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FURTHER MATERIAL OF THE CERATOSAURIAN DINOSAUR *SYNTARSUS* FROM THE ELLIOT FORMATION (EARLY JURASSIC) OF SOUTH AFRICA

by

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ABSTRACT

Two further fossils recovered from the Elliot Formation in South Africa are referred to the ceratosaurian genus *Syntarsus*: a partial pelvis and a well preserved and articulated snout.

The pelvic fragment consists of most of the posterior end of the left ilium and sacrum, with a small part of the right ilium attached. The acetabular area and 'brevis shelf' of the left ilium are well preserved, as is the ventral surface of the sacrum. These parts show features characteristic of *Syntarsus* material from Zimbabwe.

The snout has the premaxillae, maxillae, nasals and dentaries from both sides preserved, of which only the premaxillae are more or less complete. The premaxilla has four alveoli and the maxilla nine, and the maxilla bears the characteristic dimpling on its lateral surface also seen in *Syntarsus* material collected in Zimbabwe. The snout also possesses the characteristic small diastema or subnarial gap between the premaxillary and maxillary teeth shown by *Syntarsus* material from elsewhere. The snout is strongly compressed bilaterally and the jaws are tightly closed, so that the dentary teeth are obscured beneath the upper dentition. This compression has crushed the palatal region, obscuring palatal details.

KEYWORDS: Dinosauria, Theropoda, Elliot Formation, Jurassic, Stormberg

INTRODUCTION

The remains of *Syntarsus rhodesiensis*, a small ceratosaurian theropod dinosaur, were first recovered from three sites in the Forest Sandstone Formation of Zimbabwe (?Late Triassic to Early Jurassic), one in the southwest of the country – the type locality at Nyamandhlovu – and two in the north-central region in the Zambezi Valley, on the Chitake and Maura Rivers. The two Zambezi Valley localities have yielded many fossils of a limited number of taxa, mostly prosauropod dinosaurs, and the Chitake River locality in particular has yielded many individual specimens of *Syntarsus* (Raath 1969, 1977; Bond 1973). Material has been recovered in all stages of articulation, from isolated individual bones to fully articulated partial skeletons (Raath 1977).The holotype is an almost complete articulated skeleton.

A second species, *S. kayentakatae*, was described by Rowe (1989) from the Kayenta Formation of Arizona, USA, and there is also evidence of a small theropod very similar to *Syntarsus* from deposits of comparable age in South Wales (D. Warrener, *pers. comm.*, 1980).

Isolated remains of *Syntarsus* from the Karoo Supergroup in South Africa were first reported by Raath (1980), and this was also the first record of ceratosaurian dinosaurs from South Africa. All the South African remains of *Syntarsus* found so far come from within or near the *Tritylodon* Acme Zone, which lies at the top of the Middle Elliot Formation (Stormberg Group, Karoo Supergroup) (Kitching and Raath 1984). This zone is one to three metres thick and is characterised by an abundance of small (<60mm) pedogenic carbonate concretions. There is a fairly high diversity of tetrapod fossils in this zone, dominated by the prosauropod dinosaur *Massospondylus* and the cynodont therapsid *Tritylodon*, from which the acme zone gets its name. In this fauna, apart from *Syntarsus*, are also found fabrosaurid ornithischians, tritheledontid cynodonts, early mammals, protosuchian crocodilians and a chelonian (Kitching and Raath 1984).

The *Syntarsus* material found in South Africa until now has consisted only of isolated fragmentary postcranial remains, including femoral and tibial fragments, isolated bones from the pes and a few vertebrae. This note records the recovery of a partial pelvis and a relatively well preserved snout of *Syntarsus* from two localities on adjoining farms in the northeastern Free State Province, South Africa. They were found by J W Kitching in 1981 and 1985 respectively, the snout on the farm *Paradys*, and the pelvic fragment on an adjacent area between the adjoining farms *Welbedacht* and *Edelweiss* (all localities situated in the Ladybrand District, Free State Province, on 1:50 000 map sheet 2927 AB, Ladybrand) (Figures 1, 2).

