

Redescription of the aetosaur *Chilenosuchus forttae* Casamiquela (Diapsida: Archosauria): presence of continental Triassic in northern Chile

Julia B. Desojo

Departamento de Ciencias Geológicas, Facultad de Ciencias Exactas y Naturales,
Universidad de Buenos Aires, Pabellón II, Ciudad Universitaria, 1428 Buenos Aires, Argentina
julideso@gl.fcen.uba.ar

RESUMEN

Se redescubre *Chilenosuchus forttae* Casamiquela sobre la base del material original y tres nuevos moldes del sintipo. El material consiste en impresiones fragmentarias de escudos dérmicos y huesos poscraneales provenientes de la Región de Antofagasta. Este estudio confirma la identificación de estos restos como de aetosaurios, indicando de esta manera la edad triásica del nivel portador, el que fue atribuido a los Estratos El Bordo. Esta edad se contradice con la antigüedad carbónico-pérmica inferida para dicha sucesión sobre la base de plantas e invertebrados fósiles.

Palabras claves: Archosauria, Aetosauria, *Chilenosuchus forttae* Casamiquela, Estratos El Bordo, Triásico, Región de Antofagasta, Chile.

ABSTRACT

Chilenosuchus forttae Casamiquela, is redescrbed on the basis of part of the original material and three new casts of the syntype. The material consists of fragmentary impressions of dermal scutes and postcranial bones from the Antofagasta Region. This study confirms the aetosaurian nature of these remains, thus indicating a Triassic age for the bearing level which was attributed to the Estratos El Bordo. This age conflicts with the Carboniferous-Permian age inferred for this succession based on fossil plants and invertebrates.

Key words: Archosauria, Aetosauria, *Chilenosuchus forttae* Casamiquela, Estratos El Bordo, Triassic, Antofagasta Region, Chile.

Revista Geológica de Chile, Vol. 30, No. 1, p. 53-63, 1 Fig., 2 Pls., July 2003.

INTRODUCTION

During the last few years the record of Paleozoic and Mesozoic continental faunas in Chile has increased, but the presence of vertebrates in Triassic sediments continues to be rare. Until now the records of continental Triassic vertebrates, consisting mainly of bone fragments, impressions and traces, are confined to the Region of Antofagasta in the north of the country (Chong and Gasparini, 1976; Saline et al., 1991; Rubilar et al., 2002). The majority of these records come from the middle part of a volcanic-sedimentary succession that was

named the Serie El Bordo by M.A. Fortt and J. Frutos ¹ and later the Estratos El Bordo by M.A. Fortt ². This informal unit arises throughout the mountainous area Estratos El Bordo, to the east of the Cerro Quimal, Domeyko Mountain range (fig text 1), and was attributed, initially, to the Permo-Triassic although without explicit arguments (M.A. Fortt y J. Frutos ¹).

The first vertebrates recorded from this unit consist of two incomplete reptilian specimens, one of which has never been described or identified, while the other was studied by Casamiquela (1980) and considered to be a new species of aetosaur, named *Chilenosuchus forttae*.

The presence of this group of archosaurs, whose biochron is restricted to the late Triassic, seemed to confirm the Triassic age of this horizon (M.A. Fortt ²). This age also was suggested by vegetation associated with the vertebrates (Casamiquela, 1980; Ramírez y Gardeweg, 1982).

Later work in the area of El Bordo included the detailed description of geologic sections and the stratigraphic placement of ostracods and plant fragments (Breitkreuz et al., 1992). Study of these materials indicated a maximum age of early Westphalian (Permian) for the lower portion of the middle Member.

This conclusion contrasts strongly with those provided by the vertebrates and associated vegetation mentioned previously. On the basis of this new evidence, with respect to the possible Paleozoic age of the Estratos El Bordo, Lucas and Heckert (1996) argued against the presence of aetosaurs in this stratigraphic succession. The supposed loss of the syntype material and the difficult interpretation of the available photographs were additional arguments used by those authors to invalidate the record of aetosaurs presented by Casamiquela (1980). The described material was relocated and in this paper, its taxonomic assignment is confirmed and some anatomical corrections are made.

