

First report of a derived abelisaurid theropod from the Bajo de la Carpa Formation (Late Cretaceous), Patagonia, Argentina

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An isolated anterior caudal vertebra of a medium-large sized theropod dinosaur is reported here. It comes from the Bajo de la Carpa Formation (Santonian, Late Cretaceous), Río Colorado Subgroup, Río Negro Province, northern Patagonia, Argentina. The specimen, MACN-PV-RN 1012, exhibits several derived characters that are diagnostic among theropods. Specifically, MACN-PV-RN 1012 is referable to Abelisauroida because it possesses a centrodiaepophyseal lamina on the ventral surface of the transverse processes, and to Abelisauridae due to the presence of transverse processes that are 1.4 times longer than the anteroposterior length of the centrum, a large median depression anterior to the base of the neural spine, and the lack of a prespinal fossa. MACN-PV-RN 1012 is included within Carnotaurinae, sharing with *Carnotaurus* and *Aucasaurus* transverse processes that are oriented dorsolaterally at an angle of 45° or more with regard to the horizontal axis of the vertebra. Thus, the specimen described here constitutes the first record of a derived abelisaurid from the Bajo de la Carpa Formation. • Key words: Theropoda, Abelisauroida, Bajo de la Carpa Formation, Río Colorado Subgroup, Late Cretaceous, Argentina.

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Abelisauroid theropods were one of the dominant groups of Gondwanan predatory dinosaurs during the Cretaceous. Abelisauroids are scarcely known from Jurassic and Early Cretaceous outcrops (Accarie *et al.* 1995, Allain *et al.* 2007, Bonaparte 1996, Rauhut 2005, Rauhut *et al.* 2003, Sereno & Brusatte 2008); conversely they are well documented in the Late Cretaceous of Europe, South America, Africa, Madagascar and India (*e.g.*, Bonaparte 1991, Allain & Pereda-Suberbiola 2003, Sereno *et al.* 2004, Novas *et al.* 2004, Carrano & Sampson 2008). In Patagonia remains of several abelisauroids have been exhumed in the last three decades, substantially increasing our knowledge of the clade (Bonaparte 1985; 1991a, b; 1996; Bonaparte & Novas 1985; Bonaparte *et al.* 1990; Calvo *et al.* 2004; Canale *et al.* 2008; Coria 2001; Coria & Salgado 2000; Coria *et al.* 2002, 2006; Juárez Valieri *et al.* 2007; Lamanna *et al.* 2002; Martínez *et al.* 1986, 2004).

Among the Late Cretaceous dinosaur bearing beds of Patagonia, one of the more prolific is the Bajo de la Carpa Formation, cropping out in the Río Negro and Neuquén Provinces of northwestern Patagonia (Bonaparte 1991b, Martinelli & Vera 2007, Porfiri *et al.* 2008). Among the diverse tetrapod fauna of this sedimentary unit, which includes abundant notosuchian mesoeucrocodylians and snakes (Woodward 1896, 1901; Martinelli 2003; Pol 2005; Martinelli & Pais 2008), five different small-sized theropod taxa have been described: the abelisauroid *Velocisaurus unicus* (Bonaparte 1991b), the alvarezsaurids *Alvarezsaurus calvoi* (Bonaparte 1991b) and *Achillesaurus manazzonei* (Martinelli & Vera 2007), the enantiornithean *Neuquenornis volans* (Chiappe & Calvo 1994), and the basal ornithuromorph *Patagopteryx deferrariisi* (Alvarenga & Bonaparte 1992). Nevertheless, it was not until recently that a medium-sized tetanuran theropod was reported from the Bajo de la Carpa Formation, in beds corresponding to the

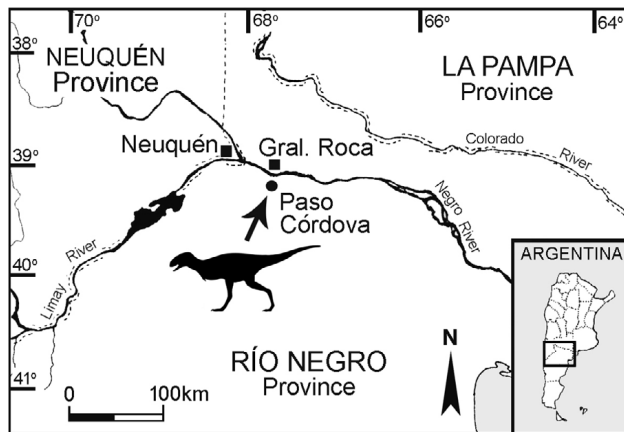


Figure 1. Map showing the Paso Córdoba locality, Río Negro Province (Bajo de la Carpa Formation), northern Patagonia, Argentina that yielded the specimen MACN-PV-RN 1012. Modified from Martinelli & Vera 2007.

