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FIRST RECORD OF *EUNOTOSAURUS* (AMNIOTA: PARAREPTILIA) FROM THE EASTERN CAPE.

by

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ABSTRACT

Eunotosaurus is a rare tetrapod fossil until recently known only from the *Tapinocephalus* zone of the main Karoo basin of Cape Province. A single specimen has recently been collected in the Free State (Welman, pers. com.). This paper describes a new find from the Eastern Cape, where outcrops of Karoo rocks are scarce. The new specimen adds previously unknown morphological detail, particularly about the limbs. Phylogenetic affinities are clearly with the Parareptilia.

KEYWORDS: *Eunostosaurus*, parareptiles

INTRODUCTION

The Permian reptile *Eunotosaurus* generally occurs in exceptionally hard, green, fine grained, crevasse splay mud rocks; it also occurs very occasionally in softer material which responds to mechanical or acid preparation. Difficulty of preparation, the incomplete nature of most specimens, and their relative rarity, have resulted in much of the anatomy of the animal remaining unknown. This new specimen preserves parts of the manus and pes and limbs which were previously unknown; it also confirms important details of the sacrum described by Cox (1969).

MATERIAL

The new specimen was found by a foreman on Schrikwaters Poort, which forms part of the larger Bucklands farm in the great Fish River valley (Figure 1). The exact locality was never recorded, but it lies within a 500 metre radius of the position indicated in Figure 1 at 33 04' 15"S - 26 43' 40"E. In September 1995 it was brought to the Albany Museum for identification and accessioned into the collection as AM 5999. Preliminary fieldwork, guided by the unpublished 1:250 000 Grahamstown geological sheet, indicates that the specimen was found 4.5 km north of the east-west trending contact between the Ecca and Beaufort Groups of the Karoo Supergroup. Dips of these strata in the area vary between 6° within the Ecca Group , to the south, and 25° adjacent to the Great Fish River in the northern part of Schrikwaters Poort (it is about 15° around Bucklands). These variable and steeper dips, observed in the southern part of the Karoo basin, are ascribed to deformation during the Cape orogeny. Smith and Keyser (1996) indicate that *Eunotosaurus* occurs in a stratigraphic range throughout the *Tapinocephalus* (predominently in the upper part) and *Pristerognathus* zones. Turner (1981) reported the most easterly occurence of *Tapinocephalus* zone fossils from a locality 28km to the NW of Jansenville. The discovery of this Eastern Cape specimen confirms an easterly extension of the Lower Beaufort 210km from the Jansenville locality.

The preservation is unusual in that the specimen is mostly impression, much of the bone having

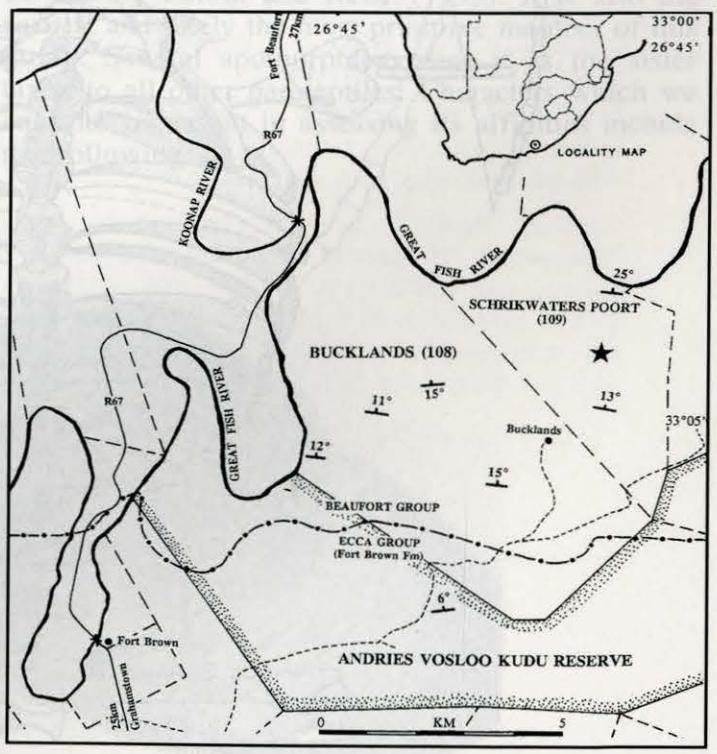


Figure 1: Locality map showing the approximate discovery site of the Bucklands *Eunotosaurus* specimen. NE part of the 3326BA Fort Brown 1:50 000 sheet.

