

Reptiles from Late Cretaceous coastal environments of northern Patagonia

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Abstract. Toward the end of the Cretaceous the Atlantic Ocean covered parts of central-western Patagonia forming a wide archipelago. Remains of terrestrial and marine reptiles have been recorded in the Campanian and Maastrichtian of this area in rocks that represent coastal or marginal marine environments. These taphocenoses are especially interesting because they include taxa not only of different environmental requirements, but also of different biogeographical backgrounds. The presence of a wide archipelago is a plausible explanation of the association recorder, such as plesiosaurs with continental chelids, boids and dinosaurs (*e.g.*, La Colonia, Chubut; Ranquil-Có, Mendoza), or plesiosaurs and mosasaurs with chelids (*e.g.*, Lui-Malal, Mendoza). From a paleobiogeographic point of view, some taxa have mainly south Gondwanan distribution (chelids, meiolanids, the plesiosaur *Aristonectes* Cabrera), others taxa are related to North American taxa (the plesiosaur *Sulcusuchus* Gasparini and Spalletti, hadrosaurid dinosaurs); and still others were cosmopolitan toward the end of the Mesozoic (elasmosaurids and mosasaurines).

Key words. Reptiles. Coastal environments. Late Cretaceous. Patagonia

Introduction

As a consequence of the Late Cretaceous transgression of the Atlantic Ocean that covered central-northern Patagonia, the area was transformed into a wide archipelago (Figure 1) (Bond *et al.*, 1995 and references therein). This scenario, together with a warm temperate climate was the environmental background for the diversity of the Campanian and Maastrichtian flora and fauna. Casamiquela (1978) listed several localities in which different Upper Cretaceous lithostratigraphic units are exposed, representing littoral environments of the Atlantic transgression (his "Mar de Kawas"). He pointed out the mix of continental and marine taxa, and recognized different paleobiogeographic relationships. Certainly, the analysis of the Late Cretaceous records of marine and continental reptiles, on the increase in recent years, shows that groups with strikingly different biogeographic histories converged in central-northern Patagonia (Bonaparte, 1986, 1996 and references therein; González Riga, 1999).

In this frame, the main purpose of this work is to update taxonomic, compositional and paleobiogeographic aspects of the reptilian assemblage that was recorded in central northern Patagonia in sediments

related with the Late Cretaceous thallosocratic episode.

Results

Ten fossiliferous localities from central northern Patagonia in which rocks from the Middle Campanian to the Upper Maastrichtian are exposed were considered in this study (Figure 1). Fossil remains recovered in these localities represent mixed marine and continental taxa (*e.g.*, La Colonia, Lui Malal, Ranquil-Có), mostly continental with a few marine species (*e.g.*, El Abra, Cerro Blanco), continental taxa only (*e.g.*, Los Alamitos) or marine taxa only (*e.g.*, Lago Pellegrini; Cañadon del Loro). The localities in chronological order are:

Locality 1: Lago Pellegrini, Río Negro province. Horizon: Allen Formation, Middle Member. Age: Late Campanian. Reptiles: Elasmosauridae. References: Gasparini and Salgado (2000).

Locality 2: Cerro Blanco, Arroyo Seco Yaminué, Río Negro province. Horizon: Wichmann's "Lacustrine Senonian" (1927), which according to Andreis *et al.* (1974) may correspond to the Allen Formation in the area of Lago Pellegrini. Age: Campanian.-Maastrichtian Reptiles: a new gen. et sp. of Chelidae of the *Hydromedusa* group, Titanosauridae indet., Theropoda indet., Plesiosauria indet. References: Wichmann (1927), Andreis *et al.* (1974), Manera de Bianco (1998), de la Fuente *et al.* (2001)

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Locality 3: La Colonia, Bajada Moreno area, Chubut province. Horizon: Middle Member of La Colonia Formation. Age: Campanian-Maastrichtian. Reptiles: Chelidae (5 spp. indet.), Meiolanidae (1 sp. indet.) Polycotyliidae (*Sulcusuchus erraini* Gasparini and Spalletti, 1990), Elasmosauridae indet., ?Boidae indet., Madtsoiidae (*Alamitophis argentinus* Albino, 1986), Abelisauridae (cf. *Carnotaurus* Bonaparte, 1985). References: Pascual *et al.* (2000), Albino (2000), Gasparini and de la Fuente (2000).

Locality 4: Los Alamitos, Río Negro province. Horizon: Los Alamitos Formation. Age: Late Campanian-Early Maastrichtian. Reptiles: Meiolaniidae (cf. *Niolamia* sp.), Chelidae (6 spp. indet.), Boidae (*Alamitophis* Albino, 1986), Titanosauria (*Aelosaurus rionegrinus?* Powell, 1987), Theropoda indet., Hadrosauridae (*Kritosaurus australis* Bonaparte, Franchi, Powell and Sepúlveda, 1984). References: Albino (1986, 1987), Andreis *et al.* (1987), Bonaparte *et al.* (1984), Bonaparte *et al.* (1987), Bonaparte and Rougier (1987), Broin (1987), Powell (1987), Broin and de la Fuente (1993).

