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NOTA PALEONTOLÓGICA

THE FIRST RECORD OF PTEROSAURIA IN THE BAJO BARREAL FORMATION (UPPER CRETACEOUS), CENTRAL PATAGONIA, ARGENTINA

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The fossil record of pterosaurs is relatively abundant in South America. Remains of this group have been primarily found in Early Cretaceous rocks exposed in two different areas, *i.e.*, in Northeastern Brazil (Kellner and Tomida, 2000) and in San Luis Province, Central Argentina (Bonaparte, 1970). Excepting the records in Neuquén Province, the fossil record of pterosaurs in Patagonia (*i.e.,* Golfo San Jorge and Austral basins) is poor and incomplete (Codorniú and Gasparini, 2007).

Continental deposits of the Bajo Barreal Formation (Cenomanian–Turonian) exposed in Central Patagonia, Argentina (Golfo San Jorge Basin, Fig. 1), preserve an important record of South American Late Cretaceous vertebrates, particularly dinosaurs (Martínez *et al*., 2004; Martínez and Novas, 2006; Casal *et al.,* 2007; Ibiricu *et al*., 2010). This record has been significantly increased over the past decade. The best known assemblages from Bajo Barreal come from the localities known as Estancia Ocho Hermanos and Estancia Laguna Palacios (Fig. 1).

Herein we report recently identified pterosaur material from rocks of the Bajo Barreal Formation exposed at Estancia Ocho Hermanos and discuss the implications of this material for the Patagonian fossil record of Pterosauria. The fossil is significant because it adds to the generally sparse global record of Cretaceous (especially Late Cretaceous) pterosaurs and constitutes the second most southern occurrence of Pterosauria worldwide. This material confirms the presence of pterosaurs in the Bajo Barreal Formation, increasing the number of taxa in the known fossil fauna from this unit and thus our knowledge of the early Late Cretaceous vertebrate assemblages of Central Patagonia.

GEOLOGICAL AND PALEOENVIRONMENTAL SETTING

The San Jorge Basin in Central Patagonia is an intracratonic basin originated essentially by extensional tectonics (Fígari *et al*., 2002). The basin spans 45ºS–47ºS and 65ºW–71ºW, over part of Chubut and northern Santa Cruz provinces, Argentina. The basin contains the continental Cretaceous stratigraphic units included in the Chubut Group; these consist of pyroclastic and epiclastic facies (Lesta and Ferello, 1972). One of these units of the Chubut Group — the Bajo Barreal Formation— is particularly important because of the assemblages of vertebrates it contains (Ibiricu *et al*., 2010). There are excellent exposures of this formation at Estancia Ocho Hermanos (45°17′S–69°36′W), reaching a thickness there of 245 m (Rodríguez, 1992). The Bajo Barreal Formation (Fig. 2) overlies the Castillo Formation and underlies the Laguna Palacios Formation. Both stratigraphic boundaries are conformable. The Bajo Barreal Formation includes two members. The lower member consists of an upward-coarsening sequence with pelitic sediments at the base and predominantly coarse sandstone at the top. The uppermost sandstone bed is greenish-gray with cross-stratification, fluvial deposits with significant pyroclastic influence.Taphonomic conditions in this uppermost bed were favorable for fossil preservation, as documented by the rich fauna contained in the ephemeral fluvial deposits (Rodríguez, 1993). This sandstone has been classified as lithic felds-sandstones and feldspar litho-sandstones with a clay matrix (Tunik *et al*., 2004).

The upper member of the Bajo Barreal Formation is composed predominantly of mudstone with conspicuous

pyroclastics. The record of fossil vertebrates is poor in this bed (Sciutto, 1981).

The Bajo Barreal Formation was deposited in a system of ephemeral stream channels and flood-plains. Paleosols developed on the flood-plains during non-sedimentation periods. Facies removed from the center of the unit show that the system was characterized by depressed zones with a predominance of fine sedimentation. This predominance of fine sedimentation is a consequence of decantation in shallow and temporary lagoons, but with sand input derived from ephemeral stream channels (Rodríguez, 1993).

