Giant specimens of the sauropod dinosaur *Barosaurus* from Utah

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**Abstract**

The diplodocid sauropod *Barosaurus* is best known from the spectacular mounted skeleton in the atrium of the American Museum of Natural History (AMNH). Apart from the disproportionately long neck it is similar in size to *Diplodocus* — but did *Barosaurus* get bigger?

BYU field jacket 3GR was collected from the Jensen/Jensen quarry, Utah, in 1966 but only recently prepared. It contains three cervical vertebrae, designated A, B and C, anterior to posterior. They belong to *Barosaurus* based on elongation, broad prezygapophyseal facets, "hinged" prezygapophyseal rami with dorsomedial and dorsolateral faces, narrow, posteriorly set diapophyses bearing posterior tubercles, and wing-like postzygadiapophyseal laminae. Based on spine bifurcation, vertebra C is C9–C11. The centra of the AMNH cervicals C9–11 are 685, 737 and 775 mm long. That of vertebra C measures 1220 mm, making it 1.57–1.78 times longer. This suggests a neck length of 13.3–15.1 m based on the established length of 8.5 m for the AMNH specimen.

BYU 9024 is an even larger cervical vertebra, referred to *Supersaurus* but indistinguishable from C9 of *Barosaurus* based on the characters above. At 1370 mm in total length, it is exactly twice the length of the AMNH C9, suggesting a neck 17 m long.

**Keywords:** *Barosaurus*, *Supersaurus*, cervical vertebra, neck, size

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# Introduction

*Barosaurus* is a diplodocid sauropod first described very briefly by Marsh (1890) in a six-page paper in which he also cursorily described the theropod *Ornithomimus* and two new species of *Triceratops*. The only *Barosaurus* elements mentioned in Marsh’s description were caudal vertebrae, and a single mid-caudal centrum was illustrated (Marsh 1890: figures 1–2). Marsh noted only that the caudals resembled those of *Diplodocus* but were proportionally shorter than in that genus and did not retain pneumatic features so far back along the tail.

The caudal vertebrae described by Marsh (1890) were part of a substantial partial specimen, YPM 492. More of this was subsequently excavated and Lull (1911) wrote an important monographic description. This specimen includes numerous elements identified by Lull as four posterior cervicals (perhaps C12–15), six dorsal vertebrae (considered to be D1, 4, 5, 7, 9 and 10), a partial sacrum, about 19 caudal vertebrae from different parts of the tail, three chevrons, many ribs and fragments, the left sternal plate, a partial scapula, a partial ilium, partial right pubis, partial left ischium, femur fragments, tibia fragments and the ends of the left fibula. As is apparent, there is no skull and the appendicular material is fragmentary, so diagnosis rested primarily on the axial material. Lull (1919: plate II) illustrated three of the cervical vertebrae, but in monochrome and with only one of them shown in more than one aspect. Taylor and Wedel (2016: figures 3, 6–8) illustrated the same three cervicals in colour, each in four or five different aspects.

Since Lull’s monograph, *Barosaurus* has become known from more complete specimens, including several mounted skeletons in public galleries (either as real bone or as casts), but none of these have yet been formally described in any detail. The most influential of these is AMNH 6341, the iconic rearing mount in the rotunda of the American Museum of Natural History (Figure B), which was briefly described in McIntosh’s (2005) revision of the genus *Barosaurus*; More recently, a rediscovered specimen (ROM 3670) was mounted at the Royal Ontario Museum, having been overlooked in collections for decades, but signage in the public gallery indicates that only three cervicals — probably 12, 13 and 16 — are real fossil material, the rest presumably having been replaced by casts of the AMNH specimen. In the public gallery of the Natural History