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Short note on a pteranodontoid pterosaur (Pterodactyloidea) from western Queensland, Australia

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ABSTRACT

Flying reptiles from Australia are very rare, represented mostly by isolated bones coming from the Early Cret ceous (Albian) Toolebuc Formation, which crops out in western Queensland. Among the first pterosaur specime discovered from this deposit is a mandibular symphysis that some authors thought to have a particular affinity to speci found in the Cambridge Greensand (Cenomanian) of England. It was further referred as a member of or closely relat to one of the genera *Ornithocheirus, Lonchodectes* or *Anhanguera*. Here we redescribe this specimen, showing that cannot be referred to the aforementioned genera, but represents a new species of pteranodontoid (*sensu* Kellner 200 here named *Aussiedraco molnari* gen. et sp. nov. It is the second named pterosaur from Australia and confirms th the Toolebuc deposits are so far the most important for our understanding of the flying reptile fauna of this country.

Key words: Pteranodontoidea, Pterosauria, Toolebuc Formation, Cretaceous, Australia.

INTRODUCTION

To date, pterosaur findings in Australia are quite rare, being recovered in only a few deposits (Kear et al. 2010, Kellner et al. 2010; Fig. 1). The most important finds are from the marine Lower Cretaceous (Albian) Toolebuc Formation, western Queensland, which has yielded several isolated remains (e.g., Fletcher and Salisbury 2010). The first report on flying reptiles from this unit was made by Molnar and Thulborn (1980) who described three specimens, all housed in the Queensland Museum (QM): a mandibular symphysis (QM F10613), an incomplete vertebra (QM F10614), and a left scapulocoracoid (QM F10612). From these, the most interesting is the lower jaw (QM F10613), first regarded as representing a species closely related to *Ornithocheirus* Seele (Molnar and Thulborn 1980). This interpretati questioned by Unwin et al. (2000) who regarded th tralian lower jaw as *Anhanguera*? *cuvieri* (see al win 2001). Molnar and Thulborn (2007) later r this specimen to *Lonchodectes* Hooley, 1914, cently Myers (2010) referred it as aff. *Ornithoc* This disagreement is mainly based on the probl on how to define several taxa of the Cambridge sand (Cenomanian) of England, to which this Au species is regarded to be related. Here we revi lower jaw (QM F10613) and show that it is no able to *Ornithocheirus, Lonchodectes* or *Anha* but represents a new taxon, which we name *Auss*

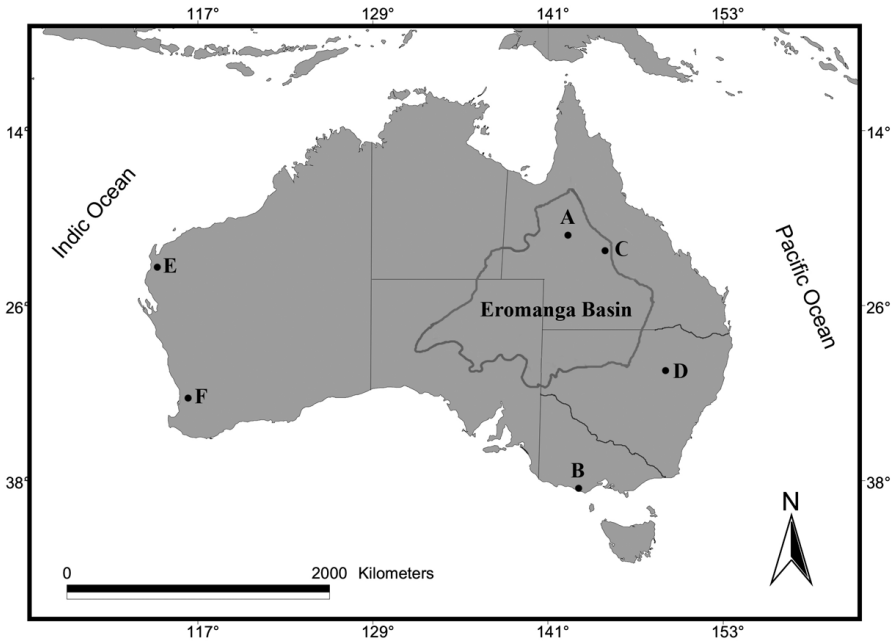

Fig. 1 – Australian pterosaur sites: (A) Toolebuc Formation (Albian); (B) Dinosaur Cove (Aptian/Albian); (C) Winton Formation (Albian); (D) Lightning Ridge (Albian); (E) Miria Formation (Maastrichtian); and (F) Molecap Greensand (Cenomanian/Conician). Adapted from Molnar and Thulborn (2007).

