Journal of Vertebrate Paleontology 25(3):583–587, September 2005

REVISION OF *PLATYPTERYGIUS HAUTHALI* von HUENE, 1927 (ICHTHYOSAURIA: OPHTHALMOSAURIDAE) FROM THE EARLY CRETACEOUS OF PATAGONIA, ARGENTINA

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ABSTRACT—Most of the Cretaceous ichthyosaurian materials are referable to the single genus *Platypterygius,* which includes seven species. Although Cretaceous ichthyosaurs were probably cosmopolitan in their distribution, South American records are scarce. In recent revisions, the name *Platypterygius hauthali* has been retained for Early Cretaceous material from South America, but no specific diagnosis has been provided. The species *P. hauthali* was proposed on the basis of fragmentary material from the Neocomian of Santa Cruz Province (Patagonia, Argentina). However, analysis of the forefin features of the holotype shows that the pattern of carpal ossifications is different from that of other species of the genus and, furthermore, that this pattern is sufficient for specific diagnosis. Based on these data and additional findings of ichthyosaurs in Neuquén, Argentina, it can be concluded that there are three valid ichthyosaur taxa present in the Early Cretaceous of South America: *Caypullisaurus bonapartei* (Berriasian of Neuquén, Argentina), *Platypterygius hauthali* (Early Barremian of Santa Cruz, Argentina) and *P. sachicarum* (Barrenian-Aptian of Colombia).

INTRODUCTION

The family Ophthalmosauridae *sensu* Motani (1999a) includes all Callovian and post-Callovian ichthyosaurs distributed among eight genera (McGowan and Motani, 2003). In spite of its being the most diverse family of ichthyosaurs, and showing a worldwide range, our knowledge of this family as a whole is still very limited. As a result, the majority of the genera are monotypic. The best-known members of the family are O*phthalmosaurus* Seeley and *Platypterygius* von Huene. The latter is widespread and includes most of the Cretaceous material described. Of the seven species previously identified by McGowan (1972) as belonging in *Platypterygius*, only five were later considered valid by McGowan and Motani (2003). Among these five species, the name *P. hauthali* was retained by these authors for New World material from the earliest Cretaceous; they pointed out that there were no apparent distinguishing features for this species, which was erected by von Huene (1927) on the basis of a humerus, incomplete forefins, and vertebrae collected in the Early Cretaceous deposits of Cerro Belgrano (Santa Cruz province, Argentina). After its original description (von Huene, 1925,1927), the material assigned to *P. hauthali* was mentioned by McGowan (1972), Bonaparte (1978), Gasparini and Goñi (1990), Maisch and Matzke (2000), Bonaparte et al. (2002), and by McGowan and Motani (2003), but it has not been redescribed.

A redescription of *P. hauthali* is particularly interesting in view of the improvement in knowledge of forefin homologies and the consequent reassessment of their systematic importance during the last few years (Motani, 1999a, b). It is also important in order to attain a better knowledge of the South American Cretaceous ichthyosaurs. The holotype is held in the Museo de La Plata collection. However, analysis of the forefin features shows that these are different from those of other species of the genus and are sufficient to allow its diagnosis. The goals of this paper are to re-describe the holotype and other referred material of *Platypterygius hauthali* and to present a diagnosis that permits its clear differentiation from other species in the genus, based on morphological characters besides its geological and geographical provincial ranges.

Geological Background

The ichthyosaur material (MLP 79-I-30-1 and 79-I-30-2) was collected by R. Hauthal at Cerro Belgrano at the beginning of the 20th century. The section was briefly described and illustrated by Wilckens (1905:fig. on p. 129) and reproduced later by Feruglio (1949:fig. 36). Figure 1A, a geological map of the area (Ramos, 1982), shows the general geology of the region including the probable site of the fossil locality. The original figure of Wilckens (1905) is shown as Figure 1B.

