

A Southern Tyrant Reptile

Roger B. J. Benson,^{1*} Paul M. Barrett,² Tom H. Rich,^{3,4} Pat Vickers-Rich^{3,4}

The 100-million-year tyrannosauroid lineage is poorly documented. Its youngest representatives, the deep-skulled, multitooth tyrannosaurids, were the apex predators of latest Cretaceous Laurasia. These are known from abundant, well-preserved fossils. Until recently, however, almost nothing was known about the ecology and biogeography of earlier tyrannosauroids. This situation is changing. A surge of new discoveries is revealing diverse ecotypes and body sizes from as early as the Middle to Late Jurassic [e.g., (1–3)]. Despite this, the record of tyrannosauroid evolutionary history has been limited to the northern

continents (Fig. 1A), an aberrant pattern given the broad distributions of other long-lived dinosaur clades. Here we report an Australian tyrannosauroid, represented by a pubis from the late Early Cretaceous of Victoria (Fig. 1, B and C) (4, 5) [National Museum of Victoria (NMV) P186046].

The pubis is almost identical to those of tyrannosaurids (Fig. 1, B to D). Several distinctive synapomorphies indicate tyrannosauroid affinities. The transversely narrow, parallel-sided pubic boot indicates referral to Coelurosauria (6). The pubic tubercle is broken, but the preserved portion indicates a prominent, anterolaterally curving, flange-

like morphology, as in tyrannosaurids (Fig. 1D) and dromaeosaurids (7) (many other features distinguish the dromaeosaurid pubis). This is confirmed by the presence of a rugose lateral surface adjacent to the tubercle, also present in tyrannosaurids. The pubic boot is large; its anteroposterior length is 0.45 times the pubic shaft length (a minimum estimate because the boot is broken). This is comparable to those of tyrannosauroids and some basal coelurosaurs, although adult tyrannosaurids possess a still larger pubic boot (Fig. 1D; ratio = 0.65). The anterior expansion of the boot is substantial, as in tyrannosaurids but unlike basal tyrannosauroids and most other coelurosaurs (fig. S1). Although allosauroids have a large pubic boot, it is transversely broad, characteristic of non-coelurosaurian theropods (6) (fig. S1), and the pubic tubercle is moundlike. An anterior expansion is also present in some ornithomimosaurs and oviraptorosaurs, but these have a small pubic boot and low pubic tubercle (fig. S1), unlike NMV P186046.

These observations show that NMV P186046 is similar to tyrannosauroids in general and shares derived features with tyrannosaurids specifically (Fig. 1A). It is derived compared with other Early Cretaceous tyrannosauroids, including *Raptorex*, in which the pubic tubercle is not flange-like or rugose. Thus, advanced cranial and appendicular characters linking *Raptorex* and tyrannosaurids (2) may be inferred for NMV P186046. This demonstrates that advanced tyrannosauroids with characteristic short arms and powerful jaws achieved a global distribution in the Early Cretaceous. The length of NMV P186046 (307 mm) is only slightly longer than the pubis of *Raptorex* [279 mm (2)]. Thus, a potentially cosmopolitan grade of small tyrannosauroids with a tyrannosaurid-like body plan preceded the Late Cretaceous rise of the colossal tyrannosaurids.