Locality 5: El Abra, Río Negro province. Horizon: unnamed unit equivalent to the Los Alamitos Formation. Age: Late Campanian-Early Maastrichtian. Reptiles: Chelidae (at least 6 different taxa of primitive species without relationships to any living group, as well as new genera and species of the groups *Phrynos* Wagler, *Chelus* Duméril and *Hydromedusa* Wagler), Plesiosauria indet. References: Broin and de la Fuente (1993), J. Bonaparte (personal commun., 1999).

Locality 6: Ranquil-Có, Mendoza province. Horizon: Loncoche Formation. Age: Late Campanian-Early Maastrichtian. Reptiles: Chelidae indet., Boidae indet., Theropoda indet., Titanosauria indet., Theropoda indet., Plesiosauria indet. References: Broin and de la Fuente (1993) González Riga and Parras (1998), González Riga (1999).

Locality 7: Northwestern Cari-Laufquen Grande, Chubut province. Horizon: Coli-Toro Formation. Age: Early-Middle Maastrichtian. Reptiles: Polycotyliid *Sulcusuchus erraini*. References: Casamiquela (1978), Gasparini and Spalletti (1990), Gasparini and de la Fuente (2000).

Locality 8: Cerro Puyén, south of Ing. Jacobacci, Río Negro province. Horizon: Coli-Toro Formation. Age: Early-Middle Maastrichtian. Reptiles: Elasmosauridae indet., cf. *Sulcusuchus* sp. (J. Bonaparte, personal commun., 1999)

Locality 9: Liu Malal, southern Malargüe Department, Mendoza province. Horizon: pelite level at the base of the Jaguel Formation. Age: Late Maastrichtian. Reptiles: ?Chelonii indet., Squamata Mosasaurinae gen. et sp. indet., Plesiosauria gen. et sp. indet. References: Gasparini *et al.* (2001).

Locality 10: Cañadón del Loro, Chubut province. Horizon: Paso del Sapo Formation. Age: Late Maastrichtian. Reptiles: *Aristonectes parvidens* Cabrera 1941. References: Lesta and Ferello (1972), Cabrera (1941).

Discussion

Except for plesiosaurs and mosasaurs, the Campanian-Maastrichtian reptiles discovered in the listed localities are terrestrial or freshwater taxa (turtles, ophidians, dinosaurs). A large part of the fossil-bearing levels have been interpreted as estuarine, tidal flat deposits (*e.g.*, La Colonia, Lui Malal, Ranquil-Có) (González Riga, 1999; Gasparini and de la Fuente, 2000; Gasparini *et al.*, 2001) or lacustrine but next to the coast (*e.g.* Los Alamitos) (Bonaparte *et al.*, 1984; Andreis, 1987). Consequently, this might explain the mix of vertebrate remains from different environments. Moreover, fragmentary material (teeth, plates, vertebrae) predominates. The most complete specimens, even articulated, belong to plesiosaurs (*e.g.*, La Colonia, Lago Pellegrini, Cañadón del Loro) and some freshwater chelids (*e.g.*, Cerro Blanco, Los Alamitos, Ranquil-Có).

The archipelago formed as a consequence of the Atlantic transgressions over northern Patagonia (Bond *et al.*, 1995) resulted in an optimal environment to support the diversity of terrestrial and marine reptiles, converging in this area taxa of different biogeographic histories. Among the continental reptiles, turtles are largely dominant. Except for a few remains of meiolanids, most of the turtles are freshwater chelids. The taxonomic diversity of chelids is noteworthy; several groups of living chelids are represented by new extinct genera and species (Broin and de la Fuente, 1993; Gasparini and de la Fuente, 2000). This diversity suggests multiple lotic and lentic environments relatively near to the coast which would facilitate these turtles take advantage of different ecological lifezones (Gasparini and de la Fuente, 2000). Such diversity of taxa might be also the consequence of post-mortem transport, along the river flood plains up to the mouth in rainfall periods.

Turtles are undoubtedly Southgondwanian. Both meiolanids and chelids, are recorded in Patagonia (Cretaceous-Paleogene) (Broin, 1987; Broin and de la Fuente, 1993, and references therein), as well as in Australasia (Eocene-Holocene) (Gaffney, 1981, 1983, 1996; Gaffney *et al.*, 1984; Lapparent de Broin, personal commun., 1997). In addition, among the Madtsoiidae snakes (Albino, 1986, 2000) *Alamitophis* is recorded in the Upper Cretaceous of Patagonia and in the Eocene of Australia (Scanlon, 1993). The taxonomic affinities of turtles and snakes suggest close

biogeographic relationships between Patagonia and Australia via Antarctica.