weathered out naturally. The matrix is a khaki coloured, fine grained, arkosic sandstone: diagenetic mobilisation of silicate and subsequent lithification around the bone has resulted in high fidelity impressions, and it was possible to remove remaining bone with hydrochloric acid as necessary. Only the head and neck and the tail are missing. There has been considerable compression of the fossil as demonstrated particularly by cracking and compression of long bones (and even phalanges), and cracking of the ribs where they curve under the belly. A second fossil vertebrate lies beneath the skeleton of *Eunotosaurus*, its presence is indicated by two regions of exposed, articulated vertebrae. X-rays reveal that this specimen consists of 27 articulated distal caudal vertebrae. Other material (Gow in prep.) indicates that *Eunotosaurus* had a substantial tail (plesiomorphic for parareptiles?), therefore, while the two specimens in this block are not in continuous articulation, it is possible that the tail belongs with the skeleton, or may be from another individual of the same taxon.

METHODS

The natural impression was first thoroughly cleaned, including the judicious use of hydrochloric acid to remove some of the residual bone. A series of latex impressions were then made (to ensure that all artifacts were identified), and these were coated with sublimating ammonium chloride before being photographed and drawn. Before X-raying, the block was cut through with a diamond saw to provide a uniform, level surface and reduce overlying bulk.

DESCRIPTION (Figures 2, 3 and 4).

There are 12 presacral vertebrae, the sacral, and three caudals preserved in articulation with each other and with their respective ribs. There are fragmentary traces of the pectoral girdle we preserved. The right forelimb is probably present intact: the proximal half of the humerus is still embedded in matrix, as are the carpus and manus (not yet prepared out as they lie too close to the second fossil in the block, nor do the small elements show up on X-ray). The exposed distal half of the humerus displays the prominent capitellum and the entepicondylar foramen noted by Cox (1969). Radius and ulna are present but poorly preserved; they do not display any morphological detail, such as the size and shape of the olecranon process. These distal limb elements appear shorter than the humerus, but this is subjective as much of the latter is still deeply encased in matrix.

Of the left forelimb, which extends backward so that the manus touches the pes, the proximal humerus and part of the carpus and manus are preserved, like the rest of the skeleton, still articulated. Three fingers are preserved, two with distal carpals attached. Two fingers (1 and 2) are