Institutional abbreviation. **UNPSJB,** Universidad Nacional de la Patagonia San Juan Bosco.

SYSTEMATIC PALEONTOLOGY

Order Pterosauria Kaup, 1834

Pterosauria indet.

Figure 3

Material. UNPSJB-Pv 1009, first wing phalanx. The material was found isolated and it is housed in the collections at the Universidad Nacional de la Patagonia "San Juan Bosco", Comodoro Rivadavia, Chubut Province, Argentina.

Horizon and Age. Lower member of the Bajo Barreal Formation, Cenomanian–Turonian (Martínez *et al.*, 2004), Central Patagonia, Argentina (Figs. 1–2).

Description. The pterosaur specimen studied herein is interpreted as a first wing-phalanx (UNPSJB-Pv 1009) and its preserved length is approximately 210 mm. It is a pneumatic bone missing the distal end. The element is slender and laterally compressed, showing an ovoid cross-section throughout the preserved shaft. The cross-section is 9.54 mm long transversally and approximately 5.42 mm wide dorsoventrally. The bone wall at the proximal surface breakage area (Fig. 3) is 0.76 mm thick. The proximal end carries two well-marked cotyles oriented approximately along the same vertical axis. The semilunar shaped cotyles of the proximal end are separated by a strong concavity which receives the distal condyles of metacarpal IV. Although difficult to recognize, the preserved part of this bone is slightly curved anteriorly. The external bone surface of the preserved material (UNPSJB-Pv 1009) is rugose, suggesting the insertion of tendons or muscles related to the support of the wing patagium, specifically the brachiopatagium, a feature common to all pterosaurs (Kellner *et al.,* 2010). The extensor tendon process is fully fused, indicating that the material corresponds to an adult or mature specimen (Kellner and Tomida, 2000).

Remarks. Specimen UNPSJB-Pv 1009 is identified as a pterosaur based on the thin-walled, long tubular shape (*i.e.*, pneumatic bone), a diagnostic feature of this group of flying reptiles (Kellner, 2003; Unwin, 2003). In addition, the semilunate shape of the first wing phalanx articulation is another of the features supporting the inclusion of UNPSJB-Pv 1009 among Pterosauria. Unfortunately, the material is too fragmentary to allow a more precise identification and therefore it is regarded as Pterosauria indet.

The vertebrate faunistic assemblage. The vertebrate fossil record recovered from the outcrops at Estancia Ocho Hermanos in central Patagonia is presently represented mainly by sauropod and theropod dinosaurs. Several remains of a

