# A busy year for a little dinosaur

August 31 2016, by Matt Baron

Credit: PLOS Blogs

Take a walk around the Free State of South Africa, or, if you fancy it, Lesotho (le-sOO-tOO), and you might just come across some genuine dinosaur fossils. Trudge around the exposed layers of red/purple rock that make up the upper Elliot Formation and, luck permitting, among the odd bits of stone and rubble that you may kick along the way, bits of claw and arm and foot and tooth of long gone animals might become apparent to you.

Most likely, if you're in the right sort of place, the fossil material will

represent the remains of a particular long-necked herbivore (sauropodomorph), Massospondylus. This herbivore, which lived around 200-180 million years ago, would have been an all too frequent sight on the plains of Early Jurassic southern Africa and, along with a number of other closely related animals, it certainly dominated during its time. This early dominance of sauropodomorphs is reflected by their relatively high occurrence frequency in the fossil record.

However, albiet far, far less common, there is another herbivorous dinosaur that can be found in the rocks of the upper Elliot, one that is only distantly related to Massospondylus and its kin: Lesothosaurus diagnosticus. Whilst only small (estimated to be around 1-2 meters in length), and relatively rare, this little dinosaur actually has a great deal to say when it comes to the question of early dinosaur evolution. In fact, without knowledge of Lesothosaurus, palaeontologists would be faced with a number of awkward questions. That being said, the presence of Lesothosaurus in the upper Elliot Formation also raises a number of new questions, ones which are only starting to be answered now. And this is where we begin…

Massospondylus. Credit: Nobu Tamura (CC BY 3.0)

At the close of 2015, the first of 3 successive new papers on Lesothosaurus diagnosticus were published. This paper, by Porro,

Witmer and Barrett, examined the known skull material of L. diagnosticus, using the modern imaging technique of CT scanning. This research revealed a number of new details of the skulls of these animals, allowing for a much more complete description of this particular part of the body. This new information was then used to refer a couple of additional specimens to the species, increasing the data that we have for it. This paper can be found here (OA via *PeerJ*).

Only a few months after Porro et al.'s work, a second paper on Lesothosaurus diagnosticus was published. This paper dealt with a number of newly discovered specimens that the authors also considered to belong to L. diagnosticus. In this work, Barrett, Butler, Yates, Baron and Choiniere provided detailed description of new skull material and new post cranial elements that were collected near the town of Fouriesburg, South Africa. This new material provided further information on L. diagnosticus, particularly regarding how we can diagnose it and distinguish it from other species. Critically, the new finds showed that the size range of L. diagnosticus was greater than had been previously supposed, and this has some implications for another species, which I will deal with shortly. Further to this, the fact that the material was found to belong to a number of individuals, all of whom were buried together at once, was suggested by the authors to be possible evidence for group-living behaviour. While group-living had been previously floated as an idea for how such early animals would have lived, the finds of this paper constituted the first real evidence for such a hypothesis. This international collaborative effort, provided some key information for the developing arguments surrounding this little dinosaur and where it might fit into the wider picture of dinosaur evolution. This paper can be found here (OA).

Last, but by no means least, was a paper covering the post-cranial anatomy of Lesothosaurus diagnosticus by Baron, Norman and Barrett, filling in the remaining bits of anatomy from Porro et al.'s study and

completing the Barrett-authored triumvirate of the subject. In this paper, the phylogenetic position and the ontogenetic profile of L. diagnosticus was examined, and the status of another upper Elliot taxon, Stormbergia dangershoeki, was re-evaluated. The bulk of this research related to the details of the anatomy of L. diagnosticus with every bone of every known species described, and with most elements of the post-cranium figured. This study added an additional set of anatomical characters to the list of diagnostic features (apomoprhies) for the species, reviving a few old ones as well. As with the second study, the size range of Lesothosaurus was shown to be great, with some specimens showing that this taxon actually got much bigger than previously thought. Additionally, the small anatomical differences recorded among the specimens was shown for the first time to be most likely related to the maturity of the individuals (ontogenetic) and a picture of the growth of Lesothosaurus was proposed.

Lesothosaurus reconstruction. Credit: Jack Wood (CC BY-SA 4.0)

