New remains of the baluchitherine *Paraceratherium bugtiense* (Pilgrim, 1910) from the Late/latest Oligocene of the Bugti hills, Balochistan, Pakistan

Pierre-Olivier Antoinea,b,c,*, S.M. Ibrahim Shahd, Iqbal U. Cheemad, Jean-Yves Crochetb,c, Dario de Franceschic,e, Laurent Marivauxb,c, Grégoire Métaisb,c, Jean-Loup Welcommeb,c

aLaboratoire des Mécanismes de Transfert en Géologie, UMR 5563 CNRS, Université Toulouse-III, 38 rue des 36 ponts, F-31400 Toulouse, France

bInstitut des Sciences de l’Évolution, CC 064, UMR 5554 CNRS, Université Montpellier-II, Place Eugène-Bataillon, F-34095 Montpellier cedex 5, France

cMission Paléontologique Française au Balouchistan, La Confrérie, F-34270 Le Triadou, France

dPakistan Museum of Natural History, Garden Avenue, Shakarparian, Islamabad 44000, Pakistan

eLaboratoire de Paléontologie, UMR 8569 CNRS, Muséum National d’Histoire Naturelle, 8 rue Buffon, F-75005 Paris, France

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Abstract

New dental and postcranial remains referred to the giant rhinocerotoid *Paraceratherium bugtiense* are described, originating from its type locality (Lundo Chur), in eastern Balochistan (Pakistan). Probable sexual dimorphism is revealed on the lower incisors. The manus was tridactyl, with a reduced fifth metacarpal. The stratigraphic range of both *P. bugtiense* and the amynodontid *Cadurcotherium indicum* extends from the Early Early Oligocene to the Late/latest Oligocene in the Bugti Hills.

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1. Introduction

The baluchitheres—or indricotheres—number among the largest land mammals that ever lived (Osborn, 1923; Granger and Gregory, 1936; Fortelius and Kappelman, 1993). These giant rhinocerotoids had a widespread distribution in Asia during the Oligocene period (Lucas and Sobus, 1989). Still, the first indricothere ever described was *Paraceratherium bugtiense* (Pilgrim, 1908) from ‘Chur Lando’ in the Bugti Hills of eastern Balochistan, central Pakistan (Fig. 1). This taxon was named on the basis of large dental and cranio-mandibular elements (Pilgrim, 1910, 1912; Forster-Cooper, 1911, 1913a,b, 1924, 1934). However, huge skeletal remains from the same area—for which the correct local name and spelling are ‘Lundo Chur’—were first referred to another rhinocerotoid taxon: *B. osborni* (Forster Cooper, 1913b). Owing to associated limb bones and cranio-dental remains, documenting other indricotheres in the Oligocene of Kazakhstan (Borissiak, 1915, 1923; Pavlova, 1922) and Mongolia (Osborn, 1923; Granger and Gregory, 1935, 1936), the genus *Baluchitherium* was later recognized as a junior synonym of *Paraceratherium* Forster-Cooper, 1911 (Matthew, 1931; Gromova, 1959; Lucas and Sobus, 1989; Fortelius and Kappelman, 1993).

Since 1910, nobody could investigate the Tertiary of the Bugti Hills because of the incessant tribal clashes in the vicinity of the Bugti-Marri Agency. Yet, a team of the Geological Survey of Pakistan (GSP) got permission to undertake short fieldwork in the Lundo Chur area in 1985 and 1987 (Shah and Arif, 1992). More recently, seven fieldwork seasons in the Bugti Hills (1995–2002) led by a French-Balochi paleontological team (Mission Paléontologique Française au Balouchistan, MPFB) have thoroughly reviewed and updated both the geology and paleontology of the Tertiary of that area (Fig. 2; Welcomme and Ginsburg, 1997; Welcomme et al., 1997, 1999, 2001; Antoine and Welcombe, 2000).
This article deals with undescribed fossil remains (Fig. 3), unearthed in the yellow sands of the Lundo Chur J2 locality (Antoine et al., 2003b) during the mid 1980s GSP fieldtrips. They are stored in the collections of the Pakistan Museum of Natural History (PMNH) in Islamabad. We have studied these specimens during the January/February 2003 MPFB-PMNH joint project. All of them are referred to *P. bugtiense*.

