

NOTA PALEONTOLÓGICA



New records of basal ornithopod dinosaurs in the Cretaceous of North Patagonia

Rodolfo A. CORIA^{1,3}, Andrea V. CAMBIASO¹ and Leonardo SALGADO^{2,3}

Introduction

During the last decade, the record of non-hadrosaur ornithopod dinosaurs (collectively called in many texts as either basal iguanodontians or, in a more inclusive way, basal ornithopods) has been significantly increased. Current sampling of this group shows a wide range of preservation, from articulated to semi-articulated specimens (Coria and Salgado, 1996a; Coria and Calvo, 2002; Novas *et al.*, 2004) disarticulated or incomplete (Martinez, 1998), to fragmentary or poorly preserved (Coria, 1999; Calvo and Porfiri, 2003).

Despite of the relative amount of osteological information in each specimen, the presence of basal ornithopods in South American Cretaceous rocks is unquestionable. Basal ornithopods are virtually pan-Patagonian throughout the Late Cretaceous.

In this contribution, fragmentary limb elements of basal ornithopod dinosaurs are reported from the Candeleros and Allen formations respectively, both from northern Patagonia (figure 1). The presence of a basitrochanteric facet in the femoral shaft of MEPyG-177 and the slender and narrow tibial shaft of MCF-PVPH-479 allow to identify the specimens as basal non-hadrosaur ornithopods and extends the temporal range of this ornithischian dinosaur group, from the oldest (Cenomanian) record for the Neuquén Basin, to the youngest record (Campanian-Maastrichtian) of the group for South America.

Institutional abbreviations. MCF-PVPH, Museo Carmen Funes, Paleontología de Vertebrados, Plaza Huincul, Neuquén Province; MEPyG, Museo Educativo de Paleontología y Geología del Instituto de Formación Docente Continua de General Roca, Río Negro Province; USNM, United States National Museum, Smithsonian Institution, Washington DC.

¹Museo Carmen Funes, Av. Córdoba 55, 8318 Plaza Huincul, Neuquén, Argentina. coriarod@copelnet.com.ar

²Museo de Geología y Paleontología, Universidad Nacional del Comahue, Buenos Aires 1400, 8300 Neuquén, Argentina.

³CONICET. Consejo Nacional de Investigaciones Científicas y Técnicas.

Systematic paleontology

DINOSAURIA Owen, 1842

ORNITHISCHIA Seeley, 1887

ORNITHOPODA Marsh, 1871

IGUANODONTIA Dollo, 1888

Iguanodontia indet.

Figures 2.A-E

Material. MCF-PVPH-479, almost complete right tibia, lacking the distal third.

Provenance. South shore of Neuquén River, near the Buena Esperanza water plant, 40 km north of Plaza Huincul, Neuquén Province, Argentina. Coordinates: 38° S 69° W (figure 1).

Horizon. Candeleros Formation, Albian-Cenomanian (Ramos, 1981; Leanza *et al.*, 2004).

Description. The specimen consists of a right tibia that lacks the distal end (figures 2.A-D). The proximal end of the bone is expanded anteroposteriorly with a robust cnemial crest as in most iguanodontians (Norman and Weishampel, 1990). The crest of MCF-PVPH-479 is transversely thick (figures 2.C, E), proportionally short dorsoventrally and strongly curved laterally (figures 2.A, D, E). In medial view, the cnemial crest of the specimen from the Candeleros Formation does not taper anteriorly as much as in other basal iguanodontians like *Anabisetia* (figures 2.D, D'). The fibular condyle on the lateral side of proximal end of the tibia is relatively more posterior in position than in *Anabisetia* (figures 2.E, E') and *Gasparinisaura*.

The tibial shaft is wider anteroposteriorly than lateromedially as in most ornithopods (figures 2.A, C). Distally, the shaft expands transversely suggesting the distal end expanded as in most ornithopods. The bone has a narrow cavity.