Neuquén Province (Porfiri *et al.* 2008). In the present contribution, we describe abelisaurid theropod remains from this prolific Cretaceous Patagonian outcrop. These remains constitute the first evidence of a medium to large-sized abelisaurid theropod from this assemblage.

Materials and methods

Institutional abbreviations. – MACN-PV – Museo Argentino de Ciencias Naturales “B. Rivadavia”, Paleontología de Vertebrados, Buenos Aires, Argentina (RN, colección Río Negro; CH, colección Chubut); MCF-PVPH – Museo Carmen Funes, Paleontología de Vertebrados de Plaza Huincul, Plaza Huincul, Argentina; MMCH-PV – Museo Municipal “Ernesto Bachmann”, Villa El Chocón, Neuquén, Argentina; MPEF-PV – Museo Paleontológico Egidio Feruglio, Paleontología de Vertebrados, Trelew, Argentina; MUCPv – Museo de la Universidad Nacional del Comahue, Paleontología de Vertebrados, Neuquén, Argentina; UCMP – University of California Museum of Paleontology, Berkeley, California, USA.

Systematic nomenclature. – We follow Rauhut (2003), Sereno *et al.* (2004) and Carrano & Sampson (2008) regarding the phylogenetic relationships of Ceratosauria and Abelisauroida within Theropoda; namely, that Coelophosoidea and Ceratosauria do not comprise a monophyletic group, and that the latter is more closely related to Tetanurae than is the former. Holtz’s (1994) cladistic definition of Abelisauroida is followed (*i.e.* the clade including all theropods closer to *Carnotaurus sastrei* than to *Ceratosaurus nasicornis*). Thus, following many previous cladistic analyses, *Elaphrosaurus* is considered here a basal abelisauroid (Rauhut 2003).

Systematic paleontology

Theropoda Marsh, 1881
 Neotheropoda Bakker, 1986
 Abelisauroida Bonaparte, 1991
 Abelisauridae Bonaparte & Novas, 1985
 Carnosaurinae Sereno, 1998

Genus et species indet.

Material. – MACN-PV-RN 1012, isolated anterior caudal vertebra.

Horizon and locality. – South bank of the Negro River, close to the city of General Roca, Paso Córdoba locality, Río Negro Province, northern Patagonia, Argentina. Bajo de la Carpa Formation, Río Colorado Subgroup, Neuquén Group [Santonian, Late Cretaceous (Bonaparte 1996, Hugo & Leanza 2001, Leanza *et al.* 2004)].

Description. – MACN-PV-RN 1012 consists of an isolated anterior caudal vertebra in a good state of preservation (Figs 2A–H, 3C). It lacks the distal half of the neural spine, the lateral end of the left transverse process, the prezygapophyses, and the anteroventral border of the centrum.

MACN-PV-RN 1012 does not correspond to the first caudal vertebra, because the transverse processes are not strongly posteriorly oriented and do not posteriorly surpass the posterior edge of the neural spine. Instead, the transversely laminar neural spine indicates that this vertebra could belong between the fourth and sixth positions in the caudal series.

On the left side, the centrum is fused to the neural arch without trace of suture, whereas a faint suture remains visible on the right side. This near-complete fusion of the neurocentral suture suggests that MACN-PV-RN 1012 does not correspond to a juvenile individual. The centrum is slightly constricted at mid-length (Fig. 2E). As observed in ventral view, the facets for articulation with the haemal arch are extended from the posterior end of the centrum towards its anteroposterior midline. The facets bound a shallow median depression.

