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NOTA PALEONTOLÓGICA

A fragmentary theropod skull from the Middle Jurassic of Patagonia

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Introduction

Jurassic dinosaurs from the Southern Hemisphere are still very poorly known, and this is especially true for theropod dinosaurs from the Middle to Late Jurassic. Only four valid taxa are currently known from this period of Gondwana, the Late Jurassic ceratosaur *Elaphrosaurus* from the Tendaguru beds of Tanzania, Africa (Janensch, 1920, 1925), the Middle Jurassic probable abelisauroid *Ozraptor* from western Australia (Long and Molnar, 1998; Rauhut, 2005a), and the Middle Jurassic basal tetanurans *Piatnitzkysaurus* (Bonaparte, 1979, 1986) and *Condorraptor* (Rauhut, 2005b) from the Cañadón Asfalto Formation, Chubut, Argentina. Of these, only *Piatnitzkysaurus* has some cranial material preserved (Bonaparte, 1986; Rauhut, 2004a).

Recent fieldwork in the Middle Jurassic (Callovian) Cañadón Asfalto Formation of Argentina has brought a wealth of new dinosaur material to light (Rauhut and Puerta, 2001; Rauhut *et al*., 2001), including a poorly preserved fragmentary theropod skull. This specimen was briefly mentioned by Rauhut (2002) as a possible ceratosaur, potentially representing the earliest known representative of this clade. However, further preparation demonstrated that this identification is not correct. The specimen is described and discussed in the present paper.

Institutional abbreviations. MACN, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; MPEF, Museo Paleontológico Egidio Feruglio, Trelew, Argentina; PVL, Paleontología de Vertebrados, Fundación Miguel Lillo, Tucumán, Argentina.

Geological and palaeontological context

The specimen is derived from a series of strongly silicified limestones that pertain to the Cañadón Asfalto Formation, a unit of lacustrine sediments that mainly crops out along the upper course of the Chubut River (figure 1; Page *et al*., 1999). In the vicinity of Cerro Cóndor, this formation is dominated by often stromatolithic lacustrine limestones, marls, tuffs, and frequent conglomeratic intercalations (Tasch and Volkheimer, 1970; Cabaleri and Armella, 1999). The age of the formation is usually given as Callovian-Oxfordian (Tasch and Volkheimer, 1970; Page *et al*., 1999), though most parts of the formation are probably Middle Jurassic in age (Volkheimer, pers. com. 2002). Dinosaurs from the Cañadón Asfalto Formation have first been reported by Bonaparte (1979, 1986).

The specimen was found close to the microvertebrate locality "Queso Rallado", some 4 km WNW of the village of Cerro Cóndor, in a level slightly below the layers that have yielded a rich vertebrate fauna at that site, including amphibians, turtles, lepidosaurs, pterosaurs, sauropod dinosaurs, and mammals (Rauhut *et al*., 2001, 2002). The same level that yielded the specimen described here also yielded other vertebrate remains, including disarticulated elements of turtles, pterosaurs, and dinosaurs. Dinosaur remains from this site are often partially associated, but strongly compacted and incomplete, as is the case with the current specimen. Apart from the theropods *Piatnitzkysaurus* and *Condorraptor*, dinosaurs are otherwise only represented by sauropods in the Cañadón Asfalto Formation, including the genera *Patagosaurus*, *Volkheimeria*, and an undescribed taxon (Bonaparte, 1986; Rauhut, 2002).

Description

The specimen MPEF 1717 consists of the associated, badly crushed anterior parts of the left and right maxilla, parts of the nasals, and probably the palatines (figures 1-2), although the latter are too poorly preserved to say anything about their morphology.

The maxilla seems to have been rather short and high, although the posterior end of the bone is missing on both sides. The left maxilla has the anterior 142 mm of the alveolar border with seven tooth positions preserved. Thus, under the assumption that

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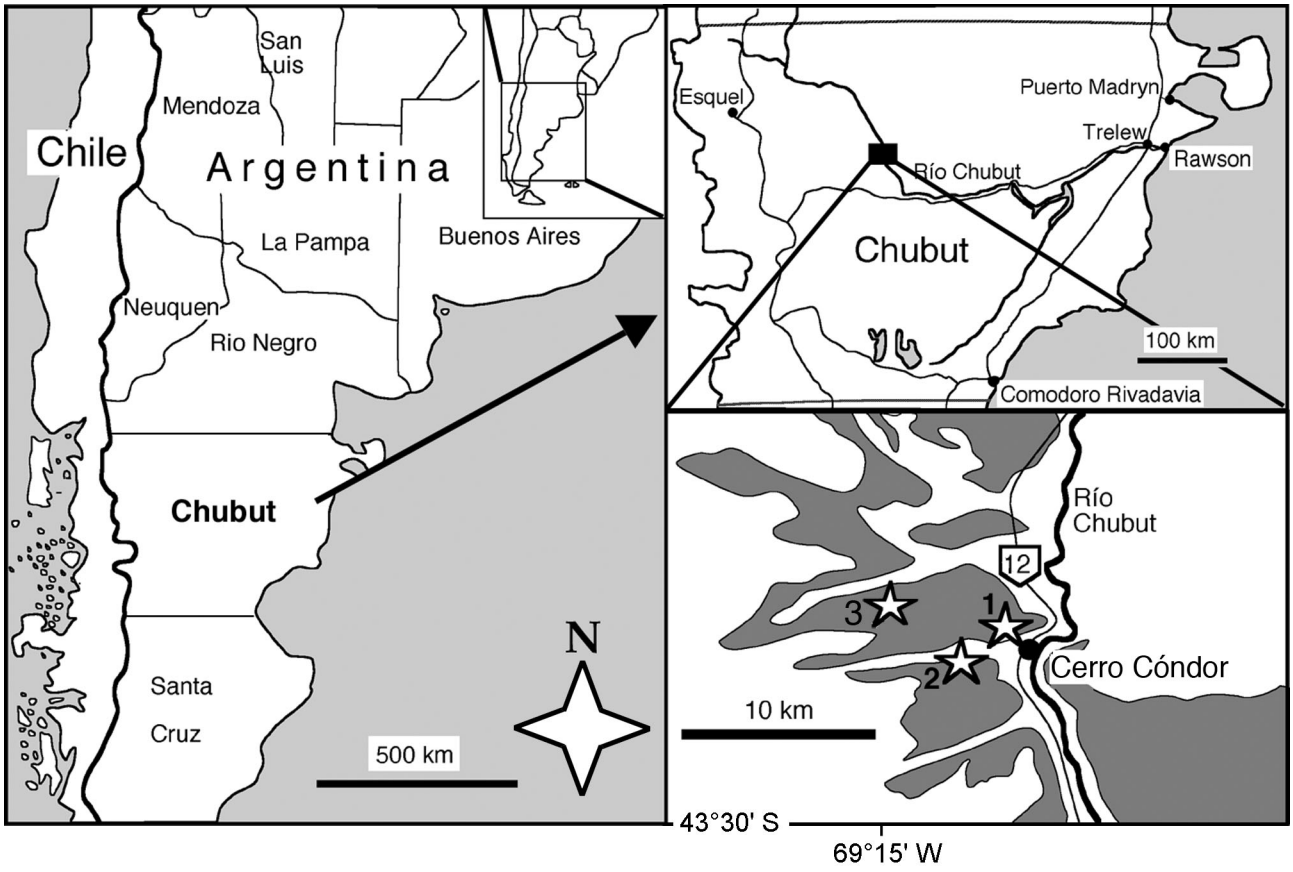

Figure 1. Theropod localities in the Cañadón Asfalto Formation in the vicinity of Cerro Cóndor. Shaded areas indicate outcrops of the Cañadón Asfalto Formation. Localities: **1,** Cerro Cóndor South, type locality of ***Piatnitzkysaurus floresi***; **2,** Las Chacritas, type locality of *Condorraptor currumili*; **3,** locality of MPEF 1717 / *localidades de terópodos en la Formación Cañadón Asfalto en las proximidades de Cerro Cóndor. Las áreas grises indican afloramientos de la Formación Cañadón Asfalto. Localidades:* ***1,*** *Cerro Cóndor Sur, localidad tipo de* Piatnitzkysaurus floresi*;* **2,** *Las Chacritas, localidad tipo de* **Condorraptor currumili; 3,** *localidad del espécimen MPEF 1717.*

at least 15 tooth positions were present, as in other basal tetanurans (*e.g.* Madsen, 1976; Bonaparte, 1986), approximately half of the length of the bone is missing, indicating that the specimen is derived from a medium- to large-sized theropod.

The ascending process of the maxilla is very broad anteroposteriorly, has a steeply sloping anterior border and does not seem to be significantly offset from the anterior end of the maxillary body. The posterior base of the ascending process is situated just posterior to the fifth tooth position. The anterior end of the maxillary body has a simple butt-joint for the contact with the premaxilla ventrally, and a well-developed anteromedial process situated at the dorsal corner of the anterior end. A very slight incision halfway between the process and the alveolar border might indicate the subnarial foramen. A narrow, elongate and transversely slightly concave facet runs along the lateral margin of the anterior side of the ascending process, indicating that the premaxilla had a long and slender posterior ascending process that extended for at least the ventralmost 30 mm along the anterior border of the ascending process. The base of the ascending process is approximately 70 mm wide in the right maxilla, 55 of which are covered by the antorbital fossa. The latter expands ventrally to some 20-25 mm above the alveolar border and its ventral border is only defined by a slight swelling on the lateral side. Anteriorly, the margin of the antorbital fossa flexes dorsally at an angle of approximately 90° and meets the anterior margin of the ascending process some 100 mm above the alveolar margin. At the base of the ascending process, the margin of the antorbital fossa is developed as a sheet of bone, which, however, does not overhang the promaxillary foramen as it is the case in many other theropods. Both a promaxillary foramen and maxillary fenestra are present. They are proportionally small, with the maxillary fenestra being less wide anteroposteriorly than the pila interfenestralis between this fenestra and the antorbital opening. The promaxillary foramen is a small, slit-like opening, which is separated from the much larger, oval maxillary foramen by a narrow, but stout pillar of bone.

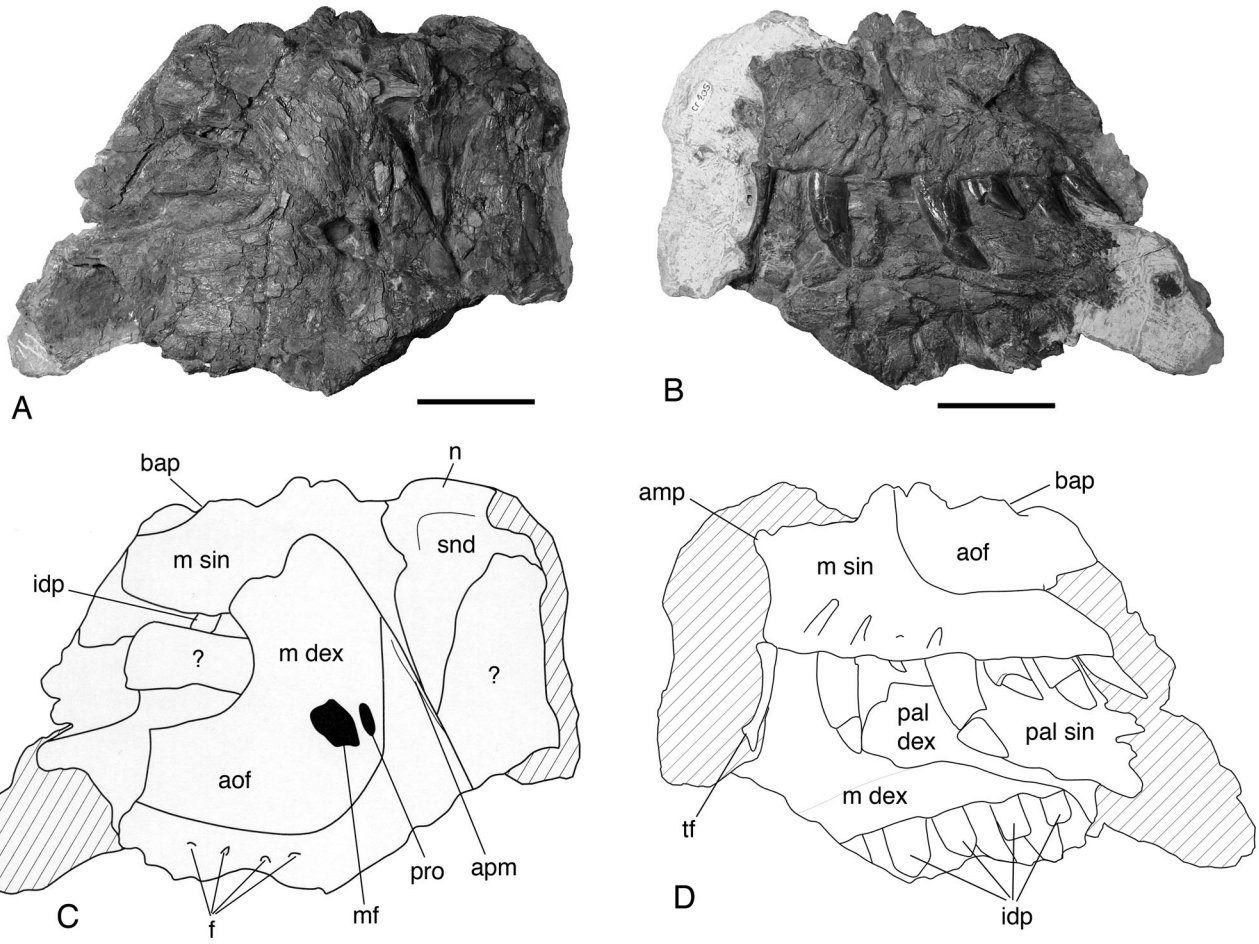

Figure 2. Partial theropod skull from the Cañadón Asfalto Formation. **A,** right lateral view; **B,** left lateral view; **C,** interpretative drawing of A; **D,** interpretative drawing of B. Scale bars are 50 mm. **Abbreviations:** amp, anteromedial process; aof, antorbital fossa; apm, facet for subnarial ascending process of the premaxilla; bap, posterior end of the base of the ascending process; f, foramina; idp, interdental plates; m dex, right maxilla; m sin, left maxilla; mf, maxillary fenestra; n, nasal; pal dex, right palatine; pal sin, left palatine; pro, promaxillary foramen; snd, supranarial depression; tf, turtle femur / cráneo parcialmente preservado de un terópodo de la Formación Cañadón Asfalto. **A,** vista lateral derecha; **B,** vista lateral izquierda; **C,** ilustración interpretativa de A; **D,** ilustración interpretativa de B. Escala gráfica = 50 mm. Abreviaturas: amp, proceso anteromedial; aof, fossa antorbital; apm, faceta para el proceso subnarial del premaxilar; bap, límite posterior de la base del proceso ascendente; f, foramina; idp, placas interdentales; m dex, maxilar derecho; m sin, maxilar izquierdo; mf, fenestra maxilar; n, nasal; pal dex, palatino derecho; pal sin, palatino izquierdo; pro, foramen promaxilar; snd, depresión supranarial; tf, fémur de una tortuga.

Several large foramina are present above the tooth row on the lateral side of the maxillary body and some of these continue ventrally with a ventrally widening groove. In medial view, the teeth are held in place by large, pentagonal interdental plates, which are only slightly higher than long and clearly separated from each other. The preserved teeth show a pattern of alternating fully erupted and erupting teeth. The teeth are of moderate size, the largest being approximately as long as the height of the maxillary body below the antorbital fenestra. The teeth are pointed, recurved and have mesiodistally convex medial and lateral sides, without flattened area adjacent to the carinae as they are found in ceratosaurids (Rauhut, 2004b). Marginal serrations are present on the distal and the apical third to half of the medial carina. The denticles are proportionally small and chisel-shaped, with 14 denticles per 5 mm on the distal and 15 denticles per 5 mm on the mesial carina. Downpointing grooves at the bases of the denticles, as they are present in tyrannosaurids, for example (Currie *et al*., 1990), are absent.

Only what seems to be the anterior end of the right nasal is preserved. The nasal was a large, platelike bone with a long and posterodorsally rapidly expanding downpointing process along the anterior rim of the ascending process of the maxilla. A large, supranarial depression seems to have been present on the anterior end of its main body, as in *Sinraptor* (Currie and Zhao, 1994).

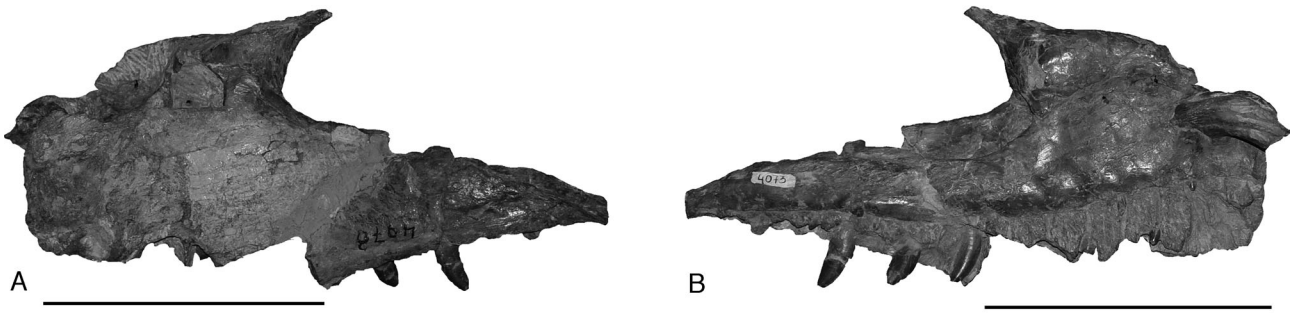

Figure 3. Left maxilla of ***Piatnitzkysaurus floresi*** (PVL 4073, holotype) from the Cañadón Asfalto Formation. **A,** lateral view; **B,** medial view. Scale bars are 100 mm / *maxilar izquierdo de* **Piatnitzkysaurus floresi** *(PVL 4073, holotipo) de la Formación Cañadón Asfalto.* ***A,*** *vista lateral;* ***B,*** *vista medial. Escala gráfica = 100 mm.*

Discussion

Although the steeply angled ascending process of the maxilla of MPEF PV 1717 is reminiscent of the situation seen in ceratosaurs (Novas, 1992; Lamanna *et al*., 2002), several characters reject the original identification of this material as ceratosaurian by Rauhut (2002). The specimen lacks the ceratosaurian synapomorphy of fused interdental plates and any synapomorphy of either ceratosaurids, such as strongly enlarged teeth (Rauhut, 2004b), or abelisauroids, such as striated interdental plates (Carrano *et al*., 2002). On the other hand, the specimen has a well-developed maxillary fenestra, which represents a tetanuran synapomorphy (Gauthier, 1986; Sereno, 1999; Holtz, 2000; Rauhut, 2003) and can therefore be referred to the Tetanurae. Thus, the oldest ceratosaurs known from South America remain the probable abelisaur *Ligabueno* from the Hauterivian-Barremian La Amarga Formation of Neuquén, Argentina (Bonaparte, 1996; Coria and Salgado, 2000), and the ceratosaurid *Genyodectes* (Rauhut, 2004b) and an unidentified abelisaurid (Rauhut *et al*., 2003) from the Barremian-Aptian Cerro Barcino Formation of Chubut, Argentina.

Two taxa of basal tetanurans have been described from the Cañadón Asfalto Formation, *Piatnitzkysaurus floresi* (Bonaparte, 1979, 1986) and *Condorraptor currumili* (Rauhut, 2005b). Cranial material, including maxillae, is only known for *Piatnitzkysaurus* (Fig. 3; Bonaparte, 1986), whereas *Condorraptor* is known only from a fragmentary postcranial skeleton.

The material described here differs from *Piatnitzkysaurus* in several characters. In the latter, the ascending process of the maxilla is not as steeply angled and more strongly convex anteriorly (figure 3; PVL 4073, MACN CH 895; Bonaparte, 1986). Furthermore, the maxillary fenestra of *Piatnitzkysaurus* seems to be proportionally larger and the promaxillary fenestra is hidden in lateral view by a bony lamina that forms the anterior border of the antorbital fossa (PVL 4073, MACN CH 895). The posterior margin of the ascending process of the maxilla is situated above the eighth tooth position in *Piatnitzkysaurus* (Fig. 3; Bonaparte, 1986), whereas it is more anterior, above the fifth alveolus, in the present specimen. There is also no indication of the significant inflation of the base of the ascending process that is diagnostic for *Piatnitzkysaurus* (Rauhut, 2003). A further difference is the lack of downpointing grooves at the bases of the denticles in the teeth of the specimen described here, whereas such grooves are present, though not very well developed, in the preserved teeth of both maxillae and the mandible known for *Piatnitzkysaurus* (PVL 4073, MACN CH 895; Rauhut, 2005b). Therefore, the specimen cannot be referred to *Piatnitzkysaurus* and thus represents further evidence for the presence of a second taxon of basal tetanurans in the Cañadón Asfalto Formation. Under the assumption that no more than two medium- to large-sized basal tetanurans were present in the Cañadón Asfalto Formation, the specimen MPEF PV 1717 may be referrable to *Condorraptor* and might thus represent the first evidence of the cranial anatomy of this taxon.

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