2. Systematics

Order Perissodactyla Owen, 1848
Family Hyracodontidae Cope, 1879
Subfamily Indricotheriinae Borissiak, 1923
Genus *Paraceratherium* Forster-Cooper, 1911
*Paraceratherium bugtiense* (Pilgrim, 1910) (Fig. 3)

_Referred material and measurements. M.V.103, left fragmentary maxilla with M2–M3 (M2: length = 82; anterior width = 80; posterior width = 69; height = 44/M3: length = 86; anterior width = 76.5; posterior width = 56; height = 50); M.V. without number, fragmentary palate with left M2 and M3 (much worn); M.V.86, left lower incisor (female?) (preserved length = 120; width = 35; height = 48; antero-posterior diameter of the crown > 32; root width = 31; root height = 40); M.V.87, right lower...
Fig. 3. *P. bugtiense* (Pilgrim, 1910). Late/latest Oligocene of Lundo Chur, Bugti Hills, Balochistan, Pakistan. (A) left maxilla with M2–M3, PMNH M.V.103, occlusal view; (B) left maxilla with M2–M3, PMNH M.V. without number, occlusal view; (C) left i1 (female?), M.V.86, in rostral view (C1), lingual view (C2), and caudal view (C3); (D) right i1 (male?), M.V.87, in rostral view (D1), lingual view (D2), and caudal view (D3); (E) left magnum, M.V.45, anterior view; (F) left unciform, M.V.46, in anterolateral view (F1) and posterolateral view (F2); (G) right calcaneus, lateral view. All the specimens are stored in the Pakistan Museum of Natural History in Islamabad. Scale bar = 5 cm (all the specimens are × 0.5).
incisor (male?) (preserved length = 108; width = 36.5; height = 47.5; antero-posterior diameter of the crown > 35; root width = 39; root height = 45); M.V.45, left broken magnum (transverse diameter > 134; anterior height = 84; transverse diameter of the McIII-facet = 130); M.V.46, left unciform (transverse diameter = 102; height = 104; antero-posterior diameter = 143; Semilunate-facet: transverse diameter = 45/antero-posterior diameter = 107; Pyramidal-facet: transverse diameter = 48/antero-posterior diameter = 108; Magnum-facet: transverse diameter = 29/antero-posterior diameter = 55; McIII-facet: transverse diameter = 32/antero-posterior diameter = 66; McIV-facet: transverse diameter = 55/antero-posterior diameter = 105); M.V.69, left broken calcaneus (height > 215; articular height = 98; transverse diameter of the tuberosity = 76; transverse diameter of the sustentaculum > 96; Minimal posterior transverse diameter = 52; Astragalus-facet: triangular, with a large anterior side and a thin posterior tip. These teeth display a straight ecteretaloph with a robust hypocone. There is a vertical and conical spur on the posterolateralial side of M3. It might be expected that this spur is a metastyle inasmuch as the latter is usually retained in most of hyracodontids. This spur, associated with the posterior cingulum, forms a shallow postossette. The posterior cingulum is developed apart from the spur, surrounding it on both M3. After wear, the vestigial ridge (metastyle) is joining the ecteretaloph, thus reproducing distinct ecteretaloph and metaloph.