The pelvis is uncompressed, but shows extensive fine surface cracking and crazing presumably due to sub-aerial exposure and sun-baking. Haematite coating is much less of a problem in this specimen than in the

case of the snout. The pelvis is relatively small, although the extent of fusion and coalescence of bone in the sacral region suggests that it may be from a mature individual.

The snout is strongly compressed laterally and the jaws are clamped shut. Because of the bilateral compression, the hard mudrock matrix, and a haematite crust which coats much of the specimen, it was decided not to attempt to separate the jaws. Besides, we concluded that the crushing which has affected the specimen would have obliterated virtually all detail in the palatal region, so little would have been gained and much might have been lost had separation been attempted.

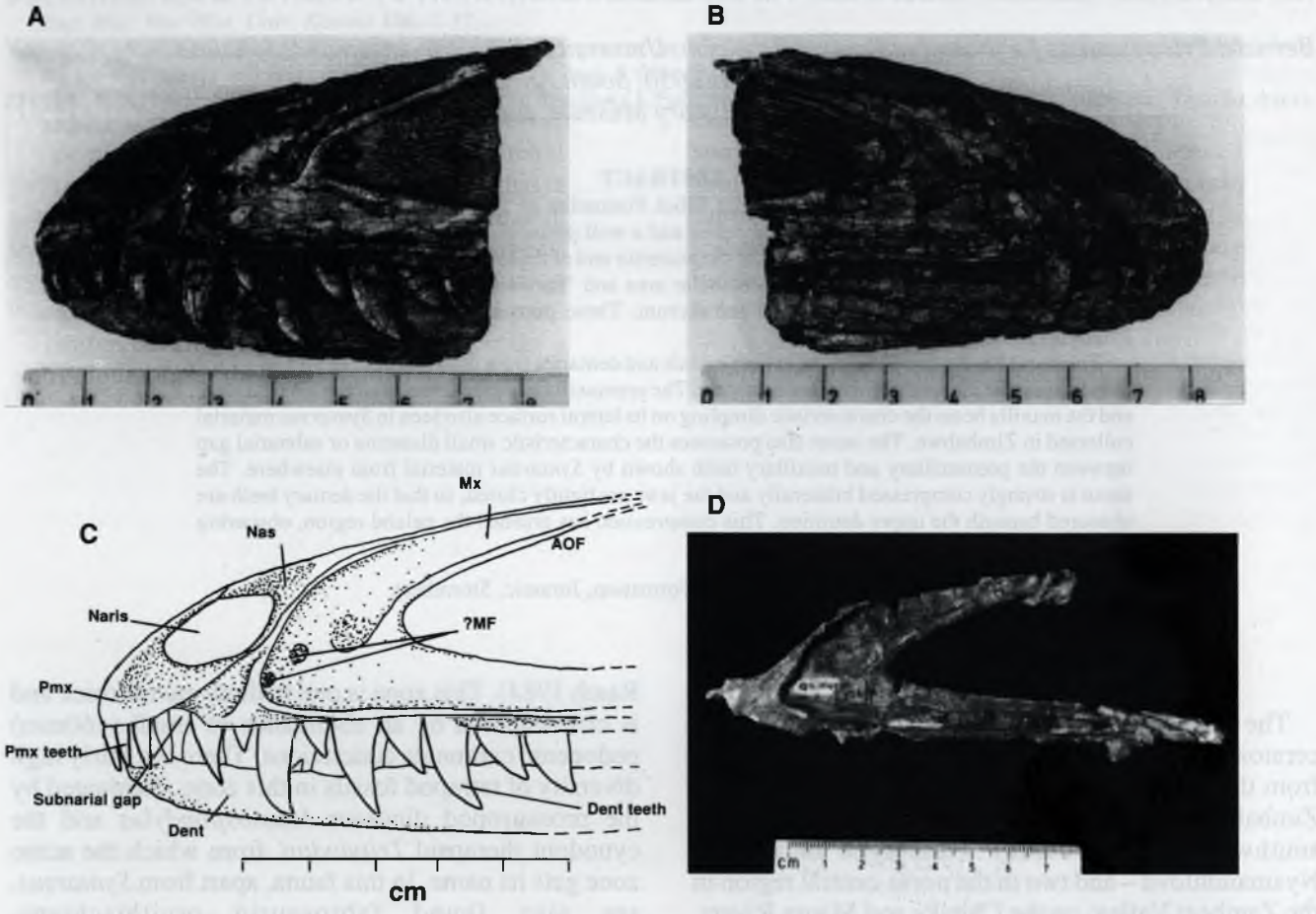

Figure 1. Snout of *Syntarsus rhodesiensis*: a-c. Specimen from the farm *Paradys* (BP/1/5278) a. Left side view; b. Right side view; c. Line drawing of (a) with principal features labelled. (Abbreviations: Mx, maxilla; Nas, nasal; Pmx, premaxilla; Dent, dentary; AOF, antorbital fenestra; ?MF, doubtful maxillary fenestra); d. Left maxilla (QG194) from Chitake River, Zimbabwe, for comparison (Scale divisions = cm).

The external nares and the antorbital fenestrae are filled with a matrix of fine-grained, pinkish-maroon silty mudstone, and the joints and teeth are covered by the haematite coating. Details of the boundaries of the major openings (external nares and antorbital fenestrae) were exposed using pneumatic engraving needles. The haematite coating had one advantage in that it helped to clarify junctions between adjacent bones which were otherwise difficult to recognise in the compressed state, but other finer details remain obscured.

DESCRIPTION OF THE SNOUT

(BP/1/5278, Figure 1)

