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Did oviraptorosaurs (Dinosauria; Theropoda) inhabit Argentina?

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Abstract

In this contribution a putative oviraptorosaurian cervical vertebra discovered in the Campanian-Maastrichtian El Brete Formation from Salta Province, NW Argentina is analysed. Based on the resemblances of this vertebra with those of the basal neoceratosaurian *Elaphrosaurus* and with the noasaurid *Noasaurus*, the Salta specimen is interpreted to belong to the third or fourth cervical vertebra of a Noasauridae (eventually *Noasaurus*). Furthermore, it is suggested that the supposed anterior cervical vertebrae of *Masiakasaurus*, *Laevisuchus* and *Noasaurus* possibly correspond to a more posterior position than previously considered. Contrary to abelisaurids, the morphology of the anterior cervical vertebrae of noasaurids indicates that they probably were long neck theropods resembling ornithomimid coelurosaurs. Therefore, the occurrence of oviraptorosaurs in Argentina is rejected.

Keywords: Theropod; Abelisauroid; Noasaurid; Argentina

1. Introduction

Theropod records from Cretaceous rocks of Gondwana are dominated by medium sized abelisaurid ceratosaurs (e.g., Bonaparte et al., 1990; Bonaparte, 1991a, 1996; Novas, 1997a; Sampson et al., 1998; Coria et al., 2002; Kellner and Campos, 2002) and gigantic carcharodontosaurid and spinosaur tetanurans (e.g., Coria and Salgado, 1995; Sereno et al., 1996; Coria and Currie, 2006). Coelurosaurian remains are relatively sparse, recently new insights provided a better understanding concerning the compositional theropod faunas in Gondwana (e.g., Novas, 1997b; Novas and Puerta, 1997; Kellner, 1999; Makovicky et al., 2005; Novas and Pol, 2005).

Among coelurosaurians, oviraptorosaurs are small theropods with a highly specialized skull, grouped in two families (Oviraptoridae and Caenagnathidae), and a series of basal lineages (e.g. *Incisivosaurus, Caudipteryx*; Osmólska et al., 2004), being relatively well known in Cretaceous outcrops of North America, Mongolia, and China (e.g., Barsbold et al., 1990; Norell et al., 2001; Dong and Currie, 1996; Clark et al., 2001; Xu et al., 2002).

Additionally, oviraptorosaur remains have also been recognized in at least three different localities from Gondwana. The first mention was made by Frey and Martill (1995) based on an incomplete sacrum from the Aptian Santana Formation in the Araripe Basin (Brazil). Later on, an isolated cervical vertebra from the Maastrichtian Lecho Formation in northwestern Argentina was interpreted as belonging to an indeterminated oviraptorosaur (Frankfurt and Chiappe, 1999). Outside South America, oviraptorosaur remains were also recognized in Lower Cretaceous rocks of Victoria, Australia (Dinosaur Cove East Locality; Rich and Rich, 1989) based on a possible incomplete right surangular and a small dorsal vertebra (Currie et al., 1996). Kellner (1999), and Makovicky and Sues (1998) cast doubt on the interpretations made of Brazilian

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and Australian specimens because the fragmentary condition of the specimens, the lack of synapomorphies, and the presence of unambiguous trait are recorded in several theropod families. The aim of this contribution is to review and discuss the affinities of the isolated vertebra (MACN-PV 622; Fig. 1) from the Lecho Formation (Maastrichtian) (Salta Province, northwestern Argentina) previously described by Frankfurt and Chiappe (1999).

Institutional Abbreviations

MACN-PV: Vertebrate Palaeontological Collection (CH, Chubut Collection; N, Neuquén Collection) of the Museo Argentino de Ciencias Naturales ''Bernardino Rivadavia'', Buenos Aires Province, Argentina; MUC-PV: Palaeontological Collection of the Museo de Ciencias Naturales de la Universidad Nacional del Comahue, Neuquén Province, Argentina; PVL: Palaeontological Collection of the Instituto Miguel Lillo, Tucumán Province, Argentina.

2. Systematic palaeontology

Suborder: Theropoda Marsh (1881)
Infraorder: Ceratosauria Marsh (1884)
Superfamily: Abelisauroidea Bonaparte (1991a)
Family: Noasauridae Bonaparte and Powell (1980)

Gen et sp. indet.

Referred specimen. MACN-PV 622: almost complete isolated cervical vertebra.