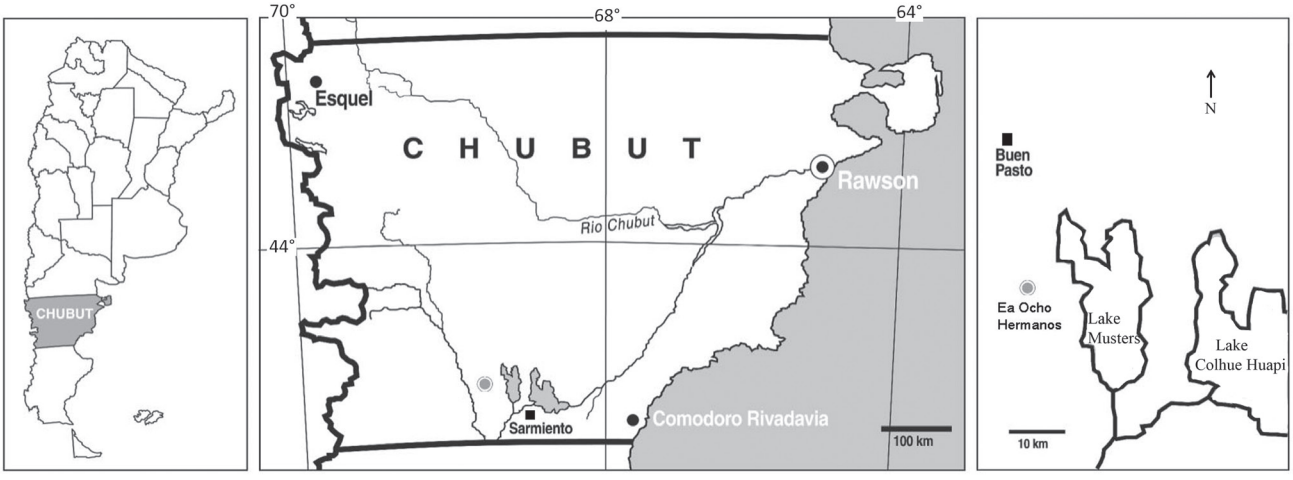

Figure 1. Location map; grey asterisk showing Estancia Ocho Hermanos, collection locality of specimen UNPSJB-Pv 1009 (modified from Martínez and Novas, 2006)/ *Mapa de ubicación, asterisco gris indica Estancia "Ocho Hermanos", lugar del hallazgo de UNPSJB-Pv 1009 (modificado de Martínez y Novas, 2006).*