Iguanodontia indet.

Figure 2.F

Material. MEPyG-177, almost complete right femur. The specimen is crushed, collapsed anteroposteriorly, and lacks most of the distal end.

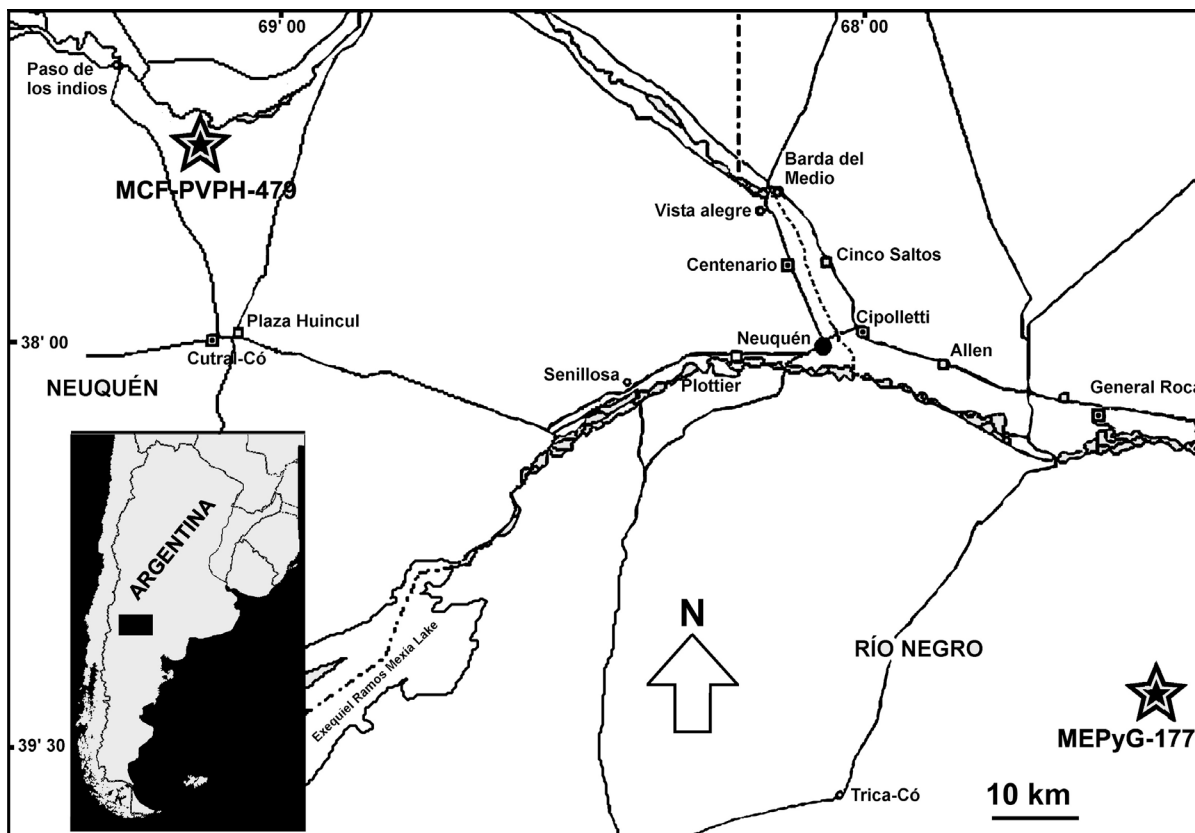


Figure 1. Map of the fossil localities. The areas where the bones were discovered are indicated by stars / *mapa de las localidades fosilíferas. Las estrellas indican las áreas donde se realizaron los hallazgos.*

Provenance. Salitral Ojo de Agua, 80 km south of General Roca, Río Negro Province, Argentina. Coordinates: 39° S, 67° W (figure 1).