INSTITUTIONAL ABBREVIATIONS

CAMSM – Sedgwick Museum of Earth Sciences, Cambridge, England.
MN – Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
NHMUK – Natural History Museum, London, England.
QM – Queensland Museum, Brisbane, Australia.
SMNS – Staatliches Museum für Naturkunde, Stuttgart, Germany.
SMU – South Methodist University, Dallas, USA.
WAM – Western Australian Museum, Perth, Australia.

SYSTEMATIC PALEONTOLOGY

PTEROSAURIA Kaup, 1834
PTERODACTYLOIDEA Plieninger, 1901
PTERANODONTOIDEA Marsh, 1876
(*sensu* Kellner 2003)

Type-species: *Aussiedraco molnari* sp. nov., type by monotypy.

Diagnosis: As for the type species.

Aussiedraco molnari sp. nov.

Etymology: The species name honors Ralph E. Molnar who made many important contributions to our knowledge of Australian vertebrate fossils.

Holotype: Partial mandibular symphysis housed at the Queensland Museum (QM F10613), Brisbane, Australia; cast at the Museu Nacional (MN 4721-V), Rio de Janeiro, Brazil.

Locality and horizon: According to Molnar and Thulborn (1980), the specimen was collected some 13 km south of Hamilton Hotel, about 70 km east of Boulia, western Queensland, and comes from the Toolebuc Formation (Albian).

with an asterisk): dorsal margin of mandibular symphysis markedly convex*, ventral margin of the symphysis straight*, distal end of the symphysis not expanded laterally, mandibular symphysis slightly deeper than wide, deep but narrow dorsal sagittal groove that does not reach the tip of the mandibular symphysis, alveoli sub-equal in size.

DESCRIPTION

The specimen QM F10613 (Fig. 2) is three-dimensionally preserved and comprises the anterior part of a long mandibular symphysis, with 88 mm in length. As is common in pterosaurs, the mandible is lightly built, with very thin bone cortex. The presence of a narrow midline groove confirms that the fossil represents a lower jaw. The transversely convex dorsal surface is marked by this groove that runs towards the anterior part of the symphysis but does not reach its tip (Fig. 2b, c). The lateral surfaces are flat and slightly bent inwards at about 40°. These surfaces meet ventrally to form a sharp edge without either expansions or crests, resulting in a triangular cross-section that is somewhat deeper than wide.

The right dental margin bears five alveoli, none of them with teeth. The left dental margin bears four complete alveoli and the remains of a fifth one paired with the fifth of the right margin (Fig. 2c). The curvature of the dorsal surface reaches its maximum height ventral to the fourth pair of alveoli from where it decreases in depth both anteriorly and posteriorly (Fig. 2a, b). The alveoli are elliptical, longitudinally longer in shape, with relatively similar sizes of their anteroposterior diameters and forming distinct bulges in the dental margins. Their size and structure indicate an isodont dentition at the front of the symphysis. As reported in the original description (Molnar and Thulborn 1980), only the fourth alveolus contains a small, incompletely erupted replacement tooth with a thin, lateromedially compressed crown. This tooth does not fill its alveolus, and thus represents a replacement stage after the loss of the former functional tooth (Edmund 1960).

Dorsally, the dental margins are quite straight be-

This arrangement could allow an interlocking of
per and lower teeth (Molnar and Thulborn 2007)
at the tip of the symphysis. The first to the fourt
oli face more dorsolaterally, while the fifth alveol
more dorsally. This arrangement could have pr
the anteriormost teeth outwards, with the first
probably carrying near-procumbent teeth. The s
between the first and the second alveoli is smalle
pared to the other well-spaced ones, with the fou
fifth alveoli being more separated from each othe