The anterior and posterior articular facets of the centrum are circular in contour and concave, the anterior facet more deeply so (Fig. 2F, H). The shape of the articular facets closely resembles that of *Carnotaurus* (Bonaparte *et al.* 1990, MACN-PV-CH 894), *Aucasaurus* (Coria *et al.* 2002, MCF-PVPH 236) and *Ilokelesia* (Coria & Salgado 2000, MCF-PVPH 35), but contrasts with *Majungasaurus*, in which these facets are elliptical (O’Connor 2007). The anterior articular facet is most deeply concave ventrally. Both facets are bounded by thick buttresses, but only the posterior buttress is completely preserved. On the posterior articular facet, the buttress is better developed towards the

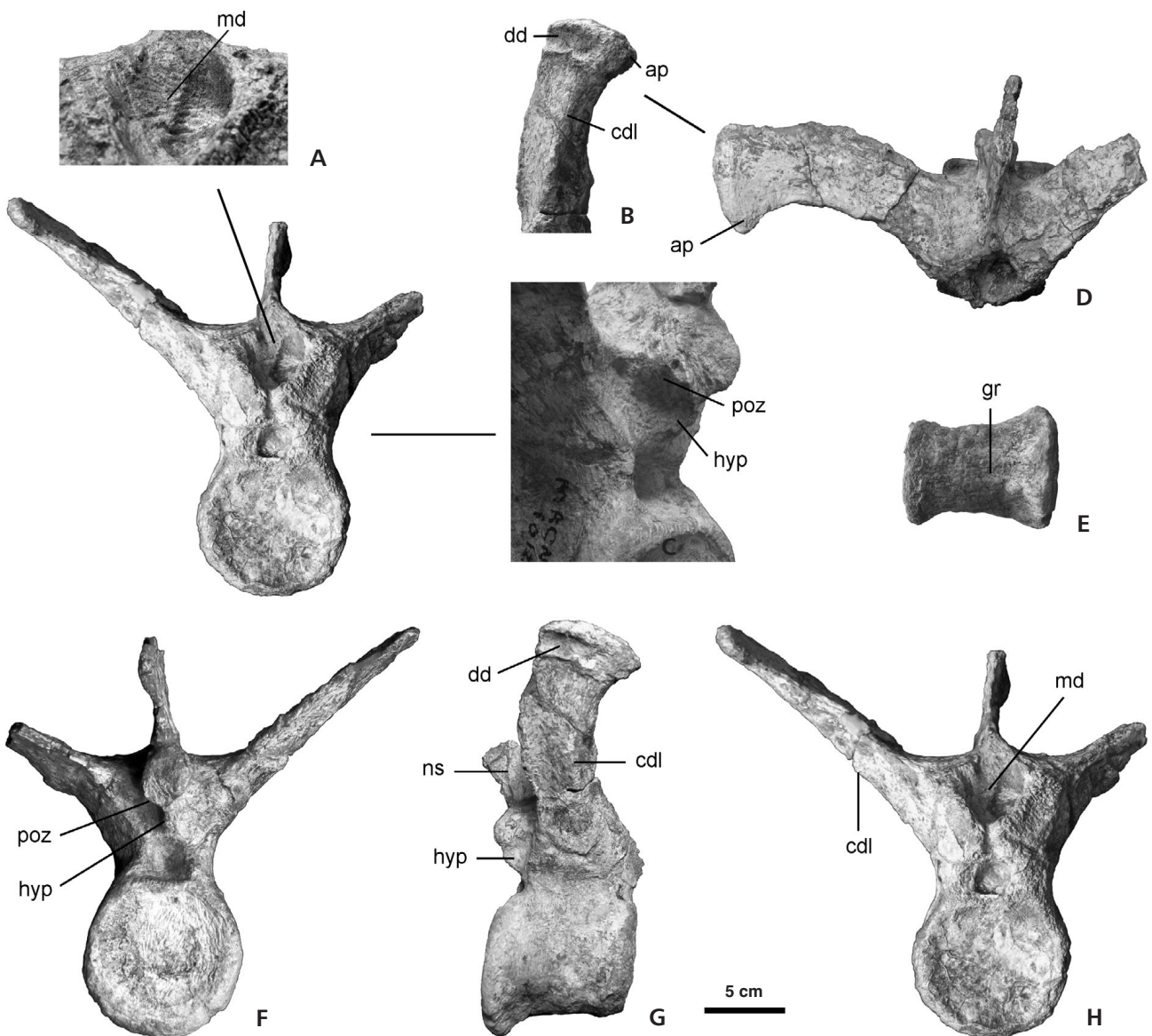


Figure 2. Detail of abelisauroid apomorphies recognized in the specimen MACN-PV-RN 1012: A – median depression in anterior view. • B – right transverse process in ventral view. • C – neural arch in posterolateral view. • D–H – MACN-PV-RN 1012 in dorsal (D), ventral (E), posterior (F), anterior (G), and right lateral views (H). • Abbreviations: ap. – anterior projection, cdl. – centrodiapophyseal lamina, dd. – distal depression, gr. – groove, hyp. – hyposphene, md. – median depression, ns. – neural spine, poz. – postzygapophysis.

ventral portion of the centrum. Although it lacks the ventral portion of the anterior buttress, the centrum is ventrally concave. The lateral surface of the centrum does not exhibit any kind of depression or foramen.