The Mesozoic sequences of this part of the Patagonian Andes rest on highly deformed sedimentary deposits of middle to late Paleozoic age of the Río Lácteo Formation (Metamorphe Gesteine of Hauthal in Wilckens, 1905). A strong angular unconformity, derived from the Gondwanan orogeny, separates these rocks from the volcanic, pyroclastic, and volcaniclastic deposits of the El Quemado Complex of Jurassic age (Porphyrtuff of Hauthal). Thick sedimentary sequences overlie the previous rocks and constitute the fill of the Austral basin. This basin opens towards the south, where the most complete Cretaceous sequences were deposited.

The volcanic relief was significantly eroded, prior to the deposition of thick blankets of intertidal quartzose sandstone facies of the Springhill Formation. This initial fill is dominant in the eastern flank of the basin, while the inner areas are covered by basinal-facies black shales of the Río Mayer Formation (Hatcher, 1897; Favre, 1908). Several fossil assemblages are known from this unit (Aguirre-Urreta, 2002). The regression of the Early Cretaceous sea is diachronically recorded as a sand progradation advancing from north to south, and from east to west. The dominant facies are represented by bioturbated green sandstones and shales of the Río Belgrano Formation bearing abundant *Hatchericeras* of early Barremian age (Ramos, 1979; Unt. Kreide of Hauthal). Facies indicate the transition to a littoral, near-shore, high-energy environment, up to the continental fluvial deposits of the Río Tarde and Cardiel Formations (Areniscas Abigarradas of Hauthal).

Tertiary molass deposits overlie basaltic rocks in the eastern foothills, and are in turn covered by younger basalt flows. Basalts