There are two lateral openings in the snout, the elliptical external naris and the incomplete large, V-shaped antorbital fenestra. The former is bordered by the premaxilla, maxilla and nasal, while the latter is surrounded by the maxilla, except at the open posterior end (which is broken – see Figure 1). The articulations between the premaxilla and nasal, and between the nasal and maxilla are slightly obscured by the haematite coating. There appears to be a loose, movable articulation between the premaxilla and the maxilla. The premaxilla and maxilla bear serrated teeth, four in the former and nine in the latter, and there is a small sub-narial gap, or diastema, between these tooth-bearing bones which is attributable to the loose kinetic joint between them.

The narrow snout tapers towards the tip of the premaxilla, and the premaxilla and nasal are the only bones visible in dorsal view. The dorsal surface of the preserved part of the snout is almost flat, formed by the nasals from either side which meet in the midline in a shallow longitudinal depression. Laterally, the junction of the nasal with the maxilla is sharply

angular, and at the junction there is a slight ridge in the position of the nasal crest described in the American form, *S. kayentakatae* (Rowe 1989).

The long, slender dentary has its teeth largely obscured by the upper dentition. There is no symphysial suture between the lower jaw rami, suggesting a kinetic joint, as in the Zimbabwean *Syntarsus* material and in material of *Coelophysis* from North America (Raath 1977; Colbert 1989).

Description of individual elements

All the bones making up the facial skeleton in this specimen are exceptionally thin, strengthened in a few places by ridges of bone.

Premaxilla

Anteriorly the premaxilla is rounded, and posteriorly it divides into two tapering prongs which form all but the hind border of the external naris. The thin upper process contacts the nasal on the dorsal surface of the snout, overlapping it slightly. The lower process, which forms the lower border of the external naris, contacts the maxilla on its curved anteromedial surface. Their junction is continuous with the line of the subnarial gap, or diastema, between the premaxillary and maxillary teeth. The joint between the premaxilla and maxilla is slightly displaced, suggesting that it was loose and kinetic. An identical loose joint was observed in *S. rhodesiensis* by Raath (1977), and a similar one in *Coelophysis bauri* by Colbert (1989).