Locality and horizon. Estancia El Brete, Salta Province, northwestern Argentina. Lecho Formation, Salta Group, Upper Cretaceous, Maastrichtian (Bonaparte et al., 1977; Bonaparte and Powell, 1980; Chiappe, 1993; Frankfurt and Chiappe, 1999).

3. Description

The vertebra is nearly complete, lacking only the postzygapophyseal and epipophyseal regions. The centrum is as high as broad and about five times long than high. The neural arch is lower than the centrum and is cranially broad. The neural spine is not preserved, but it seems to be reduced as in abelisauroids (e.g., *Ligabueino andesi*; Bonaparte, 1996; Fig. 2C), oviraptorids (e.g., *Microvenator*; Makovicky and Sues, 1998) and many tetanurans (e.g., ornithomimosaurs; Barsbold and Osmólska, 1990). Additionally, the neural spine was probably located in the anterior half of the neural arch instead of being in the middle as in oviroptorosaurs (Makovicky and Sues, 1998). The centrum is low, narrow, and elongate bearing a ventral longitudinal groove as is also present in *Elaphrosaurus*

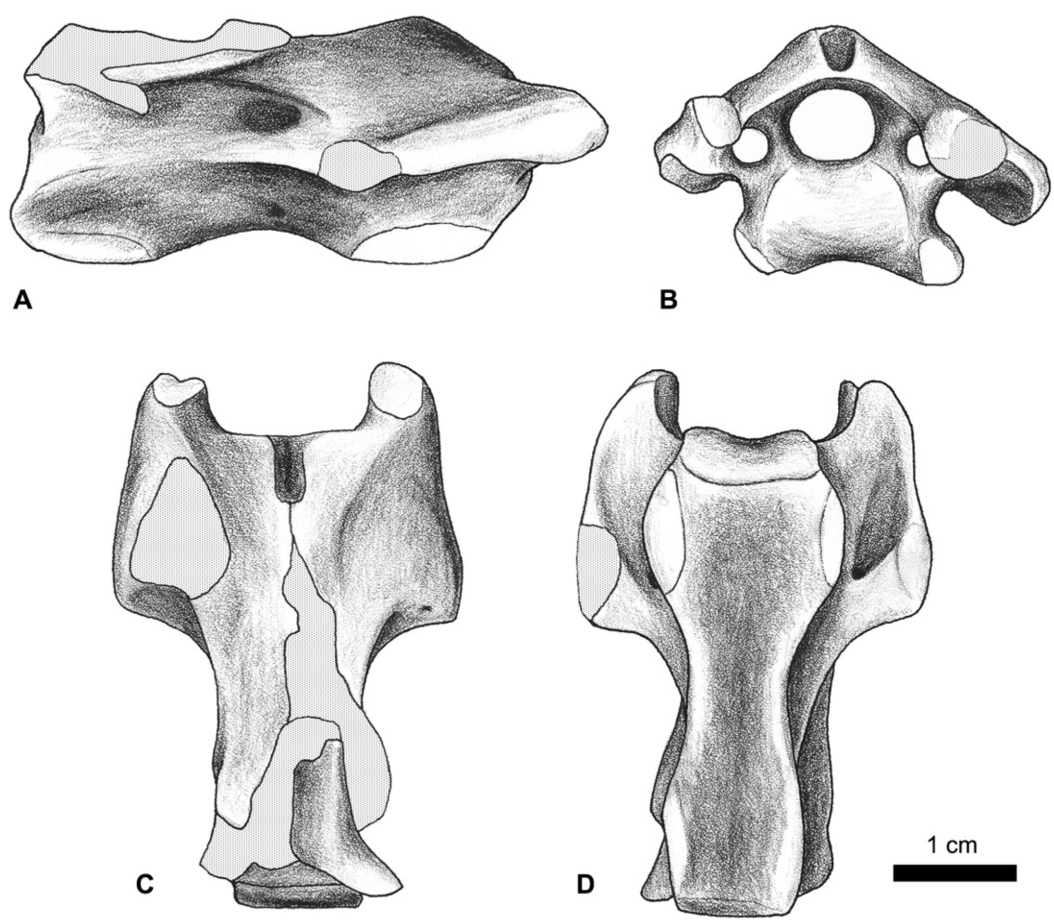

Fig. 1. MACN-PV 622. Anterior cervical vertebra of a possible Noasauridae in lateral (A), anterior (B), dorsal (C), and ventral (D) views.