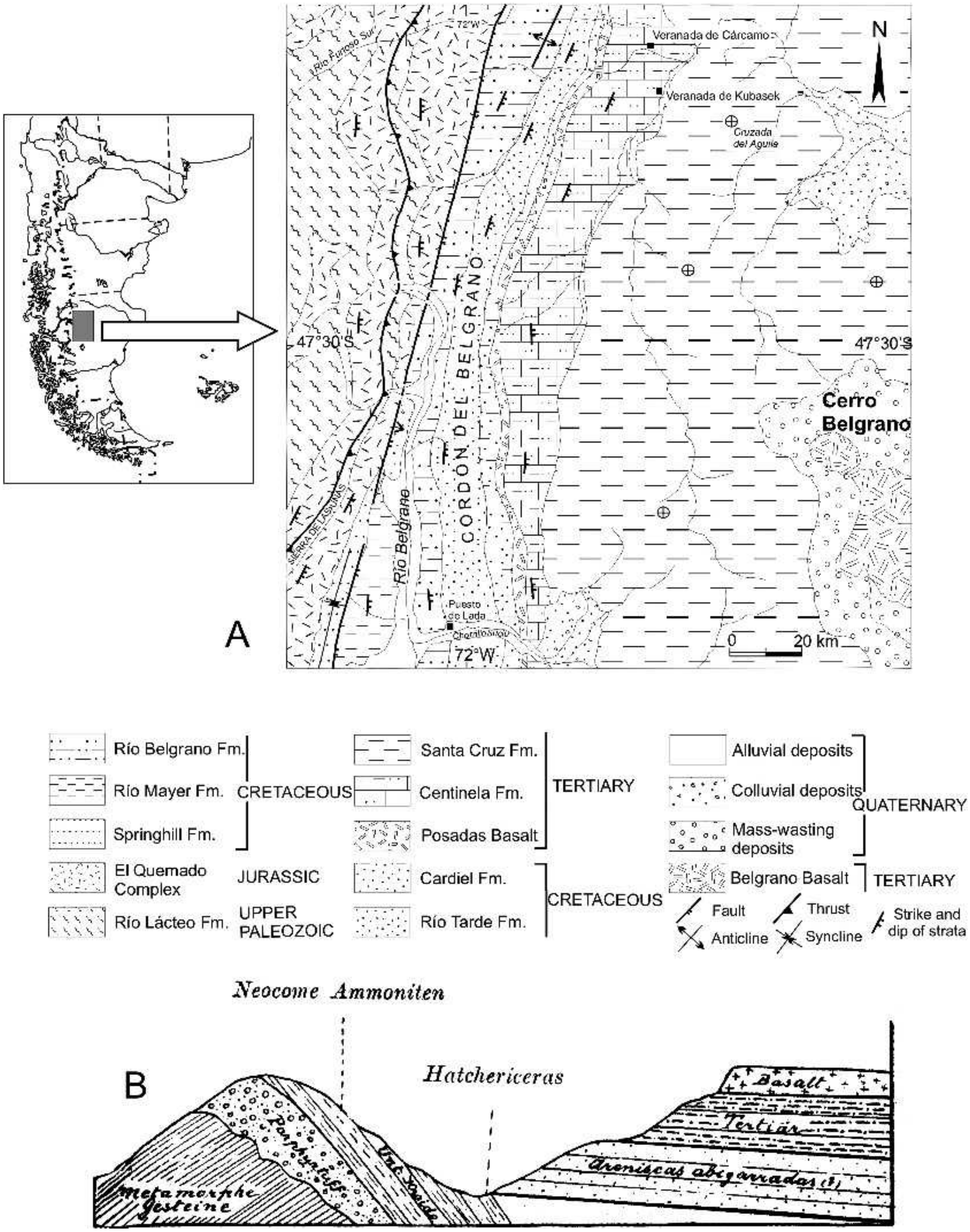

FIGURE 1. **A**, geological map of Cerro Belgrano area (modified from Ramos,1982). **B**, section illustrated by Wilckens (1905).

are widely distributed in the extra-Andean region, and are covered by glacial and alluvial deposits of Late Tertiary and Pleistocene age.

The ichthyosaurs were collected from the sandstones of the Río Belgrano Formation. The presence of abundant specimens of the ammonite *Hatchericeras* indicates an early Barremian age for these beds (Aguirre-Urreta, 2002).

Institutional Abbreviations—**MLP**, Museo de La Plata, Argentina; **QM**, Queensland Museum, Australia; **ROM**, Royal Ontario Museum, Canada; **UW**, University of Wyoming, USA.

SYSTEMATIC PALEONTOLOGY

Order ICHTHYOSAURIA de Blainville, 1835

Family OPHTHALMOSAURIDAE Baur, 1887

PLATYPTERYGIUS von Huene, 1922

PLATYPTERYGIUS HAUTHALI (von Huene, 1927)

Myobradypterygius hauthali von Huene, 1927:29.
Platypterygius hauthali: McGowan, 1972:17.
Platypterygius hauthali: Gasparini and Goñi, 1990:17.
Platypterygius hauthali: Maisch and Matzke, 2000:82.

Platypterygius hauthali: Bonaparte, Báez, Cione, and Panza, 2002:426.
Platypterygius hauthali: McGowan and Motani, 2003:124.

Emended Diagnosis—Differing from the other species of the genus by the following combination of characters: humerus with small facet for extrazeugopodial element anterior to radius; hexagonal intermedium articulating distally with two digits.

Holotype—MLP 79-I-30-1, left humerus and part of zeugopodium and autopodium (Figs. 2 A–B, 3 A).

Type Locality and Age—Cerro Belgrano, Río Belgrano Formation (Barremian), Santa Cruz province, Argentina (Aguirre-Urreta 2002; Bonaparte et al. 2002; Fig. 1)

Other Referred Material—MLP 79-I-30-2, slab with two different forefins on each side, four blocks with vertebral centra, from the type locality.

Occurrence—Type locality.

