities previously assigned to the Los Esteros Member actually occur in a thick, fine-grained interval within the Tres Lagunas Member (Table 2).

LAMY AMPHIBIAN QUARRY

The most important and well known locality within the Chinle of Santa Fe County is the Lamy amphibian quarry (also known as the Gunter bonebed). The quarry was found in 1936 by Mr. and Mrs. R. V. Witter while prospecting for Harvard University (Hunt and Lucas, 1989). It was subsequently excavated by R. V. Witter and T. E. White (1938) for Harvard and by D. H. Dunkle, F. Pearce and G. Sternberg (1947) for the National Museum of Natural History (Smithsonian Institution). This

TABLE 1. Stratigraphic distribution of Late Triassic vertebrates in the lower Chinle Group, Santa Fe County, New Mexico.

	SANTA ROSA FM Los Esteros Mb	GARITA CREEK FM
<i>Arganodus dorotheae</i>	X	
Redfieldidae indet.	X	
cf. <i>Turseo</i> sp.	X	
<i>Buettneria perfecta</i>	?	X
<i>Apachesaurus gregorii</i>	X	
<i>Trilophosaurus</i> sp.	X	
<i>Angistorhinus</i> sp.	X	
<i>Rutiodon</i> sp.	X	
undetermined phytosaur		X
<i>Desmatosuchus haplocerus</i>	X	
<i>Stagonolepis wellsi</i>	X	
<i>Typhothorax coccinarum</i>		X
new aetosaur 1	X	
new aetosaur 2	X	
new aetosaur 3	?	X
<i>Chatterjeea elegans</i>	X	X
Rauisuchia	X	
<i>Parrishia mcreai</i>	X	
cf. <i>Spinosuchus</i> sp.	X	
Theropoda	X	X
new ornithischian	X	
cf. <i>Ischigualastia</i> sp.	X	
new cynodont	X	

TABLE 2. NMMNH localities mentioned in text.

Santa Rosa Formation (Los Esteros Member):		
Locality	Coordinates	Vertebrate fauna
149	NW1/4SW1/4SE1/4 sec. 2, T14N, R10E	Metoposauridae indet. Parasuchidae indet. <i>Desmatosuchus haplocerus</i> cf. <i>Stagonolepis wellesi</i> <i>Chatterjeea elegans</i> Rauisuchia indet. <i>Parrishea mcreai</i>
1179	NW1/4SW1/4SW1/4 sec. 10, T14N, R10E	cf. <i>Ischigualastia</i> sp.
1188	SE1/4NW1/4SW1/4 sec. 12, T13N, R10E	<i>Rutiodon</i> sp.
1271	NW1/4NW1/4SE1/4 sec. 34, T15N, R10E	<i>Desmatosuchus haplocerus</i> Parasuchidae indet.
Garita Creek Formation:		
Locality	Coordinates	Vertebrate fauna
1176	SE1/4SE1/4SW1/4 sec. 7, T12N, R11E	<i>Buettneria perfecta</i> (Amphibian quarry) Parasuchidae indet. Theropoda indet. Reptilia indet. (3 morphs)
1178	SW1/4SE1/4NE1/4 sec. 18, T12N, R11E	<i>Chatterjeea elegans</i> <i>Typothorax coccinarum</i> Parasuchidae indet.

quarry contains a bonebed of metoposaurid amphibians (*Buettneria perfecta* Case). Large slabs are on display at Harvard and the Smithsonian (Colbert and Imbrie, 1956, pl. 28; Hunt, 1993, fig. 22A), and smaller specimens and isolated skulls were widely distributed to many universities and museums, including the Natural History Museum (London), South Dakota School of Mines, Field Museum of Natural History, Carnegie Museum of Natural History, Yale Peabody Museum and American Museum of Natural History. The stratigraphic position of the quarry was long considered equivocal (e. g., Gregory, 1972), but Lucas and Hunt (1989), Hunt and Lucas (1989), and Lucas (1991) demonstrated that it is within the Garita Creek Formation.