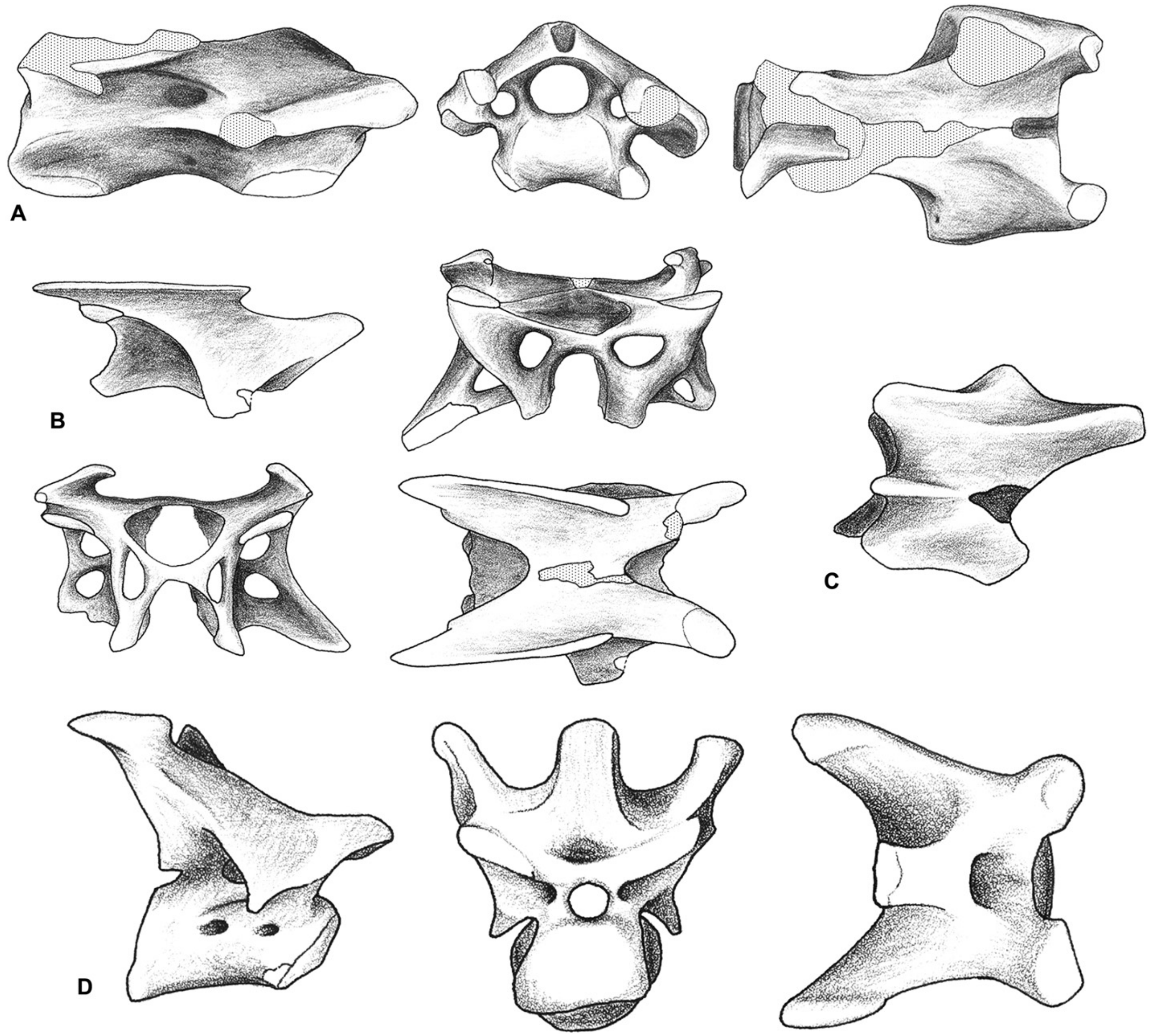

Fig. 2. Comparison of cervical vertebrae among: A, Salta specimen in lateral, anterior, and dorsal views; B, *Noasaurus leali* (after Bonaparte and Powell (1980)) in lateral (left above), anterior (right above), posterior (left below), and dorsal (right below) views; C, *Ligabueino andesi* (after Bonaparte (1996)) in dorsal view; and D, *Carnotaurus sastrei* (after Bonaparte et al. (1990)) in lateral, anterior, and dorsal views. Not to scale.