Only the bases of the prezygapophyses are preserved, with a shallow, median vertical groove between them. As in *Carnotaurus* and *Aucasaurus* (Rauhut *et al.* 2003), a very large and deep fossa is present posterior to the prezygapophyses, being posterodorsally bounded by the spinoprezygapophyseal laminae. As seen in posterior view, the postzygapophyses are ventrolaterally oriented and somewhat damaged. Ventral to the postzygapophyses, a well devel-

oped hyposphene is present (Fig. 2C, G), resembling the condition present in other basal theropods [*e.g.*, *Lophostropheus* (Ezcurra & Cuny 2007), *Dilophosaurus* (Welles 1984), UCMP 37302; *Ceratosaurus* (Madsen & Welles 2000), *Aucasaurus* (Coria *et al.* 2002), *Carnotaurus* (Bonaparte *et al.* 1990), MACN-PV-CH 894; *Condorraptor*, MPEF-PV 1682; *Monolophosaurus* (Currie & Zhao 1993)].

The right transverse process is nearly complete, lacking only parts of the anterior and posterior projections at its lateral extreme. Only the medial half of the left transverse process is preserved. In dorsal view, the transverse process shows a concave anterior border and a convex posterior

margin (Fig. 2D), which is gently anteriorly curved towards its lateral tip. The transverse process is postero-laterodorsally projected at an angle of about 50 degrees to the horizontal, resembling the condition in *Carnotaurus* (Bonaparte *et al.* 1990, MACN-PV-CH 894), *Aucasaurus* (Coria *et al.* 2002, MCF-PVPH 236) and *Masiakasaurus* (Carrano *et al.*, 2002), but contrasting with the lower angle present in *Majungasaurus* (approximately 20 degrees) (O'Connor 2007), *Ilokelesia* (Coria & Salgado 2000, MCF-PVPH 35), *Ekrixinosaurus* (Calvo *et al.* 2004, MUCPv 294) and *Skorpiovenator* (Canale *et al.* 2008). The dorsal surface of the transverse process is almost flat. As is the case in *Majungasaurus* (O'Connor 2007), *Ekrixinosaurus* (Calvo *et al.* 2004) and *Carnotaurus* (MACN-PV-CH 894), a thick lamina is present along the ventral surface of most of the transverse process. A shallow, wide concavity is present posterior to this ventral lamina. At the medial base of the transverse process, an elliptical fossa is present on the anterior surface, being ventrally bounded by the centrodiapophyseal lamina and a prominent ridge dorsally. The lateral tip of the transverse process exhibits a well-developed anterior projection. A conspicuous parasagittal ridge is present on the ventral surface of the lateral tip. This feature is also present in the abelisaurids *Ekrixinosaurus* (MUCPv 294), *Aucasaurus* (MCF-PVPH 236) and *Carnotaurus* (MACN-PV-CH 894). This ridge medially delimits a well-defined fossa that extends to the lateral end of the transverse process (Fig. 2B, G). The lateral margin of the process is rounded in dorsal view.

The neural spine is represented only by its ventral half, rendering it impossible to discern if the spine was “L”-shaped as in *Carnotaurus* (Bonaparte *et al.* 1990). As in other abelisaurids, the neural spine is posterodorsally oriented and transversely narrow, with a very sharp anterior margin that lacks a prespinal fossa. The neural spine extends anteroposteriorly along the posterior $\frac{3}{4}$ of the length of the centrum.

Discussion – Phylogenetic relationships of MACN-PV-RN 1012

Previous authors have recognized several apomorphies in the anterior caudal vertebrae of abelisauroids (Bonaparte 1991a, Bonaparte *et al.* 1990, Coria & Salgado 2000, Coria *et al.* 2002, Rauhut *et al.* 2003). MACN-PV-RN 1012 exhibits several of these characters. Derived features of Abelisauroidea and less inclusive clades recognized in the Bajo de la Carpa vertebra are discussed below.