The short diastema between the premaxilla and maxilla is largely formed by an embayment on the former. A relatively large tooth on the dentary occupies a position immediately below this gap, but because the lower teeth bite inside the upper teeth it does not seem likely that the gap is to accommodate the tip of this tooth when the jaws are closed.

Because of the crushed and occluded state of preservation, it cannot be established if the small triangular flange on the inner surface above the fourth alveolus noted in the premaxillae of *S. rhodesiensis* from Zimbabwe (Raath 1977) is also present in this specimen.

Maxilla

The maxilla occupies the greater part of the snout in lateral view. The acutely rounded antorbital fenestra divides the maxilla into upper and lower arms, both thin-walled and tapering posteriorly. The upper arm is strengthened by a shallow ridge along its border with the antorbital fenestra, and it tapers posteriorly more quickly than the lower. It contacts the nasal along the dorsolateral angle of the snout in the long, angular, ridged junction described earlier. The front border of the maxilla is curved to form the posterior and (with the lower prong of the premaxilla) the posteroventral border of the external naris. The dentigerous border of the lower arm bears an alveolar ridge that turns dorsally towards the nasal after the second maxillary alveolus, and it borders a dimpled depression in front of the antorbital fenestra, the antorbital fossa (Wittmer 1997). Within this depression the shallow dimples are exceptionally thin-walled, and indeed one appears to be perforated on the left maxilla, forming a sort of 'maxillary fenestra' (Wittmer 1997) ahead of the antorbital fenestra proper (Figure 3c, 'MF'). Whether this fenestra is real or an artefact of postmortem damage to its paper-thin wall is difficult to establish with certainty, because the corresponding position on the right maxilla is damaged. Because of the crushing in the palatal region, the maxillary dimples cannot be observed from the medial side to see if that would resolve the question. Similarly, because the medial surface of the maxilla cannot be observed, it is not possible to say whether the maxilla bears the same small shelf, or 'premaxillary ramp' (Raath 1977), noted on the maxillae of *S. rhodesiensis*.

Nasal

The two nasal elements occupy most of the dorsal surface of the snout. They are elongate, narrow bones which taper towards the tip of the snout where they are overlain by the hindmost tips of the premaxillae. Medially they meet in a long, straight and simple edge-to-edge contact devoid of interdigitating sutures, as in *S. rhodesiensis* and *Coelophysis* (Raath 1977; Colbert 1989).

The nasal terminates anteriorly in a rounded Y-shape, with an upper and a lower tapering prong defining much of the hind half of the external naris. The contact of the upper process with the upper prong of the premaxilla is long and tapering, with the latter overlapping the former. The lower process also tapers down and forwards along the front margin of the maxilla, toward the hind end of the lower premaxillary prong, but not quite reaching it (Figure 1). The naris is therefore bordered by the premaxilla anteriorly, anterodorsally, and antero-ventrally, the nasal dorsally, posteriorly and posteroventrally, and the maxilla contributes mainly to its hind and lower borders.

The contact between the nasals and maxillae laterally is sharp and angular, as noted above.

Dentary

The dentary is long and relatively thin, gently curved, and it tapers slightly towards the front. Laterally it bears a longitudinal groove which extends to the front of the jaw. The number and morphology of the dentary teeth are masked by the state of occlusion of the jaws, besides which the dentary itself is incomplete posteriorly. Shallow pits are associated with the anterior dentary alveoli, opposite the corresponding premaxillary tooth positions.

Dentition

The teeth in the upper jaw are all still in their respective alveoli, unlike the condition in most of the specimens of *S. rhodesiensis* from Zimbabwe, where most of the alveoli were empty (Raath 1977). The tight

closure of the jaws might be of some taphonomic significance. As Colbert notes, one would normally expect that 'after death and the process of disintegration and decay, there would have been some separation of the mandibular rami from their living positions' (Colbert 1989:69). He suggested that the occlusion noted in his sample of *Coelophysis* implied rapid burial soon after death, and this may also have been true of the *Syntarsus* specimen from which the Elliot Formation snout came.