(Janensch, 1920), oviraptorosaurs (e.g., Sues, 1997; Makovicky, 1997), and therizinosaurids (Britt, 1993). Both cranial and caudal articular surfaces are subquadrangular; and the centrum is slightly ophistocoelous (contra Frankfurt and Chiappe, 1999 – they interpreted it as platycoelous) with the anterior surface, although eroded slightly, convex dorsoventrally and the posterior articular surface clearly concave. The prezygapophyses are small, stout and their articular facets are oval. In dorsal view, the space between the prezygapophyses is U-shaped as occurs in *Elaphrosaurus* (Janensch, 1920), *Ligabueino* (Bonaparte, 1996; Fig. 2C), *Carnotaurus* (Bonaparte et al., 1990; Fig. 2D), oviraptorosaurs (Frankfurt and Chiappe, 1999; Holtz, 1998), and in a lesser degree, in the basal ceratosaur *Spinostropheus* (Sereno et al., 2004). The diapophyses are well developed and are highly extended laterally as in *Elaphrosaurus, Spinostropheus* and oviraptorosaurs. The diapophyses are connected with the prezygapophyses by a strong ridge. The epipophyses (contra Frankfurt and Chiappe, 1999, p.102) are not preserved, but there is a shallow ridge that runs from the base of the epipophyses to the base of the diapophyses. In anterior view, there are two peduncular foramina on the neural arch, located below the level of the prezigapophyses similar to abelisauroids (e.g., Bonaparte et al., 1990; Coria and Salgado, 1998). Another pair of pleurocoels is present caudodorsally to the diapophyses as is diagnostic of Ceratosauria (Rowe et al., 1997). A third pair of pneumatic foramina, smaller than the latter, is placed at the base of the diapophyses, facing ventrocranially. There is also a well developed prespinal depression (i.e. notch) as also occurs in neoceratosaurs (i.e., *Ceratosaurus* and abelisauroids; Bonaparte et al., 1990; Novas, 1992).

4. Comparisons

MACN-PV 622 was compared to the following taxa: Ceratosaurs: *Elaphrosaurus bambergi* from the Tithonian Tendaguru Formation of Tanzania (Janensch, 1920); *Noasaurus leali* from the Maastrichtian Lecho Formation of Salta (Argentina) (PVL 4061; Bonaparte and Powell, 1980; Fig. 2B); *Ligabueino andesi* from the Neocomian La Amarga Formation of Argentina of Neuquén (Argentina) (MACN-PV-N 42; Bonaparte, 1996; Fig. 2C); *Carnotaurus sastrei* from the Maastrichtian La Colonia Formation of Chubut (Argentina) (MACN-PV-CH 894; Bonaparte et al., 1990; Fig. 2D); *Ilokelesia aguadagrandensis* from the Albian-Cenomanian Huincul Formation of Neuquén (Argentina) (Coria and Salgado, 1998); *Laevisuchus indicus* from the Maastrichtian Lameta Formation of India (Novas et al., 2004); and *Masiakasaurus knopfleri* from the Maastrichtian Maevarano Formation of Madagascar (Sampson et al., 2001; Carrano et al., 2002). Coelurosaurs: *Alvarezsaurus calvoi* from the Coniacian Bajo La Carpa Formation of Neuquén (MUC-PV 54; Bonaparte, 1991b; Novas, 1996); *Mononykus olecranus* from the Maastrichtian Nemegt Formation of Mongolia (e.g., Perle et al., 1994); *Chirostenotes pergracilis* from the Campanian Dinosaur Park and Campanian-Maastrichtian Horseshoe Canyon formations of Alberta (Canada) (Sues, 1997); and *Microvenator celer* from the Cloverly Formation of Montana (Makovicky and Sues, 1998).

Elaphrosaurus was traditionally considered as an ornithomimosaur (Barsbold et al., 1990) but recent phylogenetic analyses nested this taxon inside the neoceratosaur clade (e.g., Holtz, 1998; Carrano et al., 2002; Wilson et al., 2003) or even within abelisauroids (Holtz, 1994; Bonaparte, 1996).

4.1. Abelisauroidea (Ceratosauria)

Specimen MACN-PV 622 shares with Ceratosauria the presence of a double pair of pleurocoels (Rowe et al., 1997; convergently acquired by oviraptorosaurs). It could be assigned to Neoceratosauria on the basis of the following features: neural spine of cervical vertebrae reduced anteroposteriorly (despite the lack of neural spine in this specimen, the surrounding area indicates that it was very reduced) (Novas, 1992), and zygapophyses displaced laterally (Makovicky, 1997).