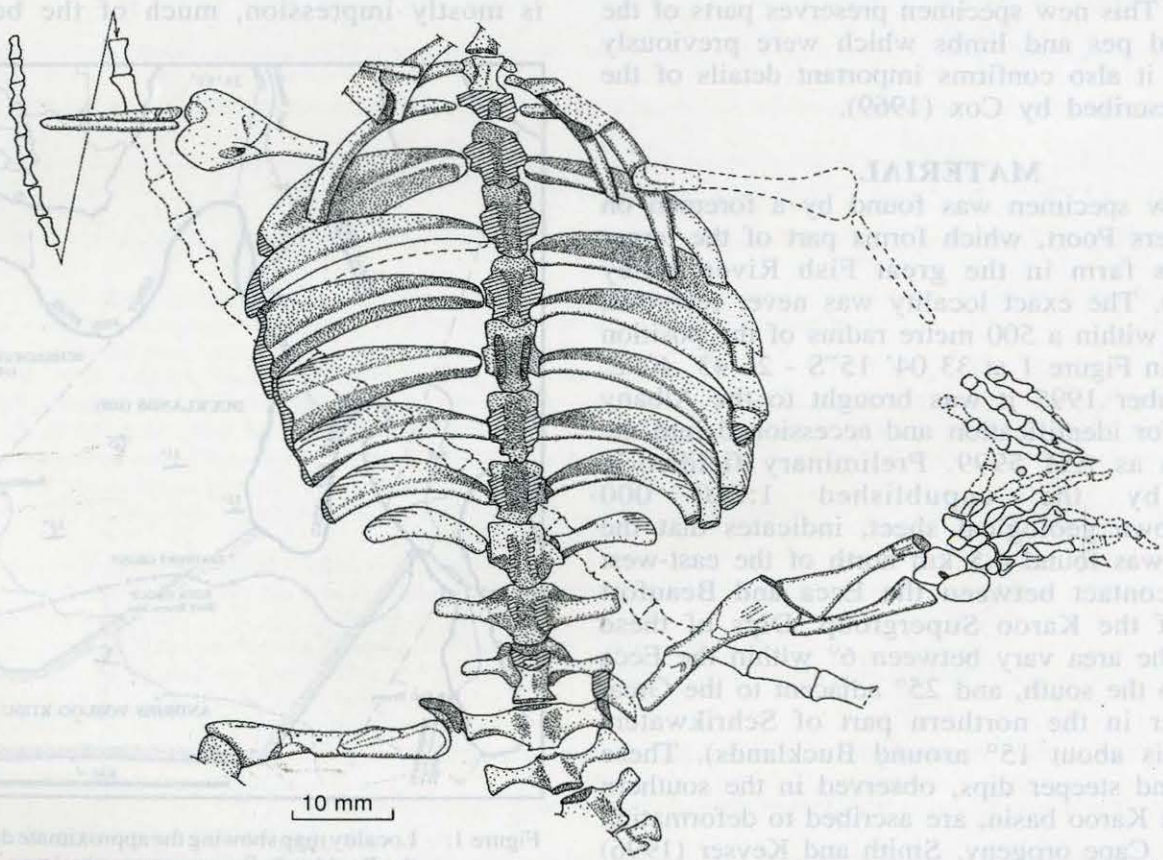


Figure 2: *Eunotosaurus* (specimen AM 5999) as exposed in ventral view. Drawn from a latex impression.

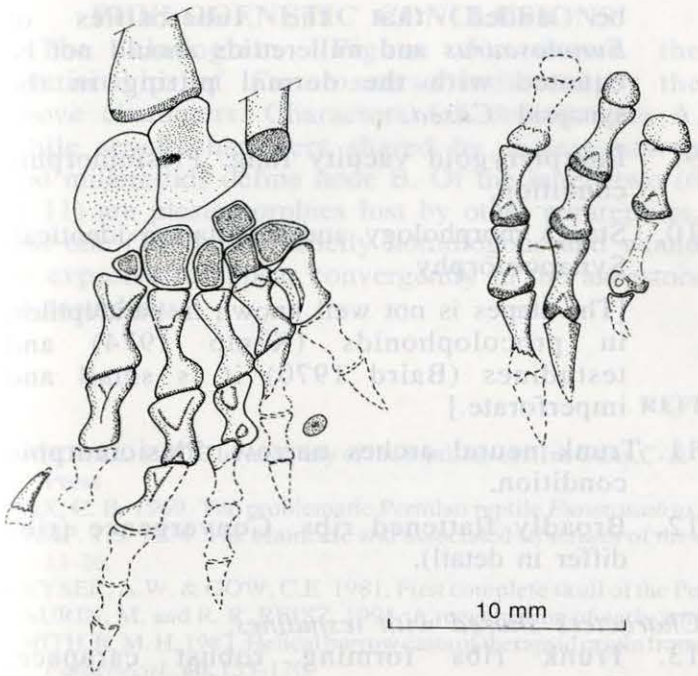


Figure 3: Detail of manus and pes as (specimen AM 599) preserved. Drawn from latex impressions.

complete, thus the three fingers are 1, 2, & 3 and their orientation indicates that the manus is exposed in ventral view.

This specimen clearly confirms the finding of Cox (1969) that there is only one sacral vertebra because the sacral ribs do not meet the ribs of the first caudal distally, (except unilaterally if the tail is strongly and unnaturally flexed as in this fossil). Both femora are preserved, but rather cracked and flattened. Tibia (15.1mm) and fibula (14.5mm) are robust and shorter than the femur (19.0mm). Astragalus and calcaneum are distinct, with the arterial foramen between them lying mainly within the astragalus. There is one centrale (the possibility of loss of a second cannot be discounted) and five distal tarsals, of which the fourth is the largest and is noticably elongate. Relative length and robusticity of the proximal phalanges, plus the conformation of the ankle, demonstrate that the pes is in the natural position.