Comments—Specimens MLP 79-I-30-1 and MLP 79-I-30-2 are catalogued in the Departamento Paleontología Vertebrados (Museo de La Plata) collection as two different specimens. Specimen MLP 79-I-30-1 was described and figured by von Huene (1925) and specimen 79-I-30-2 was described and figured by him in a later contribution (von Huene, 1927). These materials are part of the Hauthal collection and no explicit data are available to confirm that they are slab and counter-slab of the same individual. However, the matrix containing them is very similar, and the comparable forefin elements are also very similar both in shape and size (Fig. 2). The only difference is that MLP 79-I-30-1 is slightly larger, but this could be due to plastic deformation. In the present contribution they are described separately, but the possibility that they correspond to the same specimen cannot be dismissed.

DESCRIPTION

General Remarks

The identification of forefin elements follows Motani (1999b). MLP 79-I-30-2 consists of vertebral centra without distinctive features, and a slab that preserves parts of a forefin on both surfaces. This material was first described by von Huene (1925:figs. 3–4) and, as he noted, there is no correspondence in the orientation of the digit axis in any of the two different-sized specimens; therefore, they are fragments belonging to two different forefins. One of them preserves part of the zeugopodium, mesopodium, and phalanges, while the other preserves only phalanges. The description below is based on the more complete one (Figs. 2C, 3A). In both of these fins, as well as in the holotype, most of the bone has been eroded but the outline of individual elements can be distinguished perfectly well (Fig. 2B).

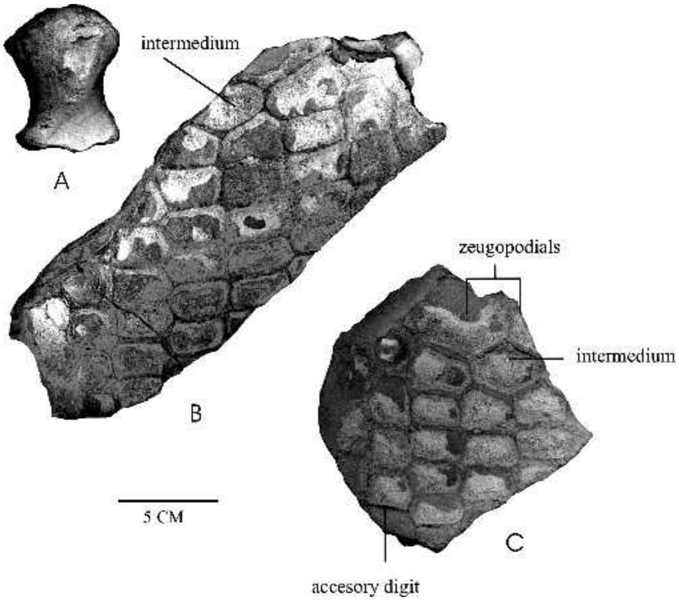

FIGURE 2. **A–B**, *Platypterygius hauthali*, MLP 79-I-30-1. **A**, humerus in dorsal view; **B**, fragment of the forefin; **C**, *Platypterygius hauthali*, MLP 79-I-30-2, fragment of a forefin.

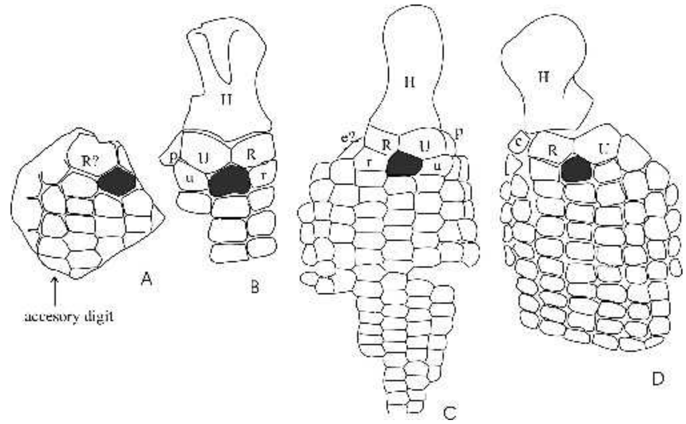

FIGURE 3. Comparison of forefins among different Cretaceous ichthyosaurs. **A**, *Platypterygius hauthali*, MLP 79-I-30-1; **B**, *Platypterygius americanus*, ROM 30.112 (cast of UW 2421); **C**, *Platypterygius platydactylus* (modified from Broili, 1907); **D**, *Platydactylus australis*, QM F3348. **B–D**, forefins in dorsal view. **Abbreviations: H**, humerus; **p**, pisiform; **R**, radius; **R?**, element identified as a radius by von Huene, 1925; **r**, radiale; **U**, ulna; **u**, ulnare; shaded areas, intermedium. Not to scale.