Presence of centrodiapophyseal laminae in anterior and anterior-middle caudals (Rauhut *et al.* 2003). – Rauhut *et al.* (2003) regarded the presence of centrodiapophyseal laminae

in anterior caudals as an apomorphy shared by several members of Abelisauroidea (*e.g.*, *Carnotaurus*, *Aucasaurus*, and an abelisaurid theropod from the La Paloma Member of the Cerro Barcino Formation, hereafter referred to as the “La Paloma abelisaurid”). Rauhut *et al.* (2003) also stated that the condition in the abelisaurids *Ilokelesia* and *Abelisaurus* was uncertain. Nevertheless, the basal abelisaurids *Ekrixinosaurus* (Calvo *et al.* 2004) and *Majungasaurus* (O'Connor 2007) also presents centrodiapophyseal laminae on the ventral surface of the transverse processes. Since Rauhut *et al.* (2003) considered this lamina to be absent in non-abelisauroid theropods (*e.g.*, *Ceratosaurus*, *Allosaurus*), this feature seems to be restricted to Abelisauroidea. Accordingly, the presence of a well-developed centrodiapophyseal lamina in MACN-PV-RN 1012 supports the assignment of the specimen to Abelisauroidea (Fig. 2B).

Transverse processes more than 1.4 times the length of the anterior caudal vertebral centrum (Rauhut *et al.* 2003). – Rauhut *et al.* (2003) provided a detailed discussion of the distribution of this feature within Neotheropoda. Short transverse processes are present in non-averostran theropods [*e.g.*, *Liliensternus* (Huene 1934), *Dilophosaurus* (Welles 1984; UCMP 37302), *Allosaurus* (Madsen 1976), *Sinraptor* (Currie & Zhao 1993)], as well as in the basal ceratosaurians *Ceratosaurus* (Madsen & Welles 2000) and *Masiakasaurus* (Carrano *et al.* 2003). On the other hand, as pointed out by Rauhut *et al.* (2003), the derived condition of strongly elongated transverse processes (more than 1.4 times longer than the anteroposterior length of the centrum) is present in the La Paloma abelisaurid and the abelisaurids *Carnotaurus* and *Aucasaurus*, as well as in the abelisaurids *Majungasaurus* (O'Connor 2007), *Skorpiovenator* (MMCH-PV 48) and *Ekrixinosaurus* (MUCPv 294). In this context, we agree with Rauhut *et al.* (2003) in considering this character as probably synapomorphic of Abelisauridae. The derived condition is also present in MACN-PV-RN 1012 (Fig. 2D), supporting the assignment of this specimen to that clade.

Presence of a parasagittal ridge on the ventrolateral end of the transverse processes of anterior caudal vertebrae. – The ventral surface of the lateral end of the right transverse process of MACN-PV-RN 1012 presents an anteroposteriorly concave and very smooth depression that is delimited medially by a sharp ventromedial ridge. This ridge is also present in the abelisaurids *Ekrixinosaurus* (MUCPv 294), *Aucasaurus* (MCF-PVPH 236) and *Carnotaurus* (MACN-PV-CH 894). Nevertheless, this ridge is absent in basal neotheropods and more basal ceratosaurians, such as the available caudals of *Dilophosaurus* (UCMP 37302) and *Ceratosaurus* (Madsen & Welles 2000). Thus, this character seems to constitute an apomorphy shared by *Ekrixinosaurus* and carnosaurians.