Although the Triassic age of the specimen has been settled, uncertainty remains with respect to the relative positions of the horizon in which these vertebrates were collected and those that contain the ostracods and plant fragments, which proposed a Paleozoic age.

FIG. text 1. Map of location of the Estratos El Bordo (modified from Ramírez and Gardeweg, 1982).

¹1976. Geología de los cuadrángulos Cerro Quimal, Llano de la Paciencia (Inédito), Instituto de Investigaciones Geológicas, 58 p. Santiago.

²1981. Geología general de los cuadrángulos Cerro Quimal, Laguna Tebinquiche, Llano de la Paciencia y Salar de Atacama, II Región (Inédito), Instituto de Investigaciones Geológicas, 48 p. Santiago.

SYSTEMATIC DESCRIPTION

Superorder Archosauria Cope, 1869
Order Crocodylotarsi Benton and Clark, 1988
Suborder Aetosauria Nicholson and Lydekker, 1889
Genus *Chilenosuchus* Casamiquela, 1980

Type Species: *Chilenosuchus forttae* Casamiquela, 1980.

Diagnosis emend.: same as that for *Chilenosuchus forttae*, the only well-known species.

***Chilenosuchus forttae* Casamiquela, 1980** Pl. 1, Figs. A-E; Pl. 2, Figs. A-C

Syntype: SNGM 987, impression of the disarticulated postcrania and osteoderms, in three sections.

Type Locality: Cerro Quimal (23°07'S-68°39'W), Cordillera Domeyko, Región de Antofagasta, Chile.

Type Horizon and age: Estratos El Bordo, Triassic levels.

Diagnosis emend.: aetosaurs that are different from other aetosaurs by the reticular pattern of the ornamentation of their plates, and other genera except *Tyothorax* Cope and *Redondasuchus* Hunt and Lucas, by possessing paramedian, lateral and ventral plates devoid of crests and furrows. Differs from the last two genera by possessing plates with pits of uniform size.

Materials: the material consists of impressions of the postcranium and dermal plates in three sections from the Paleontological Collection of the Servicio Nacional de Geología y Minería de Chile (SNGM) that have the collective number 987 and are individually numbered I-III (numbers 240873 3-5 of the Instituto de Investigaciones Geológicas of Antofagasta). Silicone molds were made (Series B), which allowed observation of the different structures in positive relief and with greater detail than in the original molds used by Casamiquela (1980) in his original description. The skeletal elements are disarticulated and poorly preserved.

Comparative Description: piece SNGM 987/I B preserves the impressions of fragmented lateral, ventral and paramedian plates, of the right humerus, scapula, dorsal ribs, pubis, gastralia and one unidentified element (Pl. 1, Fig. A). The two lateral plates are trapezoidal, almost flat, with a smooth anterior bar and ornamented with pits of reticular character (Pl. 1, Figs. A, E). The dorsal surface displays a high central protuberance, with a short tip perpendicular to the articular surface. This structure was described by Casamiquela (1980) as a spike. Nevertheless, the spikes in the lateral plates of genera of aetosaurs such as *Desmotosuchus* and *Tyothorax* of North America (Long and Ballew, 1985; Long and Murry, 1995) are conical with a sharp tip, very different from the protuberances present in *Chilenosuchus*. The ventral plates are superimposed and are square and flat in shape, with pits of reticular character and a barely evident boss perpendicular to the articular surface (Pl. 1, Figs. A, D). The right humerus is preserved in ventral view with the proximal and distal ends being incomplete. It is a short and robust bone, similar to that of *Neoaetosauroides* (Bonaparte, 1971), and with a marked curvature of the diapophysis. Casamiquela (1980) noted the presence of a deltopectoral crest truncated by breakthrough lines and an internal tuberosity, but this structure cannot be observed with clarity. The distal portion of the scapular blade has a convex margin and displays a thin, smooth surface. The shape of the visible portion suggests that this element was greatly expanded anteroposteriorly. The pubis, incomplete, has a proximal end that is narrower than the distal; no foramen can be observed in the proximal portion, it has a dorsal curvature and an expanded distal end that is bladelike. The dorsal and abdominal ribs are distributed on the surface of block (laja). The four impressions of dorsal ribs are incomplete, and correspond to the distal, proximal, and other very fragmentary portions. They have triangular cross-section, with a ventral channel parallel to the lateral margins. Casamiquela (1980) described the proximal and medial portions of four ribs. The abdominal ribs are numerous and they are distributed in random groups on the