Both manus and pes are stubby, as was to be expected, thus adding to the known tortoise-like proportions of the animal.

DISCUSSION

Biology

The dentition (Keyser & Gow 1981) suggests that this animal fed on small invertebates. According to the taphonomic observations of Smith (pers. com.), *Eunotosaurus* occurs in overbank mudrocks, which indicates terrestrial habits. This was clearly a slow moving animal, and the tortoise analogy suggests some burrowing ability (unguals are too poorly represented to display any specialisation which might support this suggestion). The thick ribs would have been a deterent against predation, protection from trampling, and possibly also against burrow collapse. In modern ecosystems it is common for members of several unrelated taxa to utilise preexisting burrows: perhaps *Eunotosaursus* made use of abandoned therapsid burrows (see Smith, 1987).

Phylogenetic position

Postcranial anatomy and details of cranial anatomy (Gow, work in progress) show *Eunotosaurus* to be a member of the Parareptilia as defined by Laurin and Reisz (1995): it is also the earliest and likely the most primitive member of this group. Several apomorphies place it as the sister taxon to all other parareptiles. Characters which we consider important in assessing its affinities include the following:-

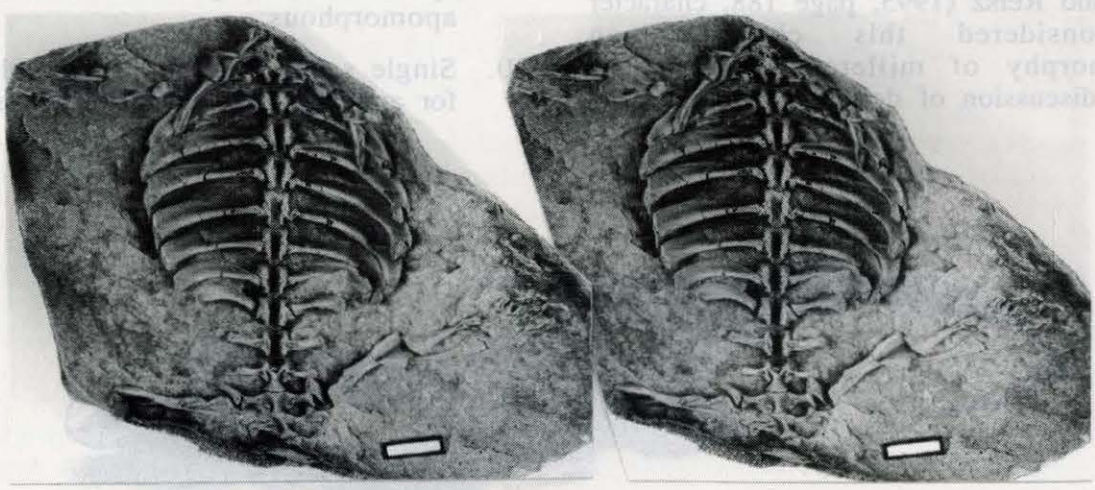


Figure 4: *Eunotosaurus* (specimen AM 5999) stereo photographs of latex impression. Scale bar = 1cm

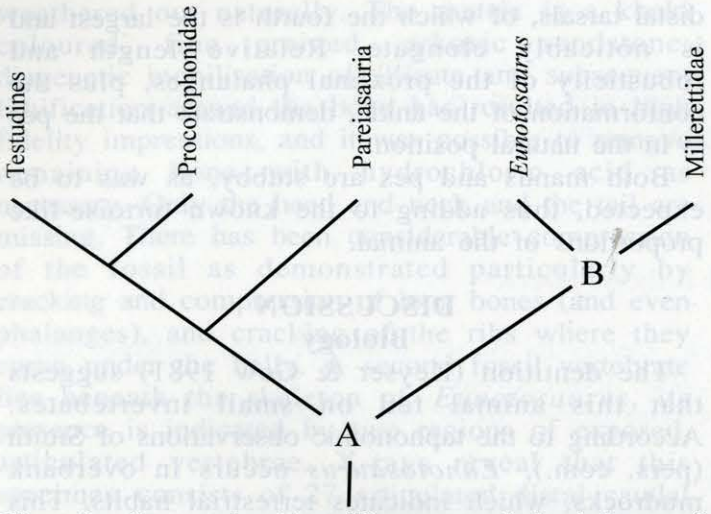


Figure 5: Suggested position of *Eunotosaurus* in the phylogeny of parareptiles determined by Laurin and Reisz (1995).