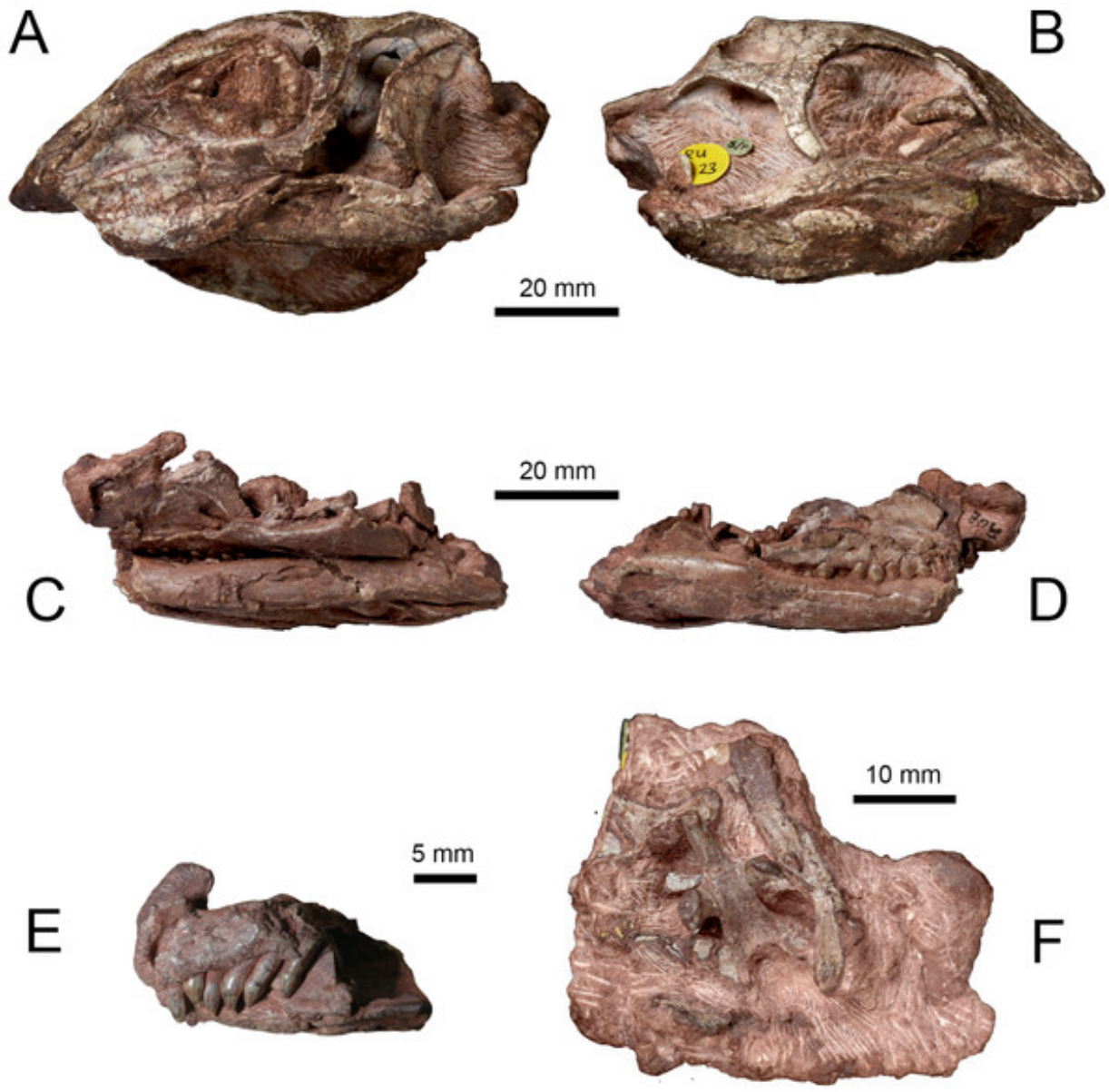
One of the interesting things about Lesothosaurus diagnosticus is that a number of elements of its anatomy appear very primitive for a dinosaur.

For example, the hole in its pelvis (acetabulum) is partially closed by a medial wall, unlike most members of Dinosauria. However, despite its primitive anatomy, Lesothosaurus nests within Ornithischia (one of the 2 major groups within Dinosauria). As one of only a few well known early ornithischians, we must turn to Lesothosaurus diagnosticus to for key information on the early evolution of this group. Much like its other early ornithischian cousins such as Heterodontosaurus, Lesothosaurus was a small and bipedal animal, probably capable of running at decent speeds, and that this seems likely to be the condition for the earliest dinosaurs and dinosaur ancestors as well. The step-wise transformation from this condition through to the very large, armoured ornithischians of the later Jurassic (and the monstrously huge duck-billed animals and tank-like lumbering herbivores of the Cretaceous) seems to find an early landmark in Lesothosaurus. In fact, with regard to armour, it has even been proposed that L. diagnosticus, with its combination of derived and primitive features, may in fact represent the earliest known member of the group that would later produce Stegosaurus and Ankylosaurus. Alternatively, L. diagnosticus may represent the earliest known member of the group that would eventually produce the three-horned icon Triceratops and the giant duck-billed, great-crested herbivores like Parasaurolophus. In their study, Baron et al. find the latter to be the case. Not that I have a bias or anything, but this seems very sensible to me.

The other major point of Baron et al. was the sinking of another Early Jurassic taxon, Stormbergia dangershoeki. This genus and species was proposed for the largest known 'fabrosaurs' (a vague term for a number of Early Jurassic ornithischians), but has since been hotly contested. Baron et al. demonstrated, as part of the broader ontogenetic study of Lesothosaurus diagnosticus, that Stormbergia dangershoeki was simply an adult form of Lesothosaurus and therefore not a valid taxon. This paper can be found here.

So all in all, it's been a very busy year for little Lesothosaurus. One thing

that has been striking about the progress of it all, for me at least, is how much of a collaborative effort it takes for such research to be successful. Counting the 3 aforementioned papers only, 8 authors from institutions on 4 different continents contributed to the ongoing discussions and investigations, and specimens housed in collections all over the world had to be visited and studied to make all of this happen. Fieldwork in the upper Elliot formation was also conducted by a number of these authors, including work done as part of an international collaborative effort between teams from the UK and South Africa. As one of the lucky few who got to go on both (2014 and 2015) excursions into the Free State, I got to witness first-hand the incredible thrill of new discovery. With any luck, the hard work of the teams that went out on each trip will provide us with heaps more information, on a whole range of animals, which will help further the field of palaeontology and our understanding of past worlds. The process of finding and exploring new sites, digging and moving material, prepping it into a condition that allows for detailed study and then doing the studying itself, is one that so many people dream of as a kid (and adult) and I feel very privileged to be a part of it. However, such work can only be done when a large number of people work together to make it so. If nothing else can be taken from the case of Lesothosaurus, at least this little dinosaur shows us just how important it is for research scientists to band together, for the good of the field, and produce work which furthers science in a way that solo efforts seldom do. Without meaning to sound cheesy… just as Lesothosaurus has been revealed by these studies to have been a group-living animal, so too have us scientists, and that is perhaps the most significant point of it all.




Syntype skull of Lesothosaurus

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