Romer (1939, p. 339) considered the quarry to represent "the last scene in the drama of drought - a shrinking residual pool." This idea was widely accepted by subsequent workers (e. g., Gregory, 1980). However, the disarticulated and mixed nature of the skeletons and the scarcity of small elements indicate a major hydrodynamic component to the accumulation (Hunt and Lucas, 1989). Taphonomically, this assemblage appears similar to other mass accumulations of metoposaurids in North America (Otis Chalk, Elkins bonebed, Sierrita de la Cruz), which are all late Carnian in age (Hunt, 1993). These accumulations are dominated by skulls and girdle elements with few other postcranial bones. They differ from Moroccan mass accumulations (e. g., Hunt, 1993, figs. 10E, 22B-D) in that the metoposaurid skeletons are not articulated, and small elements are scarce.

OTHER VERTEBRATES

Previous work

Apart from excavation at the Lamy amphibian quarry, little paleontological work was done in the Chinle Group of Santa Fe County until 1986, when Phil Bircheff started collecting in this area. Bircheff amassed large vertebrate faunas from the Santa Rosa and Garita Creek Formations. His localities (Fig. 1) include a productive microvertebrate site in the Los Esteros Member. Hunt and Lucas (1988) provided a preliminary description of some Los Esteros specimens. Hunt et al. (1993) and Lucas and Hunt (1993a) described, respectively, an *Angistorhinus* skull and a partial skeleton of cf. *Ischigualastia*, both from the Los Esteros Member. Hunt and Lucas (1993) provided preliminary faunal lists for the Santa Rosa and Garita Creek Formations.

Taxa

Class Osteichthyes

Arganodus dorotheae — Lungfish toothplates are common at the microvertebrate locality in the Los Esteros Member and can be identified as *Arganodus dorotheae* (*Arganodus* sp. of Huber et al., 1993). Redfieldiidae indet. — A single dermopterotic from the Los Esteros Member is assignable to the Redfieldiidae (Huber et al., 1993). cf. *Turseodus* sp. — Isolated scales, including some in coprolites, were tentatively referred to cf. *Turseodus* by Huber et al. (1993).

Class Amphibia

Buettneria perfecta Case — All specimens from the Lamy amphibian quarry represent *Buettneria perfecta*. These include more than 30 skulls. Other more fragmentary specimens from the Los Esteros Member, including a partial skull, probably represent this species based on size, abundance and age (cf. Hunt, 1993), but it is possible that some are another taxon (e. g., *Metoposaurus bakeri*). The Los Esteros microsite contains presumed juvenile (e. g., small) specimens of a *Buettneria*-like metoposaurid. These include anteroposteriorly short pleurocentra with a height of less than 1 cm. These are the best documentation of "short" metoposaurid pleurocentra that fall within the size range of *Apachesaurus* and demonstrate that the anteroposteriorly elongate pleurocentra of this genus do not represent a juvenile of a *Buettneria*-like form (Hunt, 1993).

Apachesaurus gregorii Hunt — Specimens of small metoposaurids are much less common than those of large forms, except at the Los Esteros microsite. No cranial specimens are generically identifiable, but elongate pleurocentra demonstrate the presence of *Apachesaurus gregorii* in the Los Esteros Member.

Class Reptilia

Trilophosaurus sp. — Partial limb bones and isolated vertebrae document the presence of *Trilophosaurus* in the Los Esteros fauna.

Angistorhinus sp. — Hunt et al. (1993) described a posterior skull fragment with undepressed supratemporal fenestrae and large, rounded posterior squamosal processes. These features identify the specimen (NMMNH P-4781) as *Angistorhinus*.