The occlusion of the jaws and their incomplete preservation make the description and determination of the number of dentary teeth impossible.

There are four premaxillary teeth which are slightly curved at their tip. They have serrations on the posterior side. Serrations on premaxillary teeth are also present in *S. kayentakatae* (Rowe 1989) but none were observed in *S. rhodesiensis* or in *Coelophysis* (Raath 1977; Colbert 1989). However, this is of questionable significance as lack of serrations could simply be due to wear.

Nine alveoli are visible in the preserved portion of the maxilla; how many more there were in the missing posterior part cannot be determined. The dentition shows clear evidence of alternate tooth replacement (Figure 1). The maxillary teeth are long and laterally compressed, with strong backward recurvature such that the tip of each tooth curves to a point vertically behind the back of its own alveolus. The same is true in *S. rhodesiensis* (Raath 1977) and *Coelophysis* (Colbert 1989). All the teeth have serrations along the entire posterior edge and the apical part of the anterior edge, except that the first tooth has serrations on the posterior side only. The posterior serrations are larger and more widely spaced than the anterior.

DESCRIPTION OF THE PARTIAL PELVIS
(BP/1/5246, Figure 2)

The pelvic fragment (BP/1/5246; Figure 2) consists of most of the left ilium including the deep almost circular acetabulum with its hood-like dorsal roof, but most of the thin preacetabular flange of the ilium is missing. The 'brevis shelf' on the ventral surface of the ilium behind the acetabulum is well developed, and the ilium in this region is broadly flared laterally as was noted in the holotype and a number of other specimens of *S. rhodesiensis* from Zimbabwe (Raath 1977). The fused posterior sacral centra and the deep circular pits between the adjacent sacral ribs also strongly resemble the holotype of *S. rhodesiensis* (Figure 2a,c). Dorsally the sacral ribs are not complete, but it appears that they were variably fused to form extensive sheets of thin bone like those noted in several Zimbabwe specimens. The neural spines of the sacral vertebrae have also coalesced into a longitudinal blade running almost the full length of the preserved portion of the sacrum. On the right side little is preserved other than the sacrum and a small piece of the ventral brevis shelf behind the acetabulum.