DISCUSSION

The elongate mandibular symphysis shows th
specimen is a member of the Pterodactyloidea (Ar
pterodactyloidea + Dsungaripteroidea), since non
dactyloid pterosaurs either have a very short man
symphysis or no symphysis at all (e.g., Kellner
Unwin 2003, Wang et al. 2009, 2010). Regard
fact that it is a toothed pterosaur, a taxonomic
ment for this specimen excludes most of dsung
roids, except the Pteranodontoidea. According t
ner (2003) this clade comprises *Pteranodon* (P
dontidae), the Istiodactylidae, *Ornithocheirus* a
Anhangueridae. *Pteranodon* and other members
Pteranodontidae are toothless (e.g., Bennett 1994
ner 2010) and therefore *Aussiedraco molnari*
cluded from this clade. The shape of the alve
the sole preserved replacement tooth clearly sho
the Australian species is also not a member of th
dactylidae that includes species with a peculiar de
formed by strongly laterally compressed teeth wi
angular crown (Howse et al. 2001, Andres and J
Wang et al. 2008). Furthermore, *Aussiedraco mo*
also not a member of the Anhangueridae that is
terized by the presence of a dentary crest and by
the symphysis expanded (e.g., Kellner 2003).

Aussiedraco molnari also differs from al
toothed pterosaurs that are regarded as members
Pteranodontoidea (*sensu* Kellner 2003) such as
dactylus sibbicki and *Brasileodactylus* cf. *arar*
(Sayão and Kellner 2000, Frey et al. 2003) due
presence of a convex dorsal surface of the lower

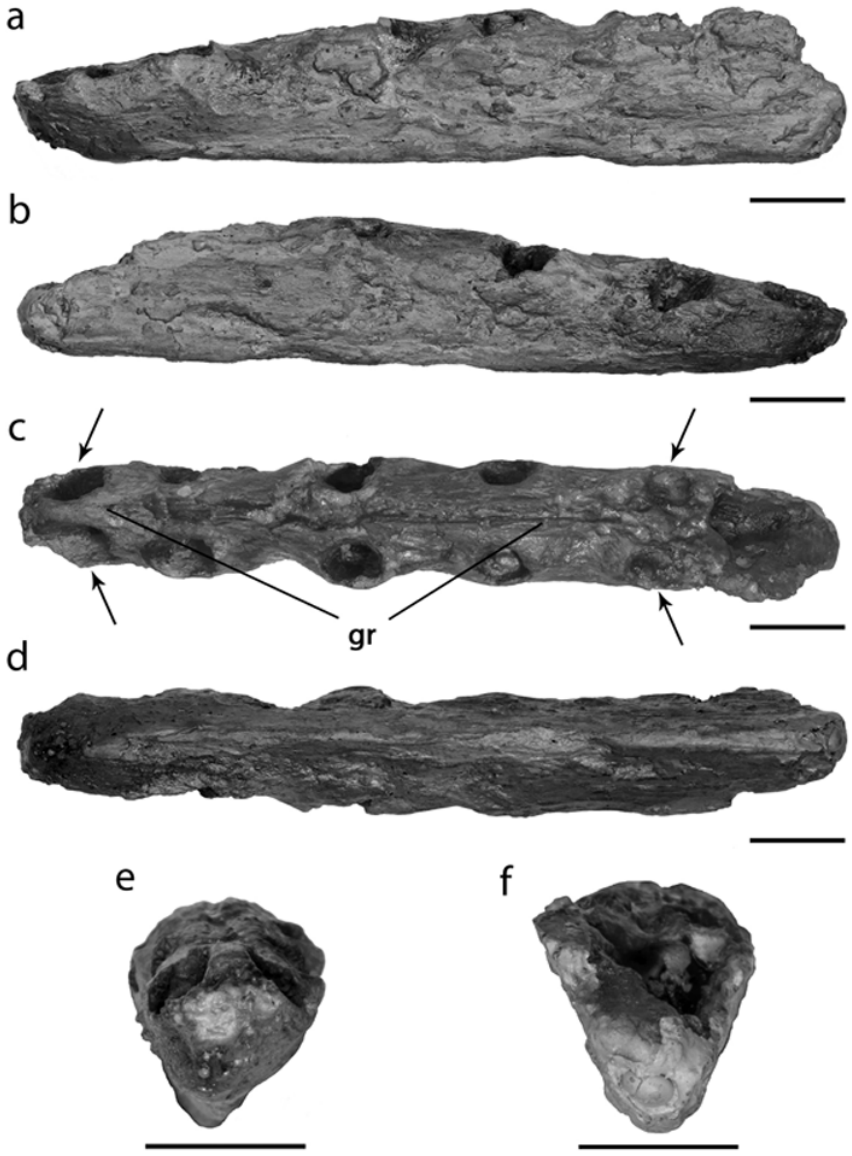

Fig. 2 – *Aussiedraco molnari* gen. et sp. nov. from the Toolebuc Formation, western Queensland, Australia. Cast (MN 4721-V) of the holotype (QM F10613). Mandibular symphysis: a, left lateral; b, right lateral; c, dorsal; d, ventral; e, anterior and f, posterior views. Setae indicate the first and last alveoli on each side. Abbreviation: gr – groove. Scale bar: 10 mm.