Rutiodon sp. — Phytosaur specimens are common in all units and most probably represent *Rutiodon*, but diagnostic cranial specimens are rare. One of these is NMMNH P-18152 (Fig. 2J) from NMMNH locality 1188, which is the posterior extremity of a right squamosal.

undetermined phytosaur — Two partial skulls from the Tres Lagunas Member have supratemporal fenestrae that are slit-like in dorsal view, rod-like squamosal processes and external nares at the level of the skull deck. These specimens, which require more preparation, appear to represent a *Belodon*-grade phytosaur (sensu Hunt, 1994).

Desmatosuchus haplocerus (Cope) — *Desmatosuchus* is the most common aetosaur in the Los Esteros fauna. Several partial skeletons and many isolated elements are known (e.g., Hunt and Lucas, 1988, figs. 2D-F). Several specimens include large pectoral horns (e. g., NMMNH P-3023, 25651; Fig. 2A).

cf. *Stagonolepis wellesi* (Long and Ballew) — Rare specimens of *Stagonolepis* armor occur in the Los Esteros fauna, including paramedian and lateral scutes from NMMNH locality 149 (e.g., Hunt and Lucas, 1988, figs. 2G-H).

new aetosaur 1 — Small, ornate scutes represent a diminutive aetosaur (body length < 50 cm) in the Los Esteros fauna.

new aetosaur 2 — This species has a relatively narrow carapace and relatively long, spinose lateral scutes that form a very acute angle in anterior/posterior view. It occurs in the Los Esteros Member.

new aetosaur 3 — The third new aetosaur is from the Tres Lagunas Member and is known from an almost complete skeleton in a private collection. The paramedian scutes of this form resemble those of *Typothorax coccinarum* in having a pattern of simple pits. However, it differs from *T. coccinarum* in being a smaller animal with a relatively narrow carapace and lateral scutes that form a less acute angle in anterior/posterior view. Fragments of the carapace of this animal can easily be confused with *Typothorax*, as was done by Long and Murry (1995).