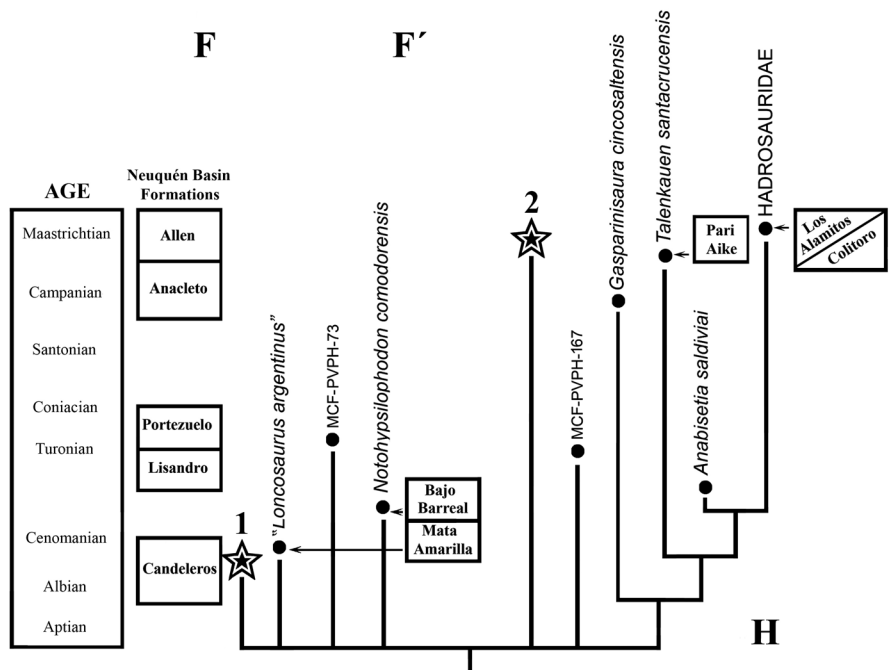
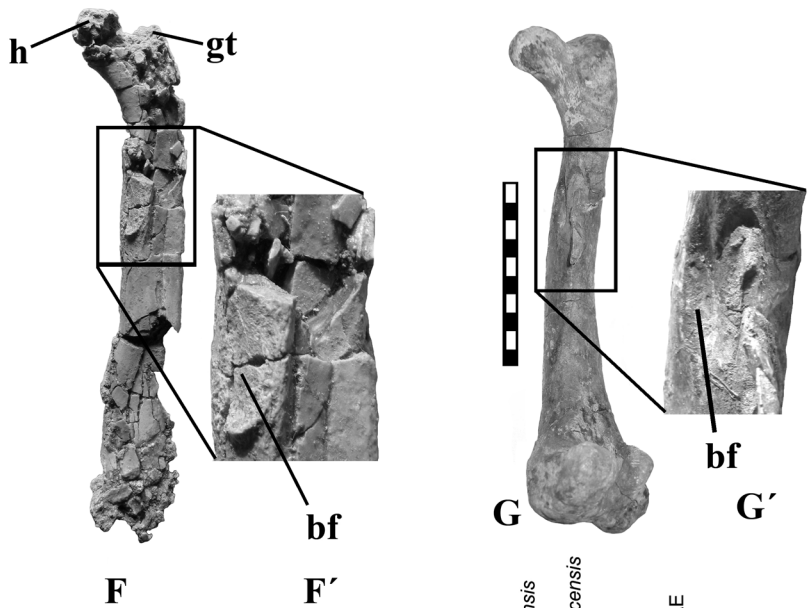
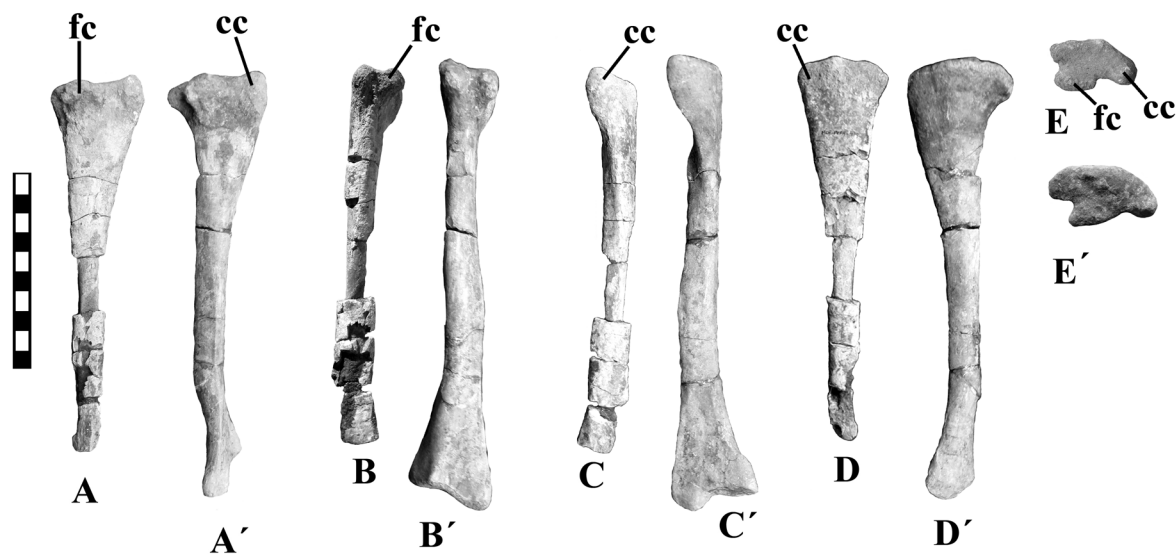
Horizon. Allen Formation (Campanian - Maastrichtian) (Hugo and Leanza, 2001).