block; they are cylindrical in form and are shorter than the dorsal ribs. The section of a short bone could not be identified.

Piece SNGM 987/II B preserves impressions of a right foot in ventral view, the right tibia, and impressions of plates (Pl. 2, Figs. A, B). Metatarsal I has been completely preserved, unlike metatarsals II, III, IV and V that are incomplete with superimposed proximal ends. The metatarsals indicated by Casamiquela (1980) to be I, II and V are interpreted instead to be V, IV, I, respectively.

The first of these pieces displays a wide proximal end and is thinned distally, a characteristic of metatarsal V found in several groups of basal archosaurs (Sereno, 1991). Metatarsal I is short, and more robust than in the South American genera *Neoaetosauroides* Bonaparte and *Aetosauroides* Casamiquela (1960) (Lucas and Heckert, 2001; J.D. Zacarias, 1982³) and in *Longosuchus* Hunt and Lucas (1990), from North America and Africa. This distal end of this element contacts the first phalange of digit I, which possesses an incomplete articular surface in the distal portion. The length of this phalange is slightly greater than that of metatarsal I (5/4), whereas in *Neoaetosauroides*, *Aetosauroides* and *Longosuchus* the first phalange of digit I is much longer than the corresponding metatarsal (5/2).

In general, the metatarsals of the Chilean taxon are shorter and robust than in *Aetosauroides* and *Neoaetosauroides*. The proximal end of the right tibia has a large, convex anterior articular surface. Casamiquela (1980) described this bone as being from the left side and preserved only at its distal end. The paramedian plates have rectangular form, are wider than long (4/2) and with a smooth anterior bar (Pl. 1, Figs. B, C; Pl. 2, Figs. A, B). They are ornamented with pits of uniform size and reticular character, and possess a keel extending perpendicular to the articular surface in their posterior half, without contacting with the posterior margin of the plate. Piece SNGM 987/III B conserves the impressions of superimposed fragmentary paramedian plates, abdominal ribs and a unidentified bone (Pl. 2, fig C). The characteristics of these structures are the same as those described previously.

DISCUSSION

The fragmentary preservation of the materials has prevented the recognition of a great number of diagnostic characters. As in many basal archosaurs, the proximal portion of metatarsal V is pronounced and the pubis is narrower at its proximal end than at the distal end, forming an anteroventrally projecting blade. The presence of an expanded scapular blade and plates of a different morphology (which allows for recognition of paramedian, lateral and ventral plates, indication of a well-developed carapace), confirm the assignment of these materials to aetosaurs (Lucas and Heckert, 1996; Heckert and Lucas, 1999, 2000). Like aetosaurs, the paramedian plates are wider than long, and their anterior margins possess smooth articular bars or laminae that underlie the preceding plates, lacking the anterior articular process present in the plates of *Crocodyliformes* (Sues, 1992). In none of the *Chilenosuchus* material, nor in that of *Neoaetosauroides* or *Aetosauroides* of South America, are lateral plates with laterally directed conical spikes clearly preserved like those that are present in many species from the Northern Hemisphere.