Also MACN-PV 622 shares with Abelisauroidea the cervical centrum in anterior view more than 20% broader than tall (Holtz, 1998), the dorsal surface of the neural arches clearly delimited from lateral surface of the diapophyses (Bonaparte, 1991a; Coria and Salgado, 1998), and the presence of a deep prespinal depression (Novas, 1992).

Moreover, MACN-PV 622 shares with *Elaphrosaurus* (Holtz, 1998, 1994) and *Masiakasaurus* (Sampson et al., 2001; Carrano et al., 2002) the lack of a lateral depression on cervical centrum, wide vertebral canal, prezygapophyses not directed dorsally and the U-shaped space between the prezygapophyses.

Finally MACN-PV 622 resembles Noasauridae in the low and craniocaudally elongated neural arch (Coria and Salgado, 1998). Additionally, a thin and low ridge connecting the postzygapophyseal area with the diapophysis is also present and better developed in *Noasaurus leali* (Bonaparte and Powell, 1980).

Noasaurus and MACN-PV 622 differ from Abelisauridae because they lack several diagnostic characters of this group, such as the presence of T-shaped epipophyses and triangular diapophyses in lateral view, strongly opistocoelic centrum, and dorsally directed epipophyses, well beyond the top of the neural spine (e.g., Bonaparte et al., 1990; Coria et al., 2002).

4.2. Oviraptorosauria (coelurosauria)

MACN-PV 622 was nested together with oviraptorosaurs because having a peduncular foramina, a U-shaped space between both prezygapophyses, and the ventral surface of the centrum antero-posteriorly grooved with lateral ridges (Frankfurt and Chiappe, 1999). Specimen MACN-PV 622 differs from oviraptorosaurs in having no lateral depression on cervical centrum, wider neural canal and articular surfaces of the centrum, prezygapophyses not directed dorsally and diapophysis almost at the same level that the prezygapophyses, wider U-shaped space between the prezygapophyses, and possibly the neural spine located in the anterior half of the neural arch, all these features are also reminiscent of noasaurid abelisauroids.

5. Discussion and conclusions

Frankfurt and Chiappe (1999) nested MACN-PV 622 together with oviraptorids, *Chirostenotes*, therizinosaurids and an unnamed coelurosaur from the Morrison Formation based on a cladistic analysis of ten cervical characters among nineteen theropod taxa. The clade formed by these five taxa shared the presence of peduncular foramina (Character 1) and of a ventral sulcus flanked by ventrolaterally directed ridges (Character 8) (Frankfurt and Chiappe, 1999). Character 1 is also reported in abelisauroids such as *Carnotaurus sastrei* (Bonaparte et al., 1990), the basal *Ilokelesia aguadagrandensis* (Coria and Salgado, 1998), the noasaurids *Noasaurus leali* (Fig. 2) and *Laevisuchus indicus* (Novas et al., 2004), while their feature 8 is unknown in noasaurids (i.e., *Noasaurus leali* and *Ligabueino andesi*; Bonaparte and Powell, 1980; Bonaparte, 1996), but is present in the neoceratosaurs *Elaphrosaurus* and *Spinostropheus*. In that analysis, therizinosaurids, *Chirostenotes*, oviraptorids and the specimen MACN-PV 622 shared the presence of a U-shaped space between prezygapophyses in dorsal view (Character 10) (Frankfurt and Chiappe, 1999). In this regard, this character state is present in some abelisauroids (e.g., *Carnotausus sastrei*, *Noasaurus leali, Elaphrosaurus bambergi*; Bonaparte et al., 1990; Bonaparte and Powell, 1980). Finally, the clade integrated by *Chirostenotes*, Oviraptoridae, and specimen MACN-PV 622 shared the presence of the caudal border of the diapophyses projected laterally at the midpoint, nearly forming a right angle with the centrum in dorsal view (Character 9) (Frankfurt and Chiappe, 1999). This feature is also observed in abelisauroids (e.g., *Carnotaurus*, *Noasaurus*, *Elaphrosaurus, Masiakasaurus,* among others) and *Spinostropheus* (Sereno et al., 2004).

As seen in the fossil record, the features considered to include MACN-PV 622 within Oviraptorosauria are widely documented in several theropod species reflecting that these do not necessarily implicate a direct phylogenetic relationship. Therefore, our assignment of MACN-PV 622 to the noasaurid family indicates the presence of several convergences acquired in abelisauroids and oviraptorosaurians.