Description. Although the specimen is badly crushed, several features can be recognized. The femoral head is voluminous and projects laterally. The greater trochanter is convex dorsally, flat laterally and the uppermost edge levels with the dorsal surface of the femoral head (figure 2.F). The anterior trochanter is flat transversely as it was mentioned for some iguan-

odonts (Norman and Weishampel, 1990) and is significantly shorter than the greater trochanter. As in most ornithopods, there is no indication of fusion between the two trochanters, which is the apomorphic condition present in *Gasparinisaura* (Coria and Salgado, 1996a).

The femoral shaft collapsed anteroposteriorly by *postmortem* pressure. However, on its medioposterior side, a conspicuous basitrochanteric facet can be observed (figure 2.F'). It is proximal on the shaft, as in most small-sized ornithopods like *Hypsilophodon*, *Dryosaurus*, *Gasparinisaura* and *Anabisetia* (Galton,

Figure 2. Comparison of the right tibiae of the Candeleros Formation specimen (MCF-PVPH-479) and the right femur of the Allen Fm. specimen (MEPyG-177) (Iguanodontia indet.) with similar bones of *Anabisetia saldiviai*. **A, B, C, D, E**, MCF-PVPH-479, in **A**, lateral; **B**, caudal; **C**, cranial; **D**, medial and **E**, proximal views; **A', B', C', D', E'**, *Anabisetia saldiviai*; in **A'**, lateral; **B'**, caudal; **C'**, cranial; **D'**, medial and **E'**, proximal views. **F, F'**, MEPyG-177 in **F**, internal view of the femur and **F'**, detail of the basitrochanteric fossa. **G, G', G''**, right femur of *Anabisetia saldiviai* in **G**, medial view, **G'**, detail of the basitrochanteric fossa; **H**, Calibrated stratigraphic cladogram depicting the record of ornithopod dinosaurs from the Neuquén Basin and from other austral basins. The tibia MCF-PVPH- 479 is represented by the number 1 and the femur MEPyG-177 by 2. **Abbreviations:** bf: basitrochanteric fossa, cc: cnemial crest, gt: greater trochanter, h: head, fc: fibular condyle. Scale bars: 10 cm / *comparación de la tibia derecha del ejemplar de la Formación Candeleros (MCF-PVPH- 479) y el fémur derecho del ejemplar MEPyG-177 (Iguanodontia indet.) de la Fm. Allen con huesos correspondientes de Anabisetia saldiviai. A, B, C, D, E*, MCF-PVPH-479 en vistas **A**, lateral; **B**, caudal; **C**, craneal; **D**, medial y **E**, proximal. **A', B', C', D', E'**, *Anabisetia saldiviai* en vistas **A'**, lateral; **B'**, caudal; **C'**, craneal; **D'**, medial y **E'**, proximal. **F, F'**, MEPyG-177 en **F**, vista interna y **F'**, detalle de la foseta basitrocantérica. **G, G', G''**, fémur derecho de *Anabisetia saldiviai* en **G**, vista medial; **G'**, detalle de la foseta basitrocantérica; **H**, Cladograma estratigráfico calibrado del registro de dinosaurios ornitópodos en la cuenca Neuquina y de otras cuencas australes. La tibia MCF-PVPH-479 está representada por el número 1 y el fémur MEPyG-177 por el 2. **Abreviaturas:** bf: foseta basitrocantérica, cc: cresta cnemial, gt: trocánter mayor, h: cabeza femoral, fc: cóndilo fibular. Escalas: 10 cm.