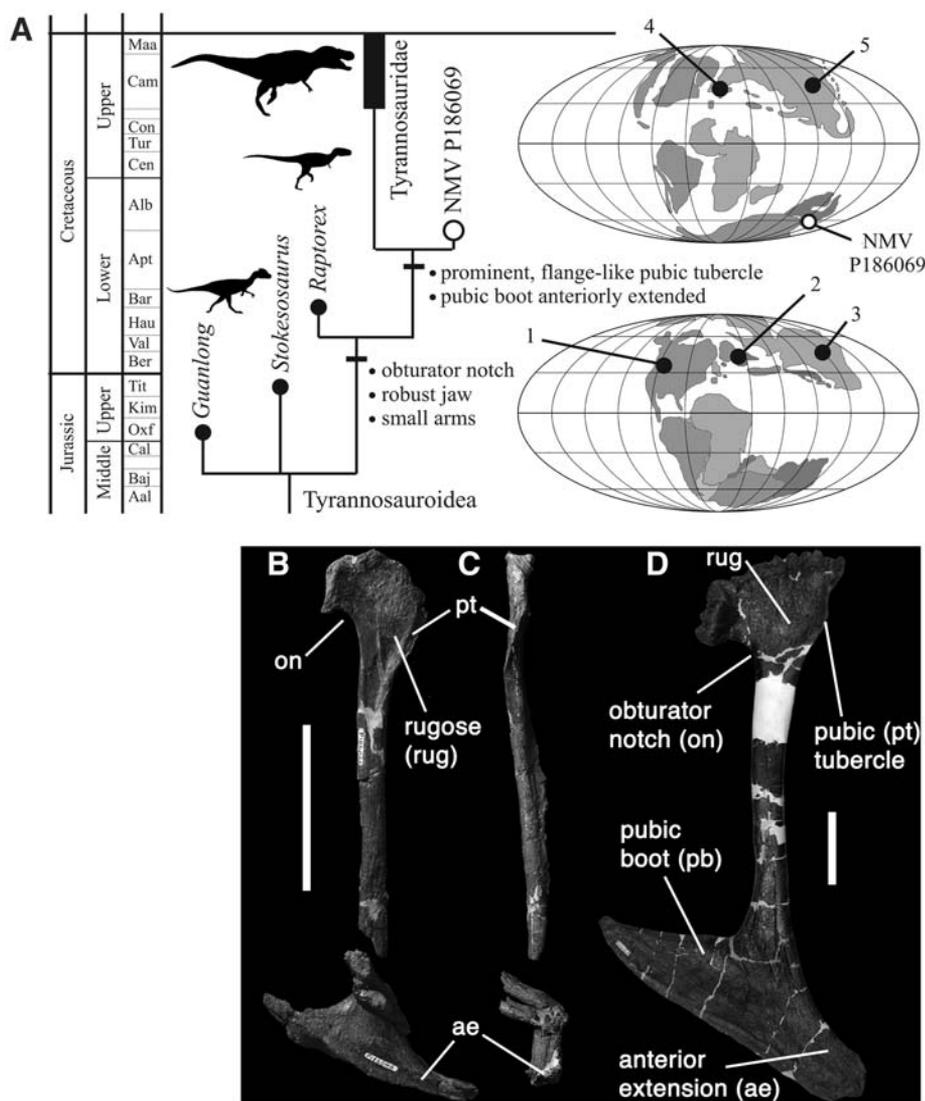


Fig. 1. (A) (Right) Distribution of Late Jurassic (bottom) and Early Cretaceous (top) tyrannosauroids: 1 and 2, *Stokesosaurus*; 2, *Aviatyrannis*; 3, *Guanlong*; 4, *Eotyrannus*; 5, *Dilong*, *Raptorex*, *Sinotyrannus*, and *Xiongguanlong*. (Left) Relationships of NMV P186046 to other tyrannosauroids for which the pubis is known, based on (2). (B to D) Tyrannosauroid pubes: NMV P186046 in right lateral (B) and anterior (C) views; albertosaurine tyrannosaurid (Royal Tyrell Museum of Palaeontology, Drumheller no. 1986.64.1) in right lateral view (D). Scale bars equal 100 mm.

References and Notes

- X. Xu *et al.*, *Nature* **439**, 715 (2006).
- P. C. Sereno *et al.*, *Science* **326**, 418 (2009); published online 17 September 2009 (10.1126/science.1177428).
- O. W. M. Rauhut, A. C. Milner, S. Moore-Fay, *Zool. J. Linn. Soc.* **158**, 155 (2010).
- NMV P186046, from the late Aptian–early Albian (5) Eumeralla Formation of the Slippery Rocks Site, Dinosaur Cove, Victoria.
- B. E. Wagstaff, J. McEwen-Mason, *Natl. Geogr. Res.* **5**, 54 (1989).
- O. W. M. Rauhut, *Spec. Pap. Palaeontol.* **69**, 1 (2003).
- M. A. Norell, P. J. Makovicky, *Am. Mus. Novit.* **3215**, 1 (1997).
- The National Geographic Society grant 3909-88, the Australian Research Council, and Atlas Copco provided funding for the excavation.

Supporting Online Material

www.sciencemag.org/cgi/content/full/327/5973/1613/DC1

Fig. S1

References

25 January 2010; accepted 24 February 2010

10.1126/science.1187456

¹Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, UK. ²Department of Palaeontology, Natural History Museum, London SW7 5BD, UK. ³Palaeontology Department, Museum Victoria, Melbourne, Victoria 3000, Australia. ⁴School of Geosciences, Monash University, Clayton, Victoria 3800, Australia.

*To whom correspondence should be addressed. E-mail: rbb27@cam.ac.uk