The magnus (M.V.45) is a massive bone, on which the posterior part is broken. In proximal view, the magnus is triangular, with a large anterior side and a thin posterior tip. The whole proximal surface is articulated. The kidney-shaped anterior facet, for the scaphoid, is nearly flat and extends backward as a narrow stripe. Postero-laterally to it, is the semilunate-facet, crescent-like and convex sagittally. This facet is elongated anteroposteriorly and widens backwardly. In anterior view, the magnus is trapezoidal, wide and low, with a straight proximal border and an oblique lateral border (bone narrower proximally). The anterior side is free of articular facet (Fig. 3E). A thick and salient pad (insertion of the M. extensor digitorum) occupies the centre of the anterior side. It is still more salient laterally. The distal border is slightly convex. The medial side displays a large trapezoidal-facet, contiguous to the anterior border, on the whole height of the bone. It displays a median constriction, posteriorly to a tendon insertion. The bone is depressed backwardly, forming a deep fossa with a rough surface. In lateral view, the bone is roughly square, with a S-shaped posteroproximal semilunate-facet and a large posterodistal unciform-facet (triangular). The distal side is subtriangular and essentially articulated with the McIII. Yet, a small triangular McII-facet is located at the anteromedial tip of the bone. The posterolateral border of the McIII-facet is deeply inflected due to a muscular/tendon insertion.
The unciform (M.V.46) is massive, deeper than wide. The posterior tuberosity is extremely reduced, especially with respect to that of rhinocerotids (Fig. 3F). Most of the proximal side is occupied by two articular facets, sagittally elongated: the medial one (semilunate-facet) is L-shaped. Contiguous to it, the pyramidal-facet has a kidney-shaped outline. They are flat transversely, except in the posterior tip of the pyramidal-facet, which is concave. Both facets are equally developed. They have a sigmoid vertical cross section (sagittal). In front of the articulation lays a thick rounded tubercle corresponding to the insertion for the M. interossei. The anterior side is not articulated. It forms a quarter circle, the right angle being proximolaterally situated. The surface is smooth, except for the salient muscular insertion, which strengthens along the distomedial border of the bone. It is extremely developed mediadly (exceeding 20 mm in height). The mediodistal border is regularly convex. In medial view, the unciform is roughly rectangular. The proximal border (semilunate-facet) is sigmoid, concave anteriorly and convex posteriorly. This facet nearly reaches the posterior tip of the bone. A narrow sagittal magnum-facet, vertical and sinuous occurs on it distally. The McIV-facet appears as an oblique stripe occupying the anterior half of the distal border. The lateral side is essentially non-articulated, except in its posterior third, with the posterior part of the pyramidal-facet, concave transversely and strongly convex sagittally. Distally to it is a deep fossa, below which the McV-facet is visible. This facet forms a small triangle (28 mm in height). The McV-facet is hardly visible, since it is essentially flat, apart of a slight concavity in its proximal third.

**Discussion.** Several morphological features—large and conical I, thick enamel, strong antecrochet on upper molars, ectoloph and metaloph fused and hypocone strongly developed on M3, reduced posterior tuberosity on the unciform, acute angle between the distal side and the anterior side on the calcaneus (60° instead of 90° in other perissodactyls)—, as well as the huge dimensions and proportions of the postcranials characterize the derived indricotheriine genus Paraceratherium (sensu Lucas and Sobus, 1989), i.e. including Indricotherium Borissiak, 1915). Moreover, the dental morphology is typically that of P. bugtiense (Forster-Cooper, 1911, 1913a, 1924, 1934; Pilgrim, 1908, 1910, 1912): among indricotheres, a lingual groove on the protocone of M2 and a spur-like metastyle on M3 are only observed in the specimens from Lundo Chur, described and illustrated by Pilgrim (1912; M3 C283) and Forster-Cooper (1924) and (1934).

The differences between both I1 (circular/pear-like cross section; cylindrical/conical root; strong/tenuous lingual cingulum) were formerly observed in other indricotheres, and interpreted as documenting two different taxa (Granger and Gregory, 1936). In agreement with Lucas and Sobus (1989), we rather consider such differences as expressing a sexual dimorphism within a single taxon, particularly since similar schemes are observed in the anterior dentition of several fossil rhinocerotid species (Antoine, 2002). In that respect, M.V.86 could belong to a female, and M.V.87 to a male. As a matter of fact, a strong sexual dimorphism, based on body size, was already suggested for P. transouralicum by Fortelius and Kappelman (1993).