1974, 1981; Coria and Salgado, 1996a; Coria and Calvo, 2002) (figure 2.G'). This is also the condition in medium sized basal ornithopods like in "*Loncosaurus argentinus*" (Coria and Salgado, 1996b) and *Thescelosaurus* (USNM 7757). Unlike hadrosaurs, where a well defined basitrochanteric fossa is present, the specimen MEPyG-177 shows a basitrochanteric facet (not a fossa) with a posterior end defined by a sharp edge like in the specimen known as "*Loncosaurus argentinus*".

Discussion

Since the first South American dinosaur was reported (see Coria and Salgado, 2000) and throughout most of the 20th Century, the only ornithopod dinosaurs known from South America were hadrosaurs (Casamiquela, 1964; Bonaparte *et al.*, 1984; Bonaparte and Rougier, 1987; Powell, 1987). However, discoveries made during the last fifteen years have added new information about basal ornithopods of the Mesozoic austral ecosystems.

The first non-hadrosaurian iguanodontian recognized for the Cretaceous of South America was *Gasparinisaura cincosaltensis* (Coria and Salgado, 1996a). The phylogenetic relationships of *Gasparinisaura*, formerly recognized as a basal iguanodontian closer to *Dryosaurus* and more derived iguanodontians than to *Hypsilophodon* and related forms, predicted the existence of iguanodontian lineages in older units than the Campanian (Coria, 1999). This hypothesis was later supported by the description of *Anabisetia* (Coria and Calvo, 2002), related to *Gasparinisaura*, but from a significantly older horizon (figure 2.H).

At present, a number of non-hadrosaur ornithopod dinosaurs have been recognized from Mesozoic beds, particularly from Patagonian Cretaceous rocks. These include *Notohypsilophodon comodorensis* from the upper part of the Lower Member of the Bajo Barreal Formation of the Chubut Province (Cenomanian?, Martinez, 1998), the Ornithopoda *insertae sedis* "*Loncosaurus argentinus*" (Ameghino, 1899; Coria and Salgado, 1996b) from the Mata Amarilla Formation (Santonian-early Campanian in age) and *Talenkauen santacrucensis* from the Pari Aike Formation (Maastriichtian) of Santa Cruz Province (Novas *et al.*, 2004).

Besides these informative specimens, a handful of fragmentary and isolated specimens from the Portezuelo Formation (Turonian-Santonian) show the presence of small to medium sized, bipedal herbivores in the Cretaceous Patagonian ecosystems (figure 2.H).