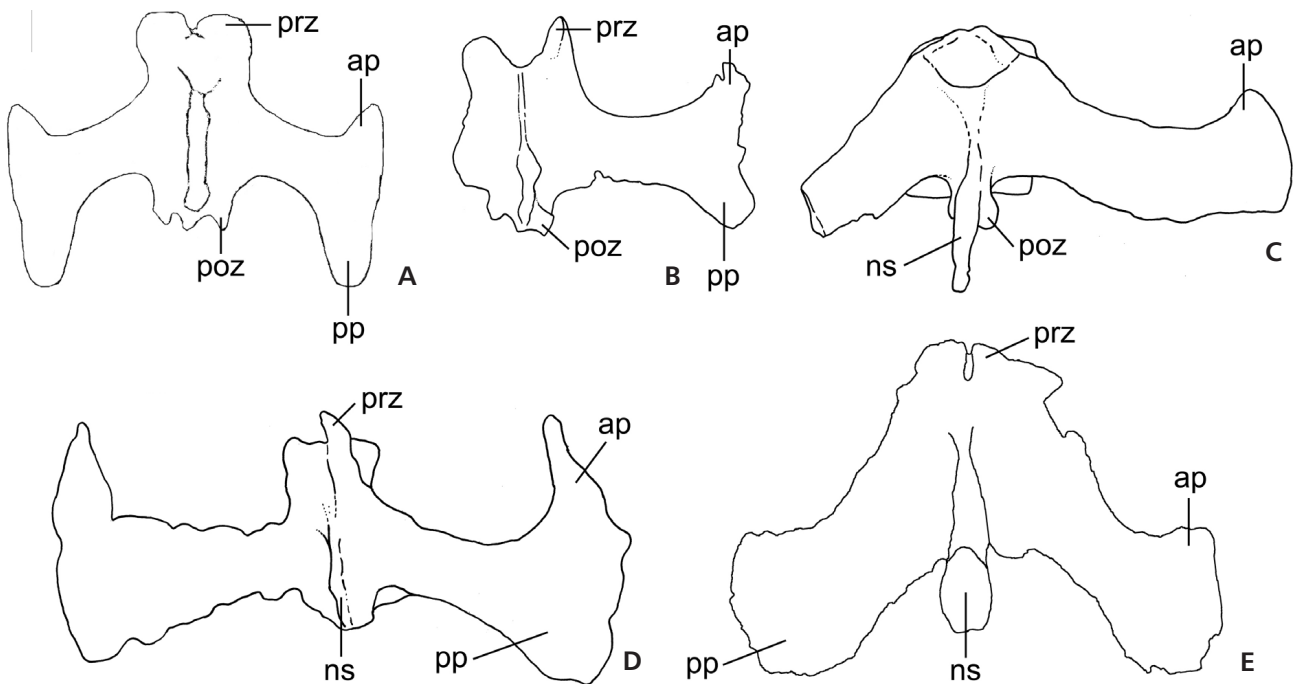


Figure 3. Line drawings of several abelisaurid anterior and mid-caudal vertebrae in dorsal view: • A – *Ekrixinatosaurus novasi* (MUCPv 294). • B – *Ilokelesia aguadagrandensis* (MCF-PVPH-35). • C – MACN-PV-RN 1012. • D – *Aucasaurus garridoi* (MCF-PVPH-236). • E – *Carnotaurus sastrei* (MACN-PV-CH 894). • Abbreviations: ap. – anterior projection, cdl. – centrodiapophyseal lamina, dd. – distal depression, hyp. – hyposphene, md. – median depression, ns. – neural spine, poz. – postzygapophysis, pp. – posterior projection, prz. – prezygapophysis. (A – after Calvo *et al.* 2004; B – after Coria & Salgado 2000).

In the anterior-most caudals (*i.e.*, C1-3) of *Aucasaurus* (MCF-PVPH 236), *Carnotaurus* (MACN-PV-CH 894) and *Ekrixinatosaurus* (MUCPv 294), the ventral ridge is positioned close to the mid-length of the transverse processes. In *Carnotaurus*, the ridge disappears posterior to the fourth caudal, whereas in *Aucasaurus* the ridge continues along most of the anterior caudal series but migrates laterally towards the tip of the tail (MCF-PVPH 236). In MACN-PV-RN 1012, the ventrolateral ridge is close to the lateral tip of the transverse process, resembling the condition in caudals 4 and 5 of *Aucasaurus* (MCF-PVPH 236).

Due to the absence of rugosities, the ventrolateral depression which is medially delimited by this ridge does not seem to correspond to the attachment area of a tendon. This depression may instead correspond to a muscle attachment area, but its surface is very smooth, providing evidence against this hypothesis as well. Following the descriptions of Coria *et al.* (2002) for *Aucasaurus*, and Canale *et al.* (2008) for *Skorpiovenator*, another possibility is that this depression received the anterior projection of the transverse process of the subsequent caudal vertebra, as a result of an overlapping articulation between these processes. However, because MACN-PV-RN 1012 consists of only a single caudal vertebra, this kind of accessory articulation cannot be ascertained for this specimen; moreover, in other taxa which exhibit the ventrolateral ridge and fossa (*e.g.*, *Ekrixinatosaurus* and *Carnotaurus*) no evidence of over-

lapping transverse processes was observed (MUCPv 294, MACN-PV-CH 894). The latter observation weakens the hypothesis that this parasagittal ridge and fossa participated in an osseous intervertebral interlocking of transverse processes, at least in *Ekrixinatosaurus* and *Carnotaurus*, contrasting with *Aucasaurus* and *Skorpiovenator* (Coria *et al.* 2002, Canale *et al.* 2008).