Synapomorphies of parareptiles.

1. Posterior temporal emargination bordered by quadratojugal and squamosal.
2. Stapedial dorsal process unossified. The stapes is remarkably similar to that of millerettids.
3. Absence of supraglenoid foramen.
4. Presence of ectepicondylar groove and foramen (Cox 1969).
5. Iliac blade dorsally expanded.

Characters shared with millerettids.

6. Occipital flange of squamosal convex above quadrate emargination and concave medial to tympanic ridge (requires confirmation). Plesiomorphic condition for parareptiles.
7. Quadrate exposed laterally. Derived condition present also in testudines.
8. Cranial dermal bones with sculpturing composed of gently domed tuberosities. Laurin and Reisz (1995, page 188, character 38) considered this character an autapomorphy of millerettids. To these authors discussion of dermal sculpturing can be added that the tuberosities of *Eunotosaurus* and millerettids should not be equated with the dermal pitting in the synapsid *Casea.*
9. Interpterygoid vacuity long. Plesiomorphic condition.
10. Stapes morphology and orientation identical. Synapomorphy.

    [The stapes is not well known in parareptiles; in procolophonids (Kemp 1974) and testudines (Baird 1970) it is small and imperforate.]
11. Trunk neural arches narrow. Plesiomorphic condition.
12. Broadly flattened ribs. Convergence (ribs differ in detail).

Characters shared with testudines.

13. Trunk ribs forming robust carapace. Convergence.
14. Short, robust limb segments. Convergence.
15. Short stubby feet. This appears to be a derived character of all parareptiles excluding millerettids.

Character shared with pareiasaurs.

16. Presacral vertebral count twenty or less. Derived character.

Character shared with Owenetta (Procolophonia)

17. Very fine pointed, cylindrical marginal teeth. Polarity uncertain; could be primitive.

Unique characters.

18. Dual rib articulations on vertebrae involving both shaft and expanded blade. Autapomorphy.
19. Very short cervicals with bulbous neural spines. Possibly two characters. Autapomorphous.
20. Single sacral vertebra. Either plesiomorphic for amniotes, or character reversal.

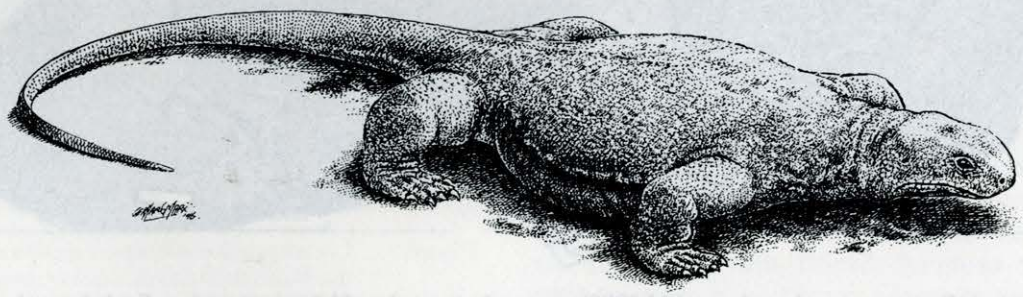


Figure 6. Reconstruction of *Eunotosaurus* by Gerhard Marx

PHYLOGENETIC CONCLUSIONS

The cladogram (Figure 5) shows the relationships of *Eunotosaurus* indicated by the above characters. Characters 1-5 define node A, while seven characters shared by *Eunotosaurus* and millerettids define node B. Of the latter, two (6 & 11) are plesiomorphies lost by other parareptiles, and one (12) is not strictly homologous and would be expected to appear convergently in the ancestors of testudines.

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