Forefins

The only humerus known is the left one from the holotype (Fig. 2A). It is complete expect for the dorsal process and the deltopectoral crest, which are broken. However, in both cases the scar outlines defining the two latter features have been preserved. The dorsal process is well defined and arises from the proximal end closer to the posterior margin than to the anterior one (in most ophthalmosaurids, the dorsal process is approximately equidistant from the anterior and posterior margins), and reaches farther distally, almost beyond the mid-shaft. Thus, the maximum length of the humerus is 72 mm, and the dorsal process measures 48 mm. On the proximal anterior part of the humerus there is a roughly triangular rugose area, which suggests the presence of cartilage covering this zone. The entire proximal and distal ends of this bone are rugose. The proximal end is strongly convex. This feature suggests that the specimen corresponds to a mature animal according to the criteria proposed by Johnson (1977). The distal end of the humerus has two main articular facets of approximately equal size. Anterior to the facet for the radius there is a small articular facet for the extrazeugopodial element. Although the distal end of the humerus of *P. hauthali* resembles that of *P. australis* (specimens QM3389 and QM 3348) in having a defined small facet for the extrazeugopodial element, in *P. hauthali* this facet is almost flat, while in *P. australis* it is concave, and the extrazeugopodial element has its proximal end strongly convex.

The zeugopodium has been partially preserved in the holotype and in MLP 79-I-30-2. In the known forefin of *Platypterygius* (e.g., QM 3348, 3389; Broili, 1907:fig.13, pl. LIV) radius and ulna can be identified based on their relative position but not on their morphology. In both specimens of *P. hauthali*, the contact with the humerus or the extrazeugopodial element is not preserved, such that it is impossible to determine the anterior and posterior margins, and consequently, the radius and ulna cannot be unequivocally identified. In the holotype, only a fragment of the distal part of one zeugopodial element has been preserved, but in MLP 79-I-30-2 one zeugopodial element is completely preserved as is its contact with the other zeugopodial element. This element is identified as part of the zeugopodium based on its larger size in comparison with the remaining elements of the fin. Von Huene (1925) described it as the radius. It is roughly pentagonal and medially contacts a small fragment of the other zeugopodial element, while distally it has three articular facets. The lateralmost one is the smallest and it bears a digit in which the two first elements are longer than wide. This type of phalanx is more common in the accessory than in primary digits; therefore, this is tentatively identified as an accessory digit (Fig. 3A). The other two distal facets articulate each with a carpal element. Of these two facets, the one placed medially contacts the intermedium. The latter (Fig. 3A) is hexagonal and wider than long. Its medial axis is just distal to the contact between radius and ulna. The identification of this element is in agreement with von Huene (1925, 1927). Although the intermedium is only partially preserved in the holotype, it has the same configuration as in MLP 79-I-30-2. In both specimens, it distally contacts two carpals, the facets for them being equal in size. The remaining part of the forefins is composed of polygonal elements. The phalanges have the typical brick-like outline that characterizes the genus *Platypterygius.* Based on the holotype forefin (Fig. 2B), *P. hauthali* has at least seven digits.