Large median depression anterior to the ventral base of the neural spine and absence of prespinal fossa in anterior caudal vertebrae (Coria & Salgado 2000, Rauhut *et al.* 2003). – Rauhut *et al.* (2003) reported that *Carnotaurus*, *Majungasaurus*, and the La Paloma abelisaurid exhibit a wide and deep median depression posterior to the prezygapophyses, and that no prespinal fossa is present at the anterior base of the neural spine. On the other hand, the vast majority of the ropods, including the non-abelisaurid ceratosaurians *Ceratosauros* (Madsen & Welles 2000), *Elaphrosaurus* (Rauhut *et al.* 2003), and *Masiakasaurus* (Carrano *et al.* 2002), lack this deep and wide median depression posterior to the prezygapophyses, and present a prespinal fossa at the base of the neural spine. Therefore this feature seems to be restricted to Abelisauridae, and MACN-PV-RN 1012 presents the apomorphic condition of the character (Fig. 2A).

Transverse processes oriented at an angle of 45° or more with respect to the horizontal axis of anterior caudal verteb-

rae (modified from Bonaparte *et al.* 1990). – In Theropoda ancestrally (e.g., *Liliensternus*, *Dilophosaurus*, *Ceratosaurus*, *Allosaurus*, *Sinraptor*, Huene 1934, Welles 1984, Madsen & Welles 2000, Madsen 1976, Currie & Zhao 1993), the transverse processes are horizontally projected in anterior caudal vertebrae. Within Abelisauroida, the latter condition is retained in *Elaphrosaurus*. In *Majungasaurus* (O'Connor 2007), *Ekrixinatosaurus* (MUCPv 294) and *Skorpiovenator* (Canale *et al.* 2008), the transverse processes are almost horizontally oriented, being only gently dorsally projected. On the other hand, in *Carnotaurus* (MACN-PV-CH 894), *Aucasaurus* (MCF-PVPH 236) and MACN-PV-RN 1012, the transverse processes of the anterior caudals are dorsolaterally oriented at an angle of 45° or more with respect to the transverse axis of the vertebra (Fig. 2F, H).

Presence of well developed hyposphene in anterior and mid-caudal vertebrae (Coria *et al.* 2002). – The presence of hyposphene-hypantrum articulations in anterior and mid-caudal vertebrae was proposed by Coria *et al.* (2002) as a synapomorphy shared by the carnosaurinins *Carnotaurus* and *Aucasaurus*. However, such articulations are also present in the anterior caudals of non-averostran theropods [e.g., *Lophostropheus* (Ezcurra & Cuny 2007), *Dilophosaurus* (Welles 1984)], tetanurans [e.g., *Condorraptor* (MPEF-PV 1682), *Monolophosaurus* (Zhao & Currie 1993), *Sinraptor* (Currie & Zhao 1993)] and the basal ceratosaurian *Ceratosaurus* (Madsen & Welles 2000). In *Majungasaurus*, hyposphene-hypantrum articulations are only incipient (O'Connor 2007), whereas anterior and mid-caudals are not available for the basal abelisauroids *Ligabueino* and *Noasaurus*. Coria & Salgado (2000) reported that the mid-caudals of *Ilokelesia* lack hyposphene-hypantrum articulations, thus contrasting with *Aucasaurus* and *Carnotaurus*. However, the presence or absence of these structures in anterior caudals of the former taxon is unknown. Accordingly, the distribution of this feature within Abelisauroida is not currently clear. Thus, we follow Rauhut *et al.* (2003) in considering the presence of hyposphene-hypantrum articulations in anterior caudals as a probable symplesiomorphy of Neotheropoda. In this context, the anterior caudal reported here (MACN-PV-RN 1012) resembles *Carnotaurus* and *Aucasaurus*, as well as other basal neotheropods, in possessing a well-developed hyposphene-hypantrum (Fig. 2C). Although the presence of this structure in the Bajo de la Carpa vertebra does not preclude its referral to Abelisauroida or clades within, it cannot be considered as definitive evidence for this referral.

In summary, based on the discussion of the above apomorphies, we can assign MACN-PV-RN 1012 to Abelisauroida due to the presence in this specimen of 1) transverse processes with a centrodiaepophyseal lamina (Rauhut *et al.* 2003). Furthermore, MACN-PV-RN 1012 can be assigned to Abelisauridae due to the presence of 2)

transverse processes more than 1.4 times the antero-posterior length of the vertebral centrum (Rauhut *et al.* 2003), 3) a large median depression anterior to the ventral base of the neural spine and the absence of a prespinal fossa (Coria & Salgado 2000, Rauhut *et al.* 2003) and 4) a ventrolaterally-positioned parasagittal ridge on the lateral end of the transverse process of the anterior caudal vertebrae. Finally, MACN-PV-RN 1012 seems to be more derived than *Ilokelesia*, *Ekrixinatosaurus*, *Skorpiovenator*, and *Majungasaurus* in that it shares with *Carnotaurus* and *Aucasaurus* 5) transverse processes oriented at an angle of 45° or more with regard to the horizontal axis of the anterior caudal vertebrae (modified from Bonaparte *et al.* 1990). In agreement with the latter assertion, MACN-PV-RN 1012 resembles *Carnotaurus* and *Aucasaurus* in possessing a well-developed hyposphene in the anterior caudal vertebrae (Coria *et al.* 2002), but the distribution of hyposphene-hypantrum articulations among abelisauroids is currently problematic (Rauhut *et al.* 2003; see above). Character 5 supports the assignment of MACN-PV-RN 1012 to the abelisauroid clade Carnosaurinae. Furthermore, at the moment, this character is shared only by MACN-PV-RN 1012 and Carnosaurini (*i.e.*, *Carnotaurus* and *Aucasaurus*). However, the specimen reported here cannot currently be included within the latter clade due to the node-based definition of the group (Coria *et al.* 2002) and the uncertain phylogenetic position of MACN-PV-RN-1012 relative to *Aucasaurus* and *Carnotaurus*. In this context, MACN-PV-RN 1012 is interpreted here as Carnosaurinae indet.

As was mentioned in the description, the transverse processes of MACN-PV-RN 1012 present concave and convex anterior and posterior borders, respectively. The convex posterior border differs from that of other abelisauroids, in which this border is concave or straight (e.g., *Ekrixinatosaurus*, *Carnotaurus*, *Aucasaurus*, *Ilokelesia*; MUCPv 294, MACN-PV-CH 894, MCF-PVPH 236, MCF-PVPH 35). Thus, the transverse processes of MACN-PV-RN 1012 exhibit a distinct but gentle anterior curvature. However, the fragmentary nature of MACN-PV-RN 1012 does not warrant erecting a new taxon without more available data.

The lateral end of the right transverse process of the Bajo de la Carpa vertebra is damaged, preserving only the base of the well-developed anterior projection. The lateral expansion of the transverse process resembles that of other abelisauroids. Previous authors (Calvo *et al.* 2004, Coria & Salgado 2000, Coria *et al.* 2002) have recognized only a single apomorphic state for the lateral expansion of the transverse processes. Nevertheless, among basal abelisauroids, the lateral end of the transverse processes present anterior and posterior projections that are strongly and equally developed (e.g., *Ilokelesia*, *Skorpiovenator*; Coria & Salgado 2000; MMCH-PV 48), or the posterior projection is more

strongly developed (e.g., *Ekrixinatosaurus*; Calvo *et al.* 2004) (Fig. 3A, B). On the other hand, in more derived forms such as *Carnotaurus* (MACN-PV-CH 894) and *Aucasaurus* (MCF-PVPH 236), the anterior projection is more developed than the posterior one (Fig. 3D, E). As preserved, the lateral end of the right transverse process of MACN-PV-RN 1012 suggests that the condition it represents would be similar to that of *Carnotaurus* and *Aucasaurus*, but this interpretation is tentative (Fig. 3C). This latter morphology could also support the assignment of specimen MACN-PV-RN 1012 to a derived position within Abelisauroida.

Conclusion

In the present contribution an isolated anterior caudal vertebra recovered from the Santonian Bajo de la Carpa Formation at the Paso Córdova locality (Río Negro Province, Argentina) is described. The specimen is interpreted as a medium-large-sized carnotaurin abelisaurid. This assignment indicates that specimen MACN-PV-RN 1012 represents a taxon distinct from *Velocisaurus* (Bonaparte 1991b), the unique abelisauroid hitherto reported from the Bajo de la Carpa Formation. Accordingly, the theropodan fauna of this sedimentary unit is represented by several small-sized theropods, as well as the medium-sized abelisaurid reported here and a basal tetanuran (Porfiri *et al.* 2008). MACN-PV-RN 1012 also exhibits deep ventrolateral depressions on the transverse processes, but it was demonstrated that they are not directly associated with the presence of osseous interlocking articulations between the transverse processes of adjacent anterior caudal vertebrae, at least in the Bajo de la Carpa abelisaurid, *Carnotaurus*, and *Ekrixinatosaurus*.

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