as aff. *Ornithocheirus* sp. More recently, in light of new publications (i.e., Unwin 2001), these authors re-evaluated their initial assignment and regarded the previously assigned the Australian lower jaw to *Anhanguera*? *cuvieri* and recently Myers (2010) referred it to aff. *Ornithocheirus*.

the Australian species can be made. Only upper jaws can be doubtlessly referred to *Ornithocheirus simus* and therefore the comparisons with *Aussiedraco* are limited. Although *Ornithocheirus simus* resembles *Aussiedraco* in not possessing a distal expansion of the skull, in the former the distal end is more rounded, suggesting that also the lower jaw might have had this shape, which differs from the relatively lanceolated mandibular tip present in the Australian material.

The Lonchodectidae *sensu* Unwin (2001) includes species that share the presence of small, uniformly spaced teeth, with a wide dorsal groove on the lower jaw, features that contrast with *Aussiedraco molnari*. The type material of *Lonchodectes compressirostris* (NHMUK PV 39410) includes a heavily compressed mandibular symphysis, which presents oval alveoli, in contrast to the more elliptical alveoli present in QM F10613. *Lonchodectes giganteus* (holotype NHMUK PV 39412) differs from QM F10613 by the rounded tip of the mandible, by the presence of a mandibular crest, and by an elevated alveolar margin. *Lonchodectes machaerorhynchus* (holotype CAMSM B54855) is known by a very distinctive piece of the mandibular symphysis lacking the tip. It differs from the Australian material by the presence of a thin crest and a much larger mandibular groove. The type specimens of *Lonchodectes microdon* (holotype CAMSM B54486) and of *Lonchodectes platystomus* (CAMSM B54835) comprise only upper jaws (Seeley 1870), while the holotype of *Lonchodectes sagittirostris* (NHMUK PV R 1823) has only mandibular rami preserved, lacking a symphysis. Thus, these species cannot be objectively compared to QM F10613. The same applies for *"Ornithocheirus" cuvieri* whose holotype is an upper jaw (NHMUK PV 39409). Although the review of the Cambridge Greensand pterosaur fauna is beyond the scope of this paper, we would like to note that *"Ornithocheirus" cuvieri* lacks the expanded distal end of the premaxillae and the tooth disparity typical of *Anhanguera*, and we see no grounds to refer this species to this genus, as previously done (Unwin 2001).

There is an overall similarity between *Aussiedraco*

R 540, R 2277, 35412a; CAMSM B 54893). The
the symphyses are lanceolate and size differences
the alveoli are not very discrepant. Although NH
PV R 540 and R 2277 are too fragmentary to eva
they had similar tooth spacing patterns as *Aussiedr*
NHMUK PV 35412a and CAMSM B 54893 the
between the second to the fifth alveoli are not
than their diameters. Furthermore, the dorsal sur
the lower jaw in both is straight and the ventral
convex, thus differing from the Australian specie

Outside England, other specimens were refe
Ornithocheirus or the Ornithocheiridae. Among
"Ornithocheirus" wiedenrothi (holotype SMNS
from Germany that differs from *Aussiedraco mol*
the curved ventral margin of the lower jaw, lack
convex dorsal margin, and by the presence of
developed and sharp process on the tip of the s
ysis (Wild 1990).

Recovered from Upper Cretaceous depo
Texas and referred to the Ornithocheiridae, *Aetod*
halli (holotype SMU 76383) differs from *Aussi*
molnari by the great number of teeth, which ar
closely spaced, and by being strongly compressed
ventrally (Myers 2010).