Based on the resemblances with *Elaphrosaurus*, specimen MACN-PV 622 probably belongs to the third or fourth cervical vertebra (was suggested as fourth or fifth by Frankfurt and Chiappe, 1999), whereas the neural arch of *Noasaurus leali*, described by Bonaparte and Powell (1980) may be the seventh or the eighth, because as in *Elaphrosaurus* it shows in lateral view a dorsal, nearly straight plane made by the spike-like pronounced epipophyses.

There is a great morphological difference between the anterior cervical vertebrae of *Elaphrosaurus* and MACN-PV 622 and those of the noasaurid *Masiakasaurus* (Carrano et al., 2002). Comparing the vertebra described as anterior cervical by Carrano et al. (2002) with those of *Elaphrosaurus*, a striking similarity is noted with the last cervical of *Elaphrosaurus*, such as general proportions, placement of neural spine and zygapophyses and the deep excavation anterior to the postzygapophyses. Also the resemblance is noted on the proportions of the centrum. So the cervical vertebrae of *Elaphrosaurus*, if we follow this interpretation, are very similar to those of typical noasaurids, and the supposed anterior vertebrae of *Masiakasaurus*, *Laevisuchus* and *Noasaurus* are probably placed in a more posterior position than previously suggested (Carrano et al., 2002).

The elongated anterior cervical vertebra of MACN-PV 622, and both *Noasaurus* (Bonaparte and Powell, 1980) and *Elaphrosaurus* (Janensch, 1920), plus the several convergences with oviraptorosaur vertebrae (e.g., U-shaped space between the prezygapophyses) suggest that probably some noasaurids were long necked theropods resembling the ornithomimid coelurosaurs (*Elaphrosaurus* was originally compared with ornithomimosaurs by Barsbold and Osmólska, 1990), in contrast with *Ceratosaurus* and specially Abelisauridae which were short and robust necked theropods (Novas, 1992; Bonaparte et al., 1990).

Because the MACN-PV 622 was found associated with the holotype of *Noasaurus leali* (Frankfurt and Chiappe, 1999), and the material resembles both in morphology (e.g., the similar position of peduncular foramina) and size we suggest that MACN-PV 622 belongs to an anteriormost cervical vertebra of *Noasaurus leali* (Bonaparte and Powell, 1980).

In our view, MACN-PV 622 shares many features with abelisauroids, and specially noasaurid instead of oviraptorosaur affinities. Thus, until there are any new findings, we reject the occurrence of oviraptorosaurs in Argentina and South America (Kellner, 1999; Makovicky and Sues, 1998).

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References

Barsbold, R., Maryanska, T., Osmólska, H., 1990. Oviraptorosauria. In: Weishampel, D.B., Dobson, P., Osmólska, H. (Eds.), The Dinosauria. University of California Press, Berkeley and Los Angeles, pp. 249–258.

Barsbold, R., Osmólska, H., 1990. Ornithomimosauria. In: Weishampel, D.B., Dobson, P., Osmólska, H. (Eds.), The Dinosauria. University of California Press, Berkeley and Los Angeles, pp. 225–244.

Bonaparte, J.F., 1991a. The gondwanan theropod families Abelisauridae and Noasauridae. Historical Biology 5, 1–25.

Bonaparte, J.F., 1991b. Los vertebrados fósiles de la Formación Río Colorado, de la Ciudad de Neuquén y cercanías, Cretácico Superior, Argentina. Revista del Museo Argentino de Ciencias Naturales 4, 17–123.

Bonaparte, J.F., 1996. Cretaceous tetrapods of Argentina. In: Arratia, G. (Ed.), Contribution of Southern South America to Vertebrate Paleontology, Münchner Geowissenschaftliche Abhandlungen (A) 30, pp. 73–130.

Bonaparte, J.F., Powell, J.E., 1980. A continental assemblage of tetrapods from the Upper Cretaceous beds of El Brete, northwestern Argentina (Sauropoda, Coelurosauria, Carnosauria, Carnosauria, Aves). Mémoires Societe Geologie France 139, 19–28.

Bonaparte, J.F., Novas, F.E., Coria, R.A., 1990. *Carnotaurus sastrei* Bonaparte, the horned, lightly built carnosaur from the Middle Cretaceous of Patagonia. Contribution in Science, Natural History Museum Los Angeles Country 416, 1–42.

Bonaparte, J.F., Salfitty, J.A., Bossi, G., Powell, J.E., 1977. Hallazgos de dinosaurios y aves cretácicas en la Formación Lecho de El Brete (Salta), próximo al límite con Tucumán. Acta Geológica Lilloana 14, 19–28.