The plates of the Chilean material, which from their trapezoidal form can be identified as laterals, correspond to the caudal region with a central projection that has a small base and a sharp tip, absent in other genera from South America. The ornamental pattern of the plates of *Chilenosuchus forttae* differs from the ones of other well-known aetosaurs (Casamiquela, 1980). The exclusive presence of pits is shared with the genera *Typochothorax* and *Redondasuchus* of North America (Long and Murry, 1995; Heckert and Lucas, 1999, 2000), but the size of these is variable in similar plates of these genera (Long and Ballew,

³1982. Uma nova espécie de tecodontes aetossaurio *Aetosauroides subsulcatus* sp. nov. da Formação Santa Maria, Triássico do Rio Grande do Sul, Brasil. Dissertação de Mestrado (Inédito), Universidade Federal do Rio Grande do Sul, 67 p. Porto Alegre, Brasil.

1985; Heckert et al., 1996), whereas in *C. forttae* they are uniform. In addition, in *Desmatosuchus*, *Typothorax* and *Redondasuchus* pits is arranged in a random pattern, unlike the reticular pattern present in the Chilean genus. The consistent ornamentation of these pits resembles that of the plates of the archosauriform *Doswellia*, a taxon of uncertain phylogenetic position (Weems, 1980; Long and Murry, 1995). Nevertheless, the absence of "tongue in groove" articulation and the presence of a single center of ossification, articular bars and ventral plates, preclude assignment of the material to this taxon. In comparison to the other South American aetosaurs, the reticular pattern ornamentation in *Chilenosuchus* clearly differs from the radial one of *Aetosauroides* and *Neoaetosauroides*. In these genera the pits are accompanied by furrows and crests (Bonaparte, 1971).

It is possible to demonstrate that the chroniosuchitans, attributed to the Seymouriamorpha although its current phylogenetic position is disputed (Laurin, 2000), possess osteoderms ornamented with irregular furrows and pits. The diverse species of this group, recorded from the Carbonifero-Triassic interval of Eurasia, nevertheless, lack true armor, and possess only one row of plates throughout the column (Golubev, 1998). Thus, the previously mentioned characteristics clearly demonstrate that the assignment of this material to a new genus of the Aetosauria by Casamiquela (1980) is correct.

CONCLUSIONS

The presence of aetosaurs verifies, according to the known record of these armored archosaurs, the existence of Triassic age rocks in the Region of Antofagasta (Casamiquela, 1980; Desojo, 2001). In effect, to a large extent these herbivorous tetrapods, until now have been restricted to the Upper Triassic of North America, Europe, India, North Africa and South America (Heckert and Lucas, 2000). The evidence, discussed here, is in conflict with the Carboniferous-Permian age assigned to the Estratos El Bordo, on the basis of the presence of ostracods and vegetation (Breitkreuz et al., 1992) and shows the importance of counting on more precise data of the stratigraphic origin of the original material of *Chilenosuchus*.

This uncertainty conspires against the explanation of the relative stratigraphic position in the sequence of the horizons containing aetosaurs and of those possessing invertebrates and plants, and, therefore, against the resolution of the segment of time represented by the Estratos El Bordo. On the other hand, the *Chilenosuchus* discovery denotes the diversity of genera of aetosaurs that lived in South America during the Triassic.

ACKNOWLEDGEMENTS

The author especially thanks A.M. Báez (Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina) for her comments and corrections. Similarly, she thanks R.M. Casamiquela (Centro Nacional Patagónico, Argentina) and to K. Moreno ((Instituto de Geociencias, Universidad Austral de Chile) for providing important information that allowed location of the material and its study. She also thanks CONICET. This work partially funded by subsidy UBACYT TX08-2000 (to A.M. Báez). In addition, the author wishes thank J.F. Bonaparte (Museo Argentino de Ciencias Naturales 'Bernardino Rivadaviá'), B. Battail (Museum National d'Histoire Naturelle, France), A. Hunt (University of New Mexico, U.S.A.) and E. Perez d'A. ((Servicio Nacional de Geología y Minería, Chile), whose critical revisions helped improve the manuscript.