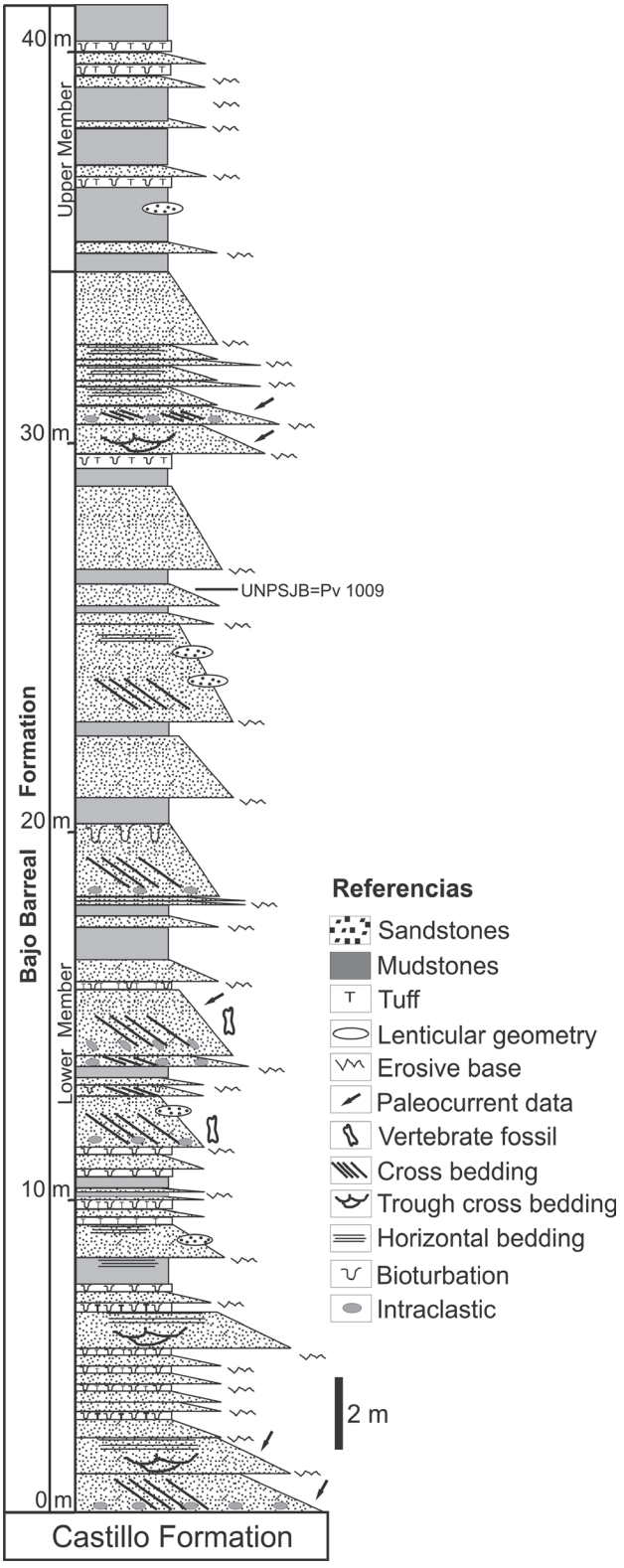

Figure 2. Stratigraphic section of the Bajo Barreal Formation of the Chubut Group, showing the fossil-bearing bed containing specimen UNPSJB-Pv 1009 (first wing-phalanx)/ *Columna estratigráfica de la Formación Bajo Barreal en el Grupo Chubut, mostrando el nivel fosilífero portador del espécimen UNPSJB-Pv 1009 (primera falange del ala).*

basal titanosaurian —including an almost complete and articulated skeleton *Epachthosaurus sciuttoi*— were recovered in the rocks expose there (Martinez *et al.*, 2004; Casal and Ibiricu, 2010; Ibiricu *et al.*, 2011). This epachthosaurine