Regarding other pterosaur material from Au
most consists of isolated elements that are not c
rable with the lower jaw of *Aussiedraco molna*
Kellner et al. 2010 for a review). Molnar and Th
(2007) erected *Mythunga camara* that was re
as a member of the Archaeopterodactyloidea, bu
ner et al. (2010) relocated this species to the P
dontoidea, closely related to (but not a member
Anhangueridae or Onithocheiridae (the latter r
redefinition). Comparisons with *Aussiedraco m*
are limited since *Mythunga camara* lacks the dist
of the jaws. Nevertheless, *Mythunga camara* bel
a comparatively larger animal and has the preserv
tion of the mandibular symphysis comparatively
than *Aussiedraco molnari*. We agree with Moln
Thulborn (2007) that *Mythunga camara* and the
jaw QM F10613 (the holotype of *Aussiedraco m*
belong to distinct taxa.

mandibular symphysis (QM F44423). The material is apparently less preserved than the holotype of *Aussiedraco molnari* (QM F10613), lacking the distal end and most of the ventral portion. Based on the published pictures, QM F44423 has the dorsal and ventral margins of the mandibular symphysis respectively, straight and convex, quite the contrary to the condition observed in *Aussiedraco molnari*.

Another Australian jaw fragment (WAM 68.5.11) was described by Kear et al. (2010) and comes from the Upper Cretaceous (Cenomanian/Coniacian) Molecap Greensand. This material is extremely fragmentary and it is not possible to determine if it belongs to the upper or lower jaw. WAM 68.5.11 presents two consecutive alveoli and, based on their morphology, the authors have identified it as an ornithocheirid (*sensu* Unwin 2003) or an anhanguerid (*sensu* Kellner 2003). These alveoli are more separated from each other than the ones preserved in *Aussiedraco molnari*, but a wider separation should be expected if this fragment comes from a more posterior portion of the jaw. As both specimens come from different lithostratigraphical units and have different ages, they possibly do not represent the same species (see discussion in Kellner 2010), although more complete material is in need to better evaluate this matter.

CONCLUDING REMARKS

Although the potential for more complete pterosaur findings is present in the Toolebuc Formation, for over three decades since the first discovery (Molnar and Thulborn 1980) only fragmentary and isolated remains have been found (Kellner et al. 2010, Fletcher and Salisbury 2010), similar to what has been observed in other deposits such as the Tendaguru layers (e.g., Costa and Kellner 2009) and the Kem Kem beds of Morocco (e.g., Wellnhofer and Buffetaut 1999). As a result, authors named new species based on incomplete specimens (e.g. Unwin and Heinrich 1999, Ibrahim et al. 2010) if a diagnostic combination of characters could be found (see Kellner 2010). Having a fossil record composed of incomplete material is particularly the case of Australian deposits (e.g., Rich and Rich 1989), in-

Based on the above comparisons, we conclude that QM F10613 neither can be referred to *Ornithocheirus* nor can be stated as *Lonchodectes* or *Anhanguera* due to the dentition, lack of dentary crest and the outline of the mandibular symphysis. The size and shape of the alveoli and the presence of a midline groove indicate that the Australian species is a member of the Pteranodontoidea, occupying a more derived position relative to *Pteranodon* (and other related taxa) and the Istiodactylidae, being closely related to (but not a member of) the Anhangueridae. This specimen further shows a distinct combination of features and is here regarded as belonging to a new taxon, *Aussiedraco molnari*. The new species shows that distinct pterosaurs are present in the Toolebuc deposits, which so far have yielded most material of flying reptiles from Australia.

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RESUMO

Répteis voadores da Austrália são muito raros e, na maioria dos casos, representados por ossos isolados procedentes da Formação Toolebuc (Cretáceo, Albiano), da região leste de Queensland. Entre os primeiros espécimes de pterossauros coletados nestes depósitos encontra-se uma sínfise mandibular que alguns autores acreditaram possuir afinidades com formas encontradas no Cambridge Greensand (Cenomaniano) da Inglaterra. O exemplar acabou sendo classificado como representando uma espécie pertencente ou proximamente relacionada aos gêneros *Ornithocheirus, Lonchodectes* ou *Anhanguera*. Neste trabalho nós redescrevemos este espécime e demonstramos que o mesmo não pode ser referido aos gêneros mencionados, mas representa uma nova espécie de pteranodontóide (*sensu* Kellner 2003), aqui denominada de *Aussiedraco molnari* gen. et sp. nov. Este exemplar constitui a segunda espécie de pterossauro da Austrália a ser denominada e confirma a que os depósitos de Toolebuc são até o momento os mais importantes para a pesquisa de pterossauros desse país.

Palavras-chave: Pteranodontoidea, Pterosauria, Formação Toolebuc, Cretáceo, Austrália.

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