REFERENCES

- Benton, M.J.; Clark, J.M. 1988. Archosaur phylogeny and the relationships of the Crocodylia. In *The Phylogeny and Classification of the Tetrapods* (Benton, M.J.; editor). Clarendon Press, Vol. 1, p. 195-338. Oxford.
- Bonaparte, J.B. 1971. Los tetrápodos del sector superior de la Formación Los Colorados, La Rioja, Argentina (Triásico Superior). Parte I. *Opera Lilloana*, Vol. 22, 183 p. San Miguel de Tucumán.
- Breitkreuz, C.; Helmdach, F.; Kohring, R.; Mosbrugger, V. 1992. Late Carboniferous intra-arc sediments in the north Chilean Andes: stratigraphy, paleogeography and paleoclimate. *Facies*, Vol. 26, p. 67-80.
- Casamiquela, R. 1960. Noticia preliminar sobre dos nuevos estagonolepoides argentinos. *Ameghiniana*, Vol. 2, No. 1, p. 3-9.
- Casamiquela, R.M. 1980. Nota sobre restos de un reptile aetosauroideo (Thecodontia, Aetosauria) de Quimal, Cordillera de Domeyko, Antofagasta. Prueba de la existencia del Neotriásico continental en los Andes del Norte de Chile. In *Congreso Argentino de Paleontología y Bioestratigrafía*, No. 2 y Congreso Latinoamericano de Paleontología, No. 1, Actas, Vol. 1, p. 135-142. Buenos Aires.
- Case, E.C. 1920. Preliminary description of a new suborder of Phytosaurian reptiles, with a description of a new species of Phytosaurus. *Journal of Geology*, No. 28, Vol. 6, p. 524-535.
- Chong, G.; Gasparini, Z. 1976. Los vertebrados mesozoicos de Chile y su aporte geo-paleontológico. In *Congreso Geológico Argentino*, No. 6, Actas, Vol. 1, p. 45-67. Bahía Blanca.
- Cope, E.D. 1869. Synopsis of the extinct Batrachia, Reptilia and Aves of North America. *Transactions of the American Philosophical Society*, new series, No. 14, p. 1-252.
- Desojo, J.B. 2001. *Chilenosuchus forttae*: un aetosauro del Triásico de Chile de relaciones filogenéticas y paleogeográficas controvertidas. *Ameghiniana*, Vol. 38, No. 4, Suplemento, p. 6R. Buenos Aires.
- Golubev, V.K. 1998. Revision of the Late Permian Chroniosuchitans (Amphibia, Anthracosauromorpha) from Eastern Europe. *Paleontological Journal*, Vol. 32, No. 4, p. 390-401.
- Heckert, A.B.; Hunt, A.P.; Lucas, S.G. 1996. Redescription of *Redondasuchus reseri*, a Late Triassic aetosaur (Reptilia: Archosauria) from New Mexico (U.S.A.), and the biochronology and phylogeny of aetosaurs. *Geobios*, Vol. 29, No. 5, p. 619-632.
- Heckert, A.B.; Lucas, S.G. 1999. A new aetosaur (Reptilia: Archosauria) from the Upper Triassic of Texas and the phylogeny of aetosaurs. *Journal of Vertebrate Paleontology*, Vol. 19, No. 1, p. 50-68.
- Heckert, A.B.; Lucas, S.G. 2000. Taxonomy, phylogeny, biostratigraphy, biochronology, paleobiogeography, and evolution of the Late Triassic Aetosauria (Archosauria: Crurotarsi). *Zentralblatt Geologie, Paläontologie*, Part I, Nos. 11-12, p. 1539-1587.
- Hunt, A.P.; Lucas, S.G. 1990. Re-evaluation of *Typhothorax meadei*, a Late Triassic aetosaur from the United States. *Palaontologische Zeitschrift*, No. 64, p. 317-328.
- Laurin, M. 2000. Seymouriamorphs. In *Amphibian Biology* (Heatwole, H.; Carroll, R.L.; editors). Surrey Beatty and Sons, Vol. 4, p. 1064-1080. Chipping Norton, Australia.
- Long, R.A.; Ballew, K.L. 1985. Aetosaur dermal armor from the Late Triassic of southwestern North America, with special reference to material from the Chinle Formation of Petrified Forest National Park. In *The petrified forest through the ages* (Colbert, E.H.; editor.; et al.). Museum of Northern Arizona, Bulletin, Vol. 54, p. 45-68.
- Long, R.; Murry, P.A. 1995. Late Triassic (Carnian and Norian) tetrapods from the Southwestern United States. *New Mexico Museum of Natural History and Science, Bulletin*, Vol. 4, p. 27-116.
- Lucas, S.G.; Heckert, A.B. 1996. Late Triassic aetosaur biochronology. *Albertina*, Vol. 17, p. 57-64.
- Lucas, S.G.; Heckert, A.B. 2001. The aetosaur *Stagonolepis* from the Upper Triassic of Brazil and its biochronological significance. *Neues Jahrbuch für Geologie und Paläontologie Monatshefte*, No. 12, p. 719-732.
- Nicholson, J.A.; Lydekker, R. 1889. A manual of palaeontology for the use of students, with a general introduction on the principles of palaeontology. *Nature*, 1624 p. London.
- Ramírez, C.F.; Gardeweg, M. 1982. Hoja Toconao, Región de Antofagasta. Servicio Nacional de Geología y Minería, Carta Geológica de Chile, No. 54, 122 p.
- Rubilar, D.; Chatterjee, S.; Vargas, A. 2002. A crocodylomorph from the Late Triassic of Chile. In *Congreso Latinoamericano de Paleontología de Vertebrados*, No. 1, Actas, Vol. 1, p. 47. Santiago.
- Salinas, P.; Marshall, L.G.; Sepúlveda, P. 1991. Vertebrados continentales del Paleozoico y Mesozoico de Chile. In *Congreso Geológico Chileno*, No. 6, Actas, Vol. 1, p. 310-313. Viña del Mar.
- Sereno, P.C. 1991. Basal archosaurs: phylogenetic relationships and functional implications. *Journal of Vertebrate Paleontology*, Vol. 11, Supplement No. 4, 53 p.