Britt, B.B., 1993. Pneumatic postcranial bones in dinosaurs and other archosaurs. Unpublished Ph.D. Thesis, University of Calgary, 375 pp.

Carrano, M.T., Sampson, S.D., Forster, C.A., 2002. The osteology of *Masiakasaurus knopfleri*, a small abelisauroid (Dinosauria: Theropoda) from the Late Cretaceous of Madagascar. Journal of Vertebrate Paleontology 22, 510–534.

Chiappe, L.M., 1993. Enantiornithine (Aves) Tarsometatarsi from the Cretaceous Lecho Formation of Northwestern Argentina. American Museum Novitates 3083, 1–27.

Clark, J.M., Norell, M., Barsbold, R., 2001. Two new oviraptorids (Theropoda: Oviraptorosauria) Late Cretaceous Djadoktha Formation, Ukhaa Tolgod, Mongolia. Journal of Vertebrate Paleontology 21, 209–213.

Coria, R.A., Currie, P.J., 2006. A new carcharodontosaurid (Dinosauria, Theropoda) from the Upper Cretaceous of Argentina. Geodiversitas 28, 71–118.

Coria, R.A., Salgado, L., 1995. A new giant carnivorous dinosaur from the Cretaceous of Patagonia. Nature 377, 224–226.

Coria, R.A., Salgado, L., 1998. A basal Abelisauria Novas, 1992 (Theropoda-Ceratosauria) from the Cretaceous of Patagonia, Argentina. Gaia 15, 89–102.

Coria, R.A., Chiappe, L., Dingus, L., 2002. A new close relative of *Carnotaurus sastrei* Bonaparte 1985 (Theropoda: Abelisauridae) from the Late Cretaceous of Patagonia. Journal of Vertebrate Paleontology 22, 460–465.

Currie, P.J., Vickers-Rich, P., Rich, T.H., 1996. Possible oviraptorosaur (Theropoda, Dinosauria) specimens from the Early Cretaceous Otway Group of Dinosaur Cove, Australia. Alcheringa 20, 73–79.

Dong, Z.-M., Currie, P.J., 1996. On the discovery of an oviraptorid skeleton on a nest of eggs at Bayan Mandahu, Inner Mongolia, People's Republic of China. Canadian Journal of Earth Sciences 33, 631–636.

Frankfurt, N.G., Chiappe, L.M., 1999. A possible oviraptorosaur from the Late Cretaceous of Northwestern Argentina. Journal of Vertebrate Paleontology 19, 101–105.

Frey, E., Martill, D.M., 1995. A possible oviraptorosaurid theropod from the Santana Formation (Lower Cretaceous, ?Albian). Neus Jarbuch für Geologie und Paläontologie Abhandlungen 7, 397–412.

Holtz Jr., T.R., 1994. The phylogenethic position of the Tyrannosauridae: implication for theropod systematics. Journal of Paleontology 68, 1100–1117.

Holtz Jr., T.R., 1998. A new phylogeny of the carnivorous dinosaurs. Gaia 15, 5–61.

Janensch, W., 1920. Über *Elaphrosaurus bambergi* und die Megalosaurier aus den Tendaguru-Schichten Deutsch-Ostafrikas. Sitzungsberichte Gesellschaft Naturforschender Freunde zu Berlin 1920, 225–235.

Kellner, A.W.A., 1999. Short note on a new dinosaur (Theropoda, Coelurosauria) from the Santana Formation (Romualdo Member, Albian), northeastern Brazil. Boletim do Museu Nacional Rio de Janeiro 49, 1–8.

Kellner, A.W.A., Campos, D.de A., 2002. On a theropod dinosaur (Abelisauria) from the continental Cretaceous of Brazil. Arquivos do Museu Nacional Rio de Janeiro 60, 163–170.

Makovicky, P.J., 1997. A new small theropod from the Morrison Formation of Como Bluff, Wyoming. Journal of Vertebrate Paleontology 17, 755–757.

Makovicky, P.J., Sues, H.-D., 1998. Anatomy and phylogenetic relationships of the theropod dinosaur *Microvenator celer* from the Lower Cretaceous of Montana. American Museum Novitates 3240, 1–27.

Makovicky, P.J., Apesteguía, S., Agnolin, F.L., 2005. The earliest dromaeosaurid theropod from South America. Nature 437, 1007–1011.

Marsh, O.C., 1881. Principal characters of American Jurassic dinosaurs. Part V. American Journal of Science ser. 3 (21), 417–423.