DISCUSSION

Cretaceous ichthyosaur material from Patagonia is very scarce. The most complete specimen known is of *Caypullisaurus bonapartei*, and consists of a complete skull and part of a vertebral column found in Berriasian levels of the Vaca Muerta Formation exposed at Yesera del Tromen (Neuquén province, Argentina) (Spalletti et al., 1999). The other known Cretaceous material is restricted to the specimens described herein; they had been included in a single species, *Platypterygius hauthali*, but without diagnosis (McGowan and Motani, 2003). However, the pattern of the carpus of *P. hauthali* differs from those of the species of the genus with best-preserved forefins, i.e., *P. australis* (M'Coy 1867), *P. platydactylus* (Broili, 1907) and *P. americanus* (Nace, 1939). In the last three species the intermedium has its distal edge formed by a main, almost straight, articular facet, which contacts carpal 3. This arrangement permits an alignment of the remaining elements of the fin, conferring a columnar aspect to the axis formed by: the radiale, carpal, and digit 2; the intermedium, carpal, and digit 3; and the ulnare, carpal, and digit 4 (Fig. 3). In *P. hauthali*, the distal edge of the intermedium is formed by two subequal facets contacting carpals 3 and 4, and the alignment of carpals and their corresponding digits can be traced distally to the distal carpal row. Until more complete material becomes available, this feature can be used to differentiate *P. hauthali* morphologically from the other members of the genus.

In their revision of Cretaceous ichthyosaurs, McGowan and Motani (2003) pointed out that *P. hauthali* could be a synonym of the contemporaneous European species, *P. platydactylus.* However, apart from the difference described above, the humerus of *P. hauthali* differs from the humerus of *P. platydactylus*, as well as from the humerus of *P. americanus*, in that the humerus in the two latter species has no distinct facet for contact with the extrazeugopodial element, and, at least in some specimens of *P. americanus*, there is a contact between the humerus and a pisiform posterior to the ulna (Fig. 3B). On the contrary, the humerus of *P. hauthali* resembles the Aptian–Albian Australian species *P. australis* in having a small, defined facet with the same orientation for contact between the humerus and the extrazeugopodial element anterior to the radius, and there is no evidence of contact between the humerus and a pisiform, posterior to the ulna.

Until more complete material becomes available, comparison between *P. hauthali* and the other early Cretaceous *Platypterygius* from South America (*P. sachicarum* Páramo, 1997) is not possible as there are no comparable elements in the type specimens of the two species. The only known specimen of *P. sachicarum*, the holotype, is a well-preserved and complete skull found in the Paja Formation, Arcillolitas Abigarradas Member (Barrenian–Aptian) of Colombia. We agree with Páramo (1997) in considering it a valid species although, as pointed out by her, it may prove to be a synonym of the contemporaneous South American *P. hauthali*. Nevertheless, it must be noted that there is a conspicuous difference in size: while *P. sachicarum* can be considered a medium-sized ichthyosaur based on its skull length (87 cm; Páramo, 1997:6) *P. hauthali* is a small ichthyosaur based on the size of the preserved parts (e.g., humerus of *P. hauthali* = 7.5 cm).

On the basis of the data and considerations presented above, as well as on the additional findings of ichthyosaurs in the Berriasian of Neuquén, Argentina (Spalletti et al., 1999), it can be concluded that there are three valid ichthyosaur taxa present in the Early Cretaceous of South America: *Caypullisaurus bonapartei*, which is the sister taxon of *Platypterygius* (Motani, 1999a), *Platypterygius hauthali*, and *P. sachicarum*.

ACKNOWLEDGMENTS

We thank Z. Gasparini (Museo de La Plata) for thoughtful commentaries on this paper, and V. A. Ramos (Universidad de Buenos Aires) for helpful geological information. We thank C. McGowan and R. Motani (Royal Ontario Museum) and R. Molnar (Queensland Museum, Australia) for access to material. M. Griffin helped with English translation. This research was partially supported by a grant (PICT 8439) from the Agencia de Promoción Científica y Tecnológica de Argentina and Facultad de Ciencias Naturales (Universidad Nacional de La Plata). We also thank R. Motani and two anonymous reviewers for their helpful comments and suggestions.

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Submitted 3 November 2004; accepted 27 January 2005.