The fifth metacarpal of P. bugtiense is undocumented so far. However, the orientation of the McV-facet on the unciform of the ceratomorph perissodactyls (tapirs, rhinos, and their extinct relatives) depends on whether the fifth metacarpal is developed or not (Antoine, 2002). As this facet is vertical on the unciform M.V.46, one can deduce that P. bugtiense had a reduced McV, like in P. prohorovi and P. transouralicum (Granger and Gregory, 1936; Gromova, 1959) but unlike Juxia from the late Eocene-early Oligocene of Asia (Lucas and Sobus, 1989). In the latter taxon, the fifth metacarpal and its phalanges are fully developed (Heissig, 1989).

**3. Age of the ‘Paraceratherium/Cadurcotherium beds’ in the Bugti Hills**

The age of the ‘Paraceratherium beds’ in Balochistan has been disputed (Oligocene vs early Miocene (Pilgrim, 1912; Raza and Meyer, 1984; Lucas and Sobus, 1989; Shah and Arif, 1992)) until an Oligocene age was argued (Welcomme and Ginsburg, 1997), then corroborated on a biochronological
basis thanks to new collections (Welcomme et al., 1999, 2001; Antoine et al., 2003a,b; Métait et al., 2003). In fact, recent fieldwork by the MPFB have established that indricotheres were occurring in five successive levels (0–3 on the northern side of the Zin Range; 0 to J2 on the southern side of it; Figs. 1 and 2), i.e. all along the Bugti Member of the Chitarwata Formation (Fig. 2).

A similar dating problem concerns the poorly documented amynodontid Cadurcotherium indicum, for a long time restricted to its type locality in the eastern part of the Bugti Hills (‘Upper Nari of Khajur Nala’; Pilgrim, 1910, 1912). Preliminary study, based on new findings by the MPFB (unpublished data), states that C. indicum is strictly contemporary with P. bugtiense (Fig. 2). This large amynodontid occurs from the basal ferruginous crust of the Bugti Member (0 in Fig. 2) up to a lateral equivalent of Lundo Chur J2, on the northern side of the Zin Range (3 in Fig. 2; ‘Kumbi 3’ locality; Welcomme et al., 2001).

As a matter of fact, the yellow sands of Lundo Chur J2 represent the uppermost indricothere-bearing levels in the Bugti Hills (Fig. 2): the mammal fauna includes P. bugtiense, the rhinocerotid Aproton, the entelodontid Paraentelodon, and the pseudo-bovid Palaeohyp sodontus (Welcomme et al., 2001; Antoine et al., 2003a; Métait et al., 2003). In addition to Paraceratherium, these taxa are limited to several Palaeogene localities throughout Asia (Antoine et al., 2003a; Métait et al., 2003). Besides, a complete faunal turnover is observed between Lundo Chur J2 (= DB3 = Kumbi 3) and the following levels, 25 m above (DBM = DB3bis), according to Welcomme et al. (2001): by contrast, these conglomelates yield a typical Early Miocene fauna, with elasmotherine rhinocerotids, deinotheres, bovids, and listriodontine suids (Antoine and Welcomme, 2000; Welcomme et al., 2001). Thus, although an earliest Miocene age cannot be excluded for the Lundo Chur J2 locality (fission track dating of 22.6 ± 2.9 Ma in the vicinity of it (Tabbutt et al., 1997)), we do consider it as the uppermost indricothere-bearing levels in the Bugti Hills (‘Upper Nari of Khajur Nala’, Fig. 2; ‘Kumbi 3’ locality; Welcomme et al., 2001).

To sum up, the stratigraphic range of both P. bugtiense and C. indicum extends from the Early Oligocene (levels 0 and C2; Marиваux et al., 1999, 2001; Antoine et al., 2003; Marivaux and Welcomme, 2003b) up to the Late/latest Oligocene (Lundo Chur J2; this work) in the Bugti Hills.

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