Among dinosaurs, the teropod Abelisauridae are distributed in Patagonia, India and Madagascar. This Gondwanan distribution was considered coincident with that of titanosaurids (Bonaparte, 1996). This latter group of Cretaceous sauropods was widely dis-

tributed in the Gondwanan subcontinents, particularly in South America (Bonaparte, 1996 and references therein). However, they have been also discovered in North America, Europe and Asia. Some authors as Wilson and Sereno (1998) postulated that the titanosaurids might have had an almost global original distribution that became later restricted to the

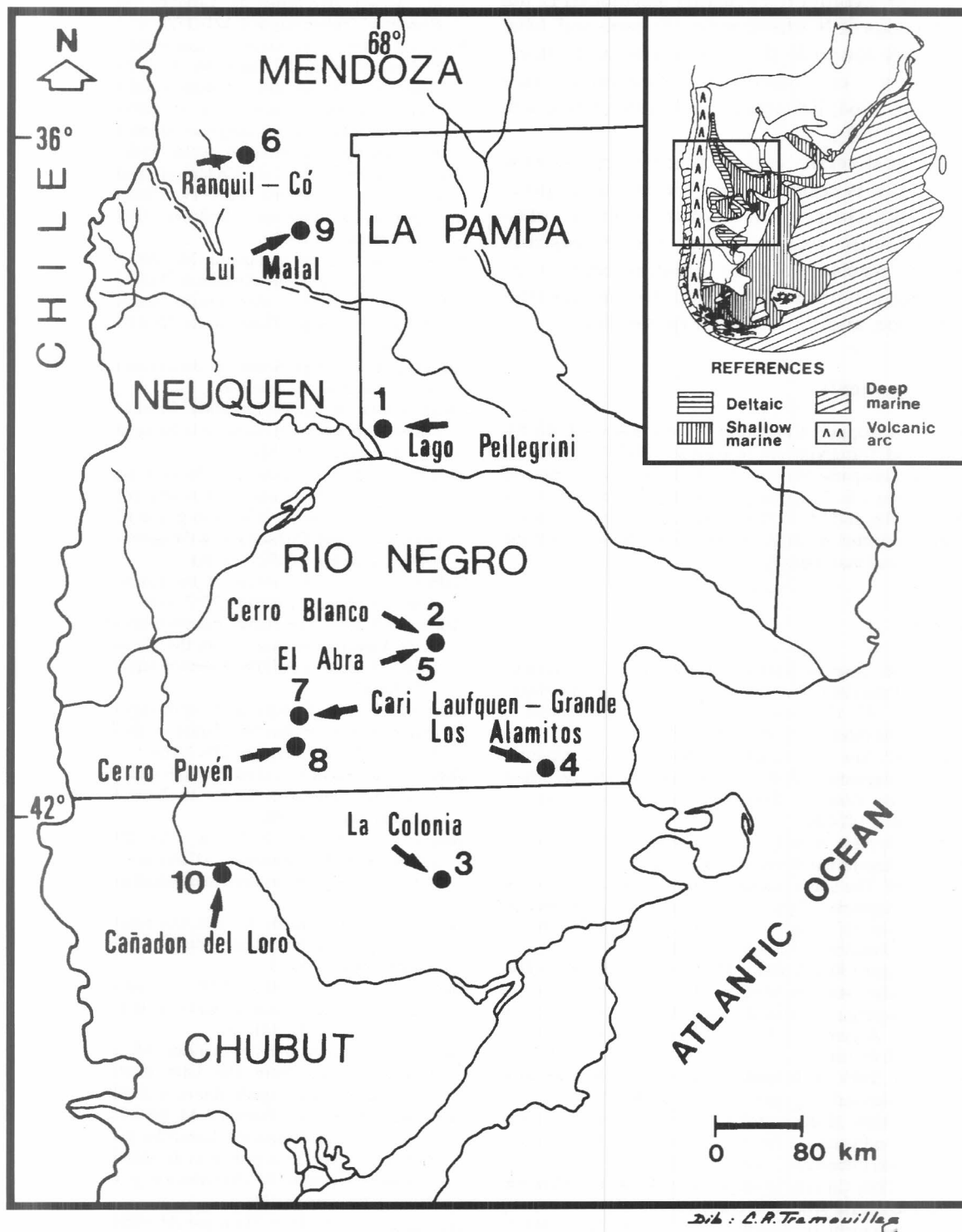


Figure 1. Location map of 10 paleontological sites of central northern Patagonia, and southern South America paleogeographic map of the Campanian-Maastrichtian (simplified from Spalletti *et al.*, 1999).

gondwanan continents. Despite their relative abundance in Patagonia, the titanosaur remains are not abundant in these lacustrine, estuarial, and littoral environments, except for *Aeolosaurus rionegrinus*? from Los Alamitos Formation (Powell, 1987). This could be related to taphonomic processes or behavioral preferences. Hadrosaurids, an ornithischian group with an evolutionary history developed in the Late Cretaceous of North America, Europe and Asia, are frequently found in these lacustrine and littoral environments of northern Patagonia (see Casamiquela, 1964; Bonaparte *et al.*, 1984, Bonaparte and Rougier, 1987).

Finally, the diversity of large marine reptiles in the listed localities is confirmed by the record of polycotyloid plesiosaurs (*Sulcusuchus erraini*), elasmosaurids with exceptionally broad rostrum (*Aristonectes parvidens*), other elasmosaurids, (e.g., Lago Pellegrini) probably related to *Elasmosaurus platyurus* Cope, and mosasaurine mosasurids.

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