Marsh, O.C., 1884. Principal character of American Jurassic dinosaurs. Pt. VIII. The order Theropoda. American Journal of Science ser. 3 (27), 329–340.

Norell, M.A., Clark, J.M., Chiappe, L.M., 2001. An embryo of an oviraptorid (Dinosauria: Theropoda) from the Late Cretaceous of Ukhaa Tolgod, Mongolia. American Museum Novitates 3315, 1–17.

Novas, F.E., 1996. Alvarezsauridae, Cretaceous basal birds from Patagonia and Mongolia. Memoirs of the Queensland Museum 39, 675–702.

Novas, F.E., 1997a. Abelisauridae. In: Currie, P., Padian (Eds.), Encyclopedia of Dinosaurs. Academic Press, San Diego, pp. 1–2.

Novas, F.E., 1997b. Anatomy of *Patagonykus puertai* (Theropoda, Avialae, Alvarezsauridae). Journal of Vertebrate Paleontology 17, 137–166.

Novas, F.E., 1992. La evolución de los dinosaurios carnívoros. In: Sanz, J.L., Buscalioni, A. (Eds.), Los dinosaurios y su entorno biótico. Actas II Curso de Paleontología en Cuenca. Instituto ''Juan de Valdés'', Ayuntamiento de Cuenca, España, pp. 125–163.

Novas, F.E., Pol, D., 2005. New evidence on deinonychosaurian dinosaurs from the Late Cretaceous of Patagonia. Nature 3285, 858–861.

Novas, F.E., Puerta, P.F., 1997. New evidence concerning avian origins from the Late Cretaceous of Patagonia. Nature 387, 390–392.

Novas, F.E., Agnolin, F.L., Bandyopadhyay, S., 2004. Cretaceous theropods from India: a review of specimens described by Huene and Matley (1933). Revista del Museo Argentino Ciencias Naturales ''Bernadino Rivadavia'' 6, 67–103.

Osmólska, H., Currie, P.J., Barsbold, R., 2004. Oviraptorosauria. In: Weishampel, D.B., Dodson, P., Osmólska, H. (Eds.), The Dinosauria, second ed. University of California Press, Berkeley, pp. 165–183.

Perle, A., Chiappe, L.M., Rinchen, B., Clark, J.M., Norell, M.A., 1994. Skeletal morphology of *Mononykus olecranus* (Theropoda: Avialae) from the Late Cretaceous of Mongolia. American Museum Novitates 3105, 1–29.

Rich, T.H., Rich, P.V., 1989. Polar dinosaurs and biotas of the Early Cretaceous of southern Australia. National Geographic Research 5, 15–53.

Rowe, T., Tykoski, R., Hutchinson, J., 1997. Ceratosauria. In: Currie, P., Padian, K. (Eds.), Encyclopedia of Dinosaurs. Academic Press, San Diego, pp. 106–110.

Sampson, S.D., Witmer, L.A., Forster, C.A., Krause, D., O'Connor, P., Dodson, P., et al., 1998. Predatory dinosaur remains from Madagascar: implications for the Cretaceous biogeography of Gondwana. Science 280, 1048–1051.

Sampson, S.D., Carrano, M.T., Forster, C.A., 2001. A bizarre new predatory dinosaur from Madagascar. Nature 409, 504–506.

Sereno, P.C., Dutheil, D., Iarochene, M., Larsson, H., Lyon, G., Magwene, P., et al., 1996. Predatory dinosaurs from the Sahara and Late Cretaceous faunal differentiation. Science 272, 986–991.

Sereno, P.C., Wilson, J.A., Conrad, J.L., 2004. New dinosaurs link southern landmasses in the Mid-Cretaceous. Proceedings of the Royal Society of London B, FirstCite online publication. www.journal.royalsoc.ac.uk.

Sues, H.-D., 1997. On *Chirostenotes*, a Late Cretaceous oviraptorosaur (Dinosauria: Theropoda) from the western North America. Journal of Vertebrate Paleontology 17, 698–716.

Wilson, J.A., Sereno, P., Srivastava, S., Bhatt, D.K., Khosla, A., Sahni, A., 2003. A new abelisaurid (Dinosauria, Theropoda) from the Lameta Formation (Cretaceous, Maastrichtian) of India. Contributions from the Museum of Paleontology, University of Michigan 31, 1–42.

Xu, X., Cheng, Y.-N., Wang, X.-L., Chang, C.-H., 2002. An unusual oviraptorosaurian dinosaur from China. Nature 419, 291–293.