The specimen MCF-PVPH-479 is the oldest record for ornithopod dinosaurs from the Neuquén Basin, and it is probably contemporaneous with the record of *Notohypsilophodon* from the Cenomanian San Jorge AMEGHINIANA 44 (1), 2007

Basin of Chubut Province (figure 2.H). *Notohypsilophodon* is represented by a juvenile individual (Martínez, 1998), the tibia of which is significantly smaller than the tibia of MCF-PVPH-479. The tibia of *Notohypsilophodon* has a smaller cnemial crest than that of the Neuquén specimen. Nevertheless, more anatomical evidence is needed for either linking or differentiating *Notohypsilophodon* and MCF-PVPH-479.

The femur (MEPyG-177) was found in outcrops of the Allen Formation, considered mid Campanian-lower Maastrichtian in age (Hugo and Leanza, 2001). Until this discovery, the only ornithopods recorded from this level (and correlated) were the hadrosaurs (Brett Surman, 1979; Bonaparte *et al.*, 1984; Powell, 1987; Apesteguía and Cambiaso, 1999; González Riga and Casadío, 2000).

MEPyG-177 suggests a Campanian-Maastrichtian basal group of ornithopods existed in South America together with the hadrosaurs. However, the available evidence prevents further specifications about the phylogenetic relationships of the femur MEPyG-177. Therefore, the information is insufficient for proposing an endemic or exotic origin for the basal ornithopod dinosaur represented by this specimen.

The new specimens extend the stratigraphic distribution of non-hadrosaurian ornithopods from the oldest record of the group in the Neuquén Basin, to the youngest record of South America (figure 2.H).

Acknowledgments

The authors would like to thank the crews that participated in the field works during the summers of 2003 and 2004. A. Paulina Carabajal processed the first drafts of the manuscript and made the illustrations. We are indebted to P.J. Currie for useful comments and suggestions. O. Rauhut reviewed the manuscript and his observations are deeply appreciated. The Municipalidad de Plaza Huincul provided institutional support. Field works were funded by the National Geographic Society, NGS CRE Grants # 7318-02 to R.A. Coria and # 7396/03 to L. Salgado.

Bibliography

- Ameghino, F. 1899. Nota preliminar sobre el *Loncosaurus argentinus*, un representante de la familia Megalosauridae de la República Argentina. *Anales de la Sociedad Científica Argentina* 49: 61-62.
- Apesteguía, S. and Cambiaso, A. 1999. Hallazgo de hadrosaurios en la Formación Paso del Sapo (Campaniano-Maastrichtiano, Chubut): otra localidad del "Senoniano lacustre". 15^o Jornadas Argentinas de Paleontología de Vertebrados (La Plata y Luján), *Ameghiniana Suplemento Resúmenes* 36: 5R.
- Bonaparte, J.F. and Rougier, G. 1987. The Late Cretaceous fauna of Los Alamitos, Patagonia, Argentina. Part VII-The hadrosaurs. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*, *Paleontología* 3: 155-161.
- Bonaparte, J.F., Franchi, M.R., Powell, J.E. and Sepúlveda, E.C. 1984. La Formación Los Alamitos (Campaniano-Maas-