Sues, H.D. 1992. A remarkable new armored Archosaur from the Upper Triassic of Virginia. *Journal of Vertebrate Paleontology*, Vol. 12, No. 2, p. 142-149.

Troncoso, A.; Basso, M.; Herbst, R. 2002. Redescubrimiento de *Sphenobaiera steinmanni* (Solms Laubach) Anderson y Anderson (Pinophyta, Ginkgoales). In *Congreso Argentino de Paleontología y Bioestratigrafía*, No. 8, Actas, p. 37. Corrientes.

Manuscript received: September 12, 2001; accepted: March 25, 2003.

Weems, R.E. 1980. An unusual newly discovered archosaur from the Upper Triassic of Virginia, U.S.A. *American Philosophical Society, Transactions*, Vol. 70, No.7, p. 1-53.

PLATE 1

(Scale bar equals 2 cm)

Figs. A-E *Chilenosuchus forttae* Casamiquela, 1980
p. 54

Cerro Quimal (23°07'S-68°39'W), Cordillera Domeyko, Región de Antofagasta, Chile. Estratos El Bordo, Triassic levels.
A-E. SNGM 987/IB.

- A. Original mold. Impression of plates and diverse poscranial bones.
- B. Paramedian plate.
- C. Paramedian plate fragments.
- D. Ventral plate.
- E. Lateral plate.

PLATE 2

Figs. A-C *Chilenosuchus forttae* Casamiquela, 1980
p. 54

Cerro Quimal (23°07'S-68°39'W), Cordillera Domeyko, Región de Antofagasta, Chile. Estratos El Bordo, niveles triásicos. SNGM 987/II y IIIB.

A. SNGM 987/IIIB. Original mold. Impressions of the right foot, right tibia and paramedian plates. Scale bar equals 2 cm.

B. SNGM 987/IIIB. Details of metatarsals IV and first phalange of the digit I. Scale bar equals 1 cm.

C. SNGM 987/IIIB. Original mold. Impressions of paramediales plates. Scale bar equals 2 cm

Abbreviations: **F1**: phalange 1. **M1-5**: metatarsal 1-5. **PP**: paramedian plate. **TI**: tibia.