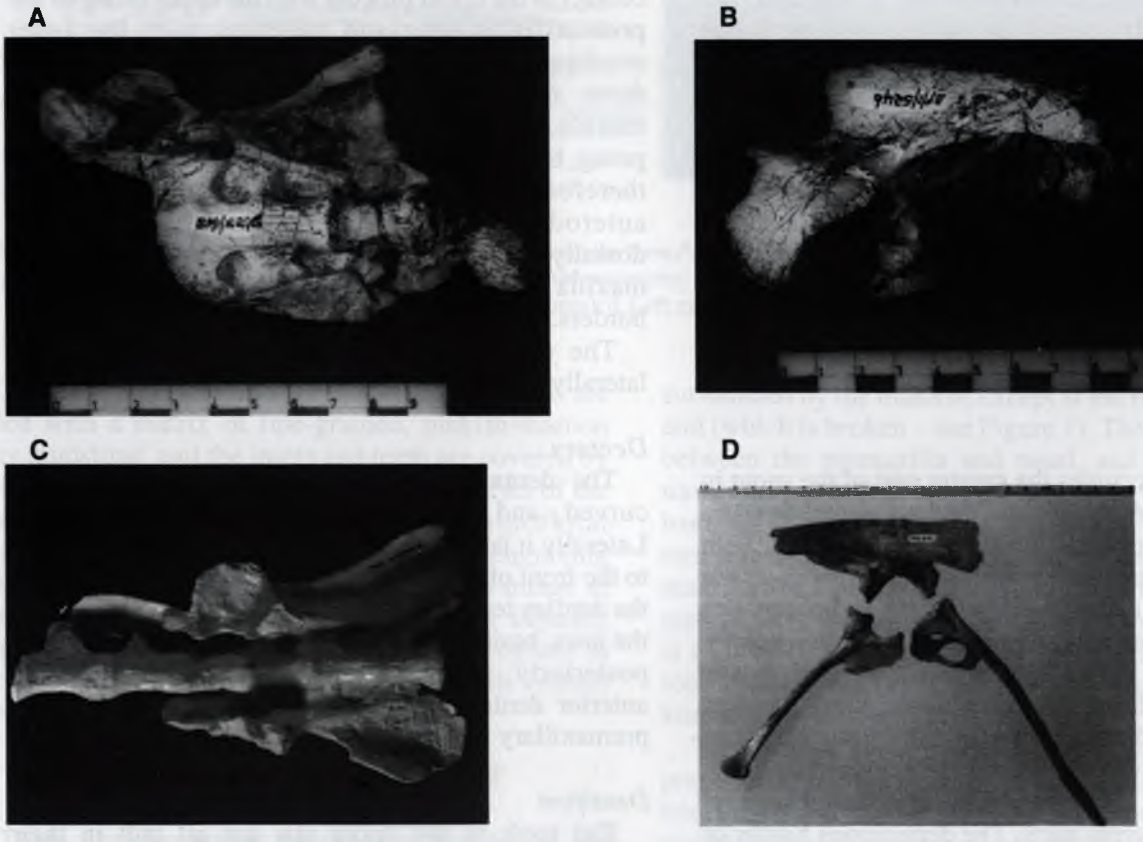

Figure 2. Pelvis and sacrum of *Syntarsus rhodesiensis*: a-b. Specimen BP/1/5246 from *Welbedacht / Edelweiss*, Free State Province, S. Africa a. Ventral view; b. Left side view; c. Cast of holotype pelvis and sacrum (QG1, from Nyamandhlovu, Zimbabwe), in ventral view for comparison (pubes and ischia removed to reveal sacrum); d. Right side view of disarticulated juvenile pelvis (QG691, from the Chitake River, Zimbabwe). (Scale divisions = cm).

DISCUSSION

Comparison of the snout with other ceratosaurs is limited because so little of BP/1/5278 is preserved: only the premaxilla, maxilla, nasal and the dentary are present, and the last three are not complete. The situation is worsened by the compression and tight closure at the tip of the jaws, making study of the palate impossible. However, comparison of the snout with the relevant parts of the skull of *Ceratosaurus nasicornis*, *Dilophosaurus wetherilli*, *Lilliensternus lilliensterni*, *Coelophysis bauri*, *Syntarsus rhodesiensis* and *S. kayentakatae*, shows a close agreement between the characters of BP/1/5278 and those of the ceratosaurs in general (Benton 1990; Colbert 1989; Raath 1977; Rowe 1989; Rowe & Gauthier 1990; Welles 1984), and of *Coelophysis* and *Syntarsus* in particular (Figure 1). The presence a of subnarial gap between the premaxilla and maxilla also unites the snout with members of the sub-clade Coelophysoidea within Ceratosauria (Rowe 1989; Holtz 1994). In these features, and in the presence of the depression of the antorbital fossa in front of the antorbital fenestra, the South African form is inseparable from Zimbabwean *Syntarsus*. The only noted difference between *Syntarsus* from Zimbabwe and the South African snout is the lack of serrations on the premaxillary teeth of the former. However, if the absence of serrations is due to wear, it has no diagnostic value, and in any case *S. kayentakatae* has serrations on its premaxillary teeth.

Although the pelvic fragment (BP/1/5246) is significantly smaller than the holotype pelvis of *S. rhodesiensis*, their morphology, especially in ventral view, is essentially identical.

There seems little doubt that the South African remains reported here belong to the same taxon as the Zimbabwean material, and these specimens are therefore assigned to *Syntarsus rhodesiensis*.

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