- trichtiano) del sudoeste de Río Negro, con descripción de *Kritosaurus australis* nov. sp. (Hadrosauridae). Significación paleobiogeográfica de los vertebrados. *Revista de la Asociación Geológica Argentina* 39: 284-299.
- Brett-Surman, M.K. 1979. Phylogeny and palaeobiogeography of hadrosaurian dinosaurs. *Nature* 277: 560-562.
- Calvo, J.O. and Porfiri, J. 2003. More evidence of basal iguanodontians from Barreales Lake (Upper Turonian-Lower Coniacian), Neuquén, Patagonia, Argentina. 19° Jornadas Argentinas de Paleontología de Vertebrados (La Plata y Luján), *Ameghiniana Suplemento Resúmenes* 40: 53R.
- Casamiquela, R.M. 1964. Sobre un dinosaurio hadrosáurido de la Argentina. *Ameghiniana* 3: 285-308.
- Coria, R. 1999. Ornithopod dinosaurs from the Neuquén Group, Patagonia, Argentina: phylogeny and biostratigraphy. *National Science Museum Monographs* 15: 47-60.
- Coria, R.A. and Calvo, J.O. 2002. A new Iguanodontian ornithopod from Neuquén Basin, Patagonia, Argentina. *Journal of Vertebrate Paleontology* 22: 503-509.
- Coria, R.A. and Salgado, L. 1996a. A basal Iguanodontian (Ornithischia: Ornithopoda) from the Late Cretaceous of South America. *Journal of Vertebrate Paleontology* 16: 445-457.
- Coria, R.A. and Salgado, L. 1996b. "*Loncosaurus argentinus*" Ameghino, 1898 (Ornithischia: Ornithopoda): A revised description with comments on its phylogenetic relationships. *Ameghiniana* 33: 373-376.
- Coria, R.A. and L. Salgado. 2000. Los dinosaurios de Ameghino. In: S. Vizcaíno (ed.), *Obra de los Hermanos Ameghino*, Publicación Especial Universidad Nacional de Luján, Luján: pp. 43-49.
- Galton, P.M., 1974. The ornithischian dinosaur *Hypsilophodon* from the Wealden of Isle of Wight. *Bulletin of the British Museum (Natural History) Geology* 25: 1-152.
- Galton, P. 1981. *Dryosaurus*, a hypsilophodontid dinosaur from the Upper Jurassic of North America and Africa, postcranial skeleton. *Paläontologische Zeitschrift* 55: 271-312.
- González Riga, B. and Casadío, S. 2000. Primer registro de Dinosauria (Ornithischia, Hadrosauridae) en la provincia de La Pampa (Argentina) y sus implicancias paleobiogeográficas. *Ameghiniana* 37: 341-351.
- Hugo, C.A. and Leanza, H.A. 2001. Hoja Geológica 3969-IV, General Roca, provincias del Neuquén y Río Negro. *Instituto de Geología y Recursos Naturales, SEGEMAR, Boletín* 308: 1-71.
- Leanza, H.A., Apesteguía, S., Novas, F. and de la Fuente, M.S. 2004. Cretaceous terrestrial beds from the Neuquén Basin (Argentina) and their tetrapod assemblages. *Cretaceous Research* 25: 61-87.
- Martínez, R. 1998. *Notohypsilophodon comodorensis*, un Hypsilophodontidae (Ornithischia: Ornithopoda) del Cretácico Superior de Chubut, Patagonia Central, Argentina. *Acta Geológica Leopoldensia* 21: 119-135.
- Norman, D.B. and Weishampel, D.B. 1990. Iguanodontidae and related Ornithopoda. In: D.B. Weishampel, P. Dodson and H. Osmolska (eds.), *The Dinosauria*, University of California Press, Berkeley, pp. 510-533.
- Novas, F.E., Cambiaso, A.V. and Ambrosio, A. 2004. A new basal iguanodontian (Dinosauria, Ornithischia) from the Upper Cretaceous of Patagonia. *Ameghiniana* 41: 75-82.
- Powell, J.E. 1987. Hallazgo de un dinosaurio hadrosáurido (Ornithischia, Ornithopoda) en la Formación Allen (Cretácico Superior) de Salitral Moreno, Provincia de Río Negro, Argentina. 10° Congreso Geológico Argentino (Tucumán), *Actas* 3: 149-152.
- Ramos, V. 1981. Descripción Geológica de la Hoja 33c, Los Chihuidos Norte, Provincia del Neuquén. *Servicio Geológico Nacional, Boletín* 182: 1-103.

Recibido: 16 de junio de 2005.

Aceptado: 8 de junio de 2006.