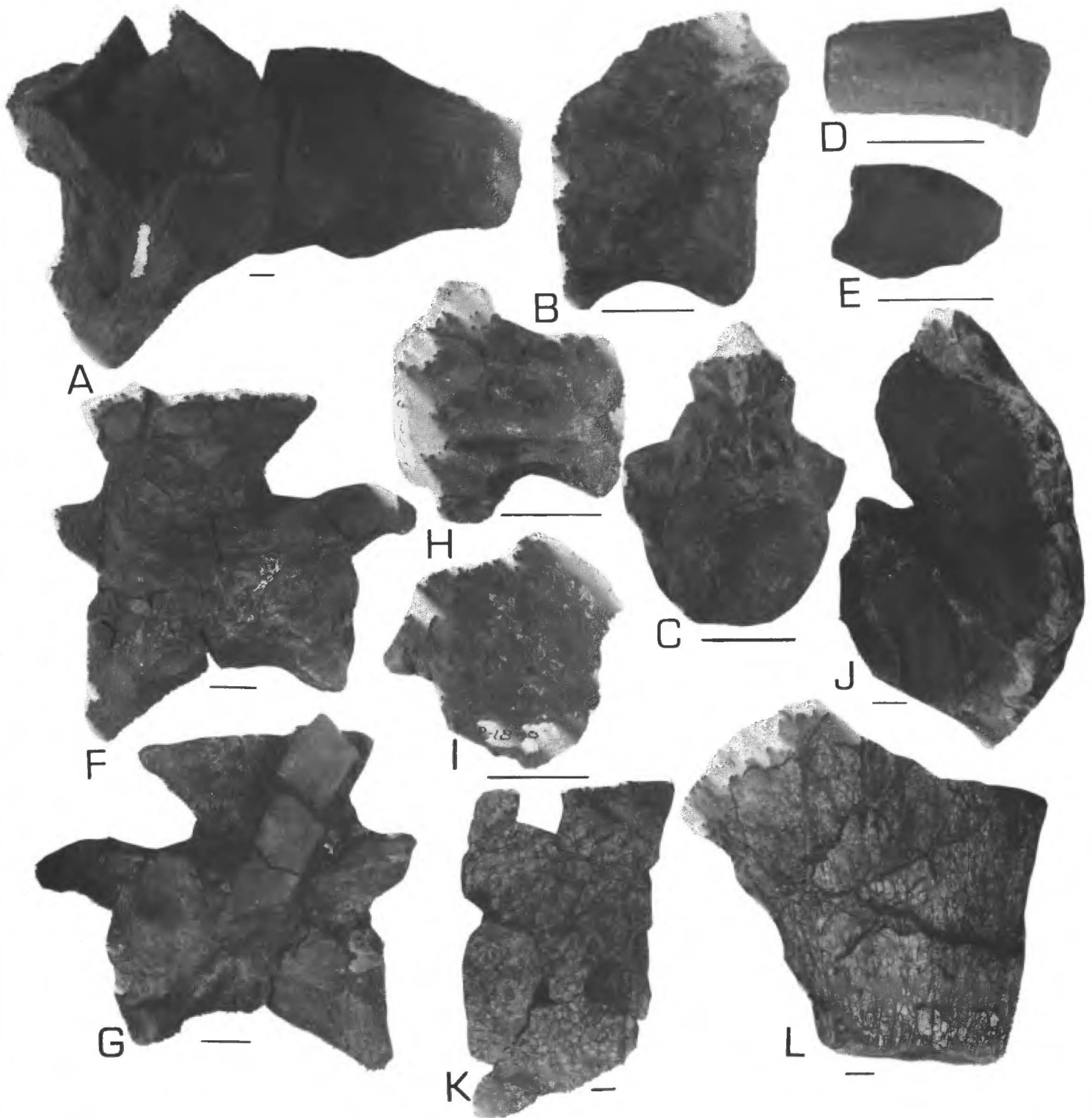


FIGURE 2. Late Triassic vertebrate fossils from the Santa Rosa and Garita Creek Formations of Santa Fe County, New Mexico. A, Fifth cervical horn of *Desmatosuchus* (NMMNH P-25651, NMMNH locality 1271) in posterior view. B-C, Unidentified reptile vertebra (MCZ uncatalogued, NMMNH locality 1176) in lateral (B) and posterior (C) views. D, Theropod caudal vertebra (MCZ uncatalogued, NMMNH locality 1176) in lateral view. E, Theropod ungual (MCZ uncatalogued, NMMNH locality 1176) in lateral view. F-G, Unidentified reptile cervical vertebra (MCZ uncatalogued, NMMNH locality 1176) in lateral (F) and ventral (G) views. H-I, Caudal vertebra of *Parrishea mcreai* (NMMNH P-18002) in ventral (H) and anterior (I) views. J, Posterior extremity of squamosal process of *Rutiodon* sp. (NMMNH P-18152, NMMNH locality 1188) in medial view. K, Dorsal paramedian osteoderm of *Typothorax coccinarum* (NMMNH P-17880, NMMNH locality 1178) in dorsal view. L, Proximal femur of cf. *Ischigualastia* sp. (NMMNH P-17947, NMMNH locality 1179) in anterior view. Scale bars are 1 cm. A, G-H, J and L are from the Los Esteros Member of the Santa Rosa Formation and B-G and K are from the Garita Creek Formation.

Typhothorax coccinarum Cope — This species is represented by a single paramedian scute (NMMNH P-17880 from NMMNH locality 1178; Fig. 2K) from the Garita Creek Formation (not Tres Lagunas Member as reported in Long and Murry, 1995).

Chatterjeea elegans Long and Murry — Proximal femora from the Garita Creek (NMMNH P-17881) and Los Esteros (NMMNH P-3018; Hunt and Lucas, 1988, figs. 3C-D) faunas are referable to this species (R. A. Long, personal commun., 1989; Long and Murry, 1995).

Rauisuchia indet. — Isolated elements (e. g., caudal centrum NMMNH-P-3019 from NMMNH locality 149; Hunt and Lucas, 1988, figs. 3A-B) and laterally compressed teeth from the Los Esteros Member represent *Postosuchus*-like rausuchians. Some of these indeterminate specimens were erroneously referred to *Postosuchus kirkpatricki* by Hunt and Lucas (1988) and Long and Murry (1995).

Hesperosuchus — A few vertebrae from the Los Esteros Member appear to represent a *Hesperosuchus*-like sphenosuchian.

Parrishia mcreai Long and Murry — Vertebral centra (e. g., NMMNH P-3014, 3015 from NMMNH locality 149; Hunt and Lucas, 1988, figs. 3E-H; Figs. 2G-H) demonstrate the presence of this poorly known archosaur in the Los Esteros fauna. Contrary to Long and Murry (1995), we do not consider this taxon to represent a sphenosuchian.

cf. *Spinosuchus* sp. — Several distinctive vertebrae have elongate neural spines reminiscent of *Spinosuchus* (Case, 1927).

Theropoda indet. — Elongate, hollow metapodials are the only evidence for theropods in the Los Esteros fauna. Metapodials, caudal centra (Fig. 2D) and an unguis (Fig. 2E) from the amphibian quarry in the Garita Creek Formation pertain to a small theropod.

new ornithischian — More than 10 teeth from the Los Esteros microsites represent a new ornithischian. These are the same taxon as teeth from the St. Johns area of Arizona identified by several authors (e. g., Murry and Long, 1989) as prosauropod or as representing the ornithischian *Revueltosaurus* (Long and Murry, 1995). These teeth are more derived than other Triassic ornithischian teeth in having well developed cingula.

cf. *Ischigualastia* sp. — Lucas and Hunt (1993) described a fragmentary skeleton of a dicynodont from the upper Los Esteros Member and assigned it to cf. *Ischigualastia* on the basis of femoral morphology. Other fragmentary specimens, including a partial femur (NMMNH P-17947 from NMMNH locality 1179; Fig. 2L), also represent this taxon.

new cynodont — a complete left humerus (NMMNH P-18074) represents an undescribed cynodont.

undetermined reptiles — Several undescribed reptiles are present in the Garita Creek Formation at the amphibian quarry. These include elongate cervical vertebrae (Figs. 2F-G) which superficially resemble those of some prosauropod dinosaurs, small dorsal vertebrae (Figs. 2B-C) and an enigmatic snake-like vertebra.

Trace fossils — Tracks are locally common in the Los Esteros Member but all pertain to invertebrates. Vertebrate coprolites are locally common (e. g., NMMNH P-3024 from NMMNH locality 149).

BIOSTRATIGRAPHY

Three fossiliferous intervals in the Los Esteros Member have distinctive faunas. Initial results suggest differences between the faunas of the lower and upper portions of this unit. New aetosaurs 1 and 2, cf. *Ischigualastia*, cf. *Hesperosuchus* and *Angistorhinus* are restricted to the lower half and *Trilophosaurus* to the upper half. The Tres Lagunas Member is most productive in its upper part, but there are no differences in the fauna throughout this unit. The Garita Creek Formation has not been sufficiently prospected to determine its internal biostratigraphy.

BIOCHRONOLOGY

The Los Esteros fauna can be assigned to the Adamanian land vertebrate faunachron (Lucas and Hunt, 1993b) on the basis of the presence of *Rutiodon*, *Desmatosuchus* and cf. *Stagonolepis*. The presence of *Angistorhinus* low in the Los Esteros Member suggests an Otischalkian age. However, as the remainder of the fauna is clearly Adamanian, it is more likely that this occurrence is a range extension for *Angistorhinus* (Hunt et al., 1993).

The Garita Creek fauna contains *Typhothorax*, which indicates the

Revueltian land-vertebrate faunachron (Lucas and Hunt, 1993b). The Tres Lagunas Member fauna contains several elements in common with the Los Esteros Member, but has a distinct phytosaur taxon. Further study will show if this fauna is Adamanian, Revueltian or intermediate in age. We suspect the first hypothesis is correct.

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