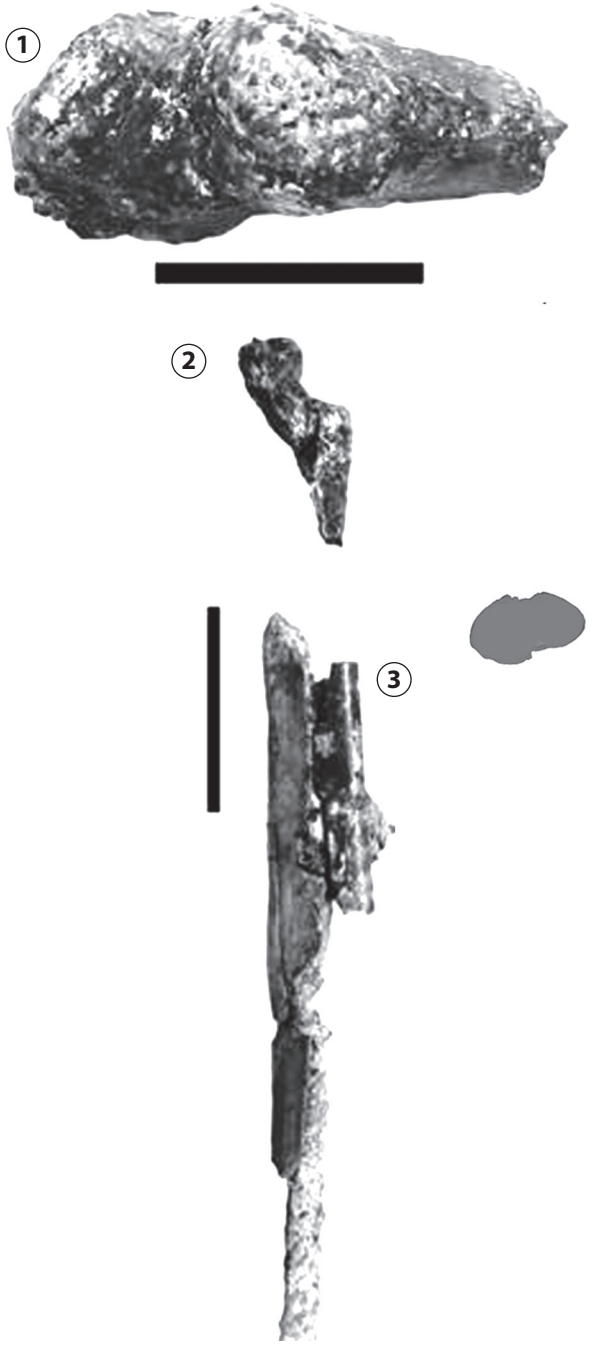

Figure 3. UNPSJB-Pv 1009. 1, Detailed view of the proximal end of the first wing phalanx. Scale bar= 1cm; **2,** Photo of the preserved portion of the first wing phalanx in ventro-lateral view. Scale bar= 2 cm; **3,** Schematic interpretation of the cross-section/ ***1,*** *Vista en detalle del extremo proximal de la primer falange del ala. Escala= 1 cm;* ***2,*** *Foto de la porción preservada de de la primera falange del ala en vista ventro-lateral. Escala= 2 cm;* ***3,*** *Interpretación esquemática de la sección transversal.*

sauropod is represented by four different specimens. The abundance of epachthosaurines contrasts with their absence from other levels of the Bajo Barreal Formation (Casal and Ibiricu, 2010). In addition, the sauropod record shows a well-preserved rebbachisaurid cervical vertebra (Ibiricu *et al.*, 2012). The dinosaur fauna is also represented by abelisaurid theropods such as *Xenotarsosaurus bonapartei* (Martinez *et al.*, 1986) and an indeterminate left maxilla (Lamanna *et al.*, 2002). Teeth of Dromaeosauridae and Carcharodontosauridae are also present in these Cretaceous outcrops (Casal *et al.*, 2009). The vertebrate fauna also includes a humerus preliminarily interpreted as belonging to a pleurodire Chelidae. Other turtles present are *Prochelidella argentinae* and *Bonapartemys bajobarealis* (Lapparent de Broin and de la Fuente, 2001). Finally, the fossil record in this stratigraphic includes remains assigned to crocodyliforms and holeostean fish (Martínez, *pers. obs.*).

DISCUSSION AND CONCLUDING REMARKS

Specimen UNPSJB-Pv 1009 is identified as a pterosaur based on the relatively thin-walled long tubular bone (*i.e.*, pneumatic bone) (Martill *et al.*, 2006). In addition, the semi-lunate shape of the first wing-phalanx articulation is another of the features supporting such an assignment of UNPSJB-Pv 1009 to Pterosauria. Unfortunately, the material is too fragmentary to allow a more precise identification beyond Pterosauria indet.

Patagonian pterosaurs range from the Middle Jurassic (Callovian) to the Late Cretaceous (Coniacian) (Codorniú and Gasparini, 2007). Late Cretaceous pterosaur remains were recorded from the Portezuelo and Candeleros Formations (Kellner *et al.*, 2004; Codorniú and Gasparini, 2007), both stratigraphic units exposed in Neuquén Province. The fragmentary material described herein (UNPSJB-Pv 1009) is the first record of this group in the Golfo San Jorge Basin, particularly in the Bajo Barreal Formation. Thus, UNPSJB-Pv 1009 is important because it helps span the gap in the record of Late Cretaceous pterosaurs in central Patagonia. Kellner *et al.* (2003) described a left ulna and a tentative wing metacarpal and assigned this material to the clade Pterodactyloidea, with affinities to the Anhangueridae. Their material was collected from the Río Belgrano Formation (Barremian) in Santa Cruz Province. Therefore, UNPSJB-Pv 1009 represents the second most southern record of pterosaurs in South America (and worldwide) and the current most southern record of Late Cretaceous pterosaurs.

Discoveries over the past decade have greatly increased the number of vertebrates included in the fauna recovered from the Bajo Barreal Formation. The extensive outcrops are especially well-exposed in two areas, *i.e.*, Estancia Laguna Palacios and Estancia Ocho Hermanos. At Estancia Ocho Hermanos, the vertebrate assemblage carries a well-represented dinosaurian fauna. However, several new and important non-dinosaurian fossils have been discovered too. These fossils enabled reconstruction of the paleoenvironment in that area. Finally, the identification of UNPSJB-Pv 1009 as a pterosaur increases the diversity of tetrapods in that particular area and thus our knowledge of the early Late Cretaceous vertebrate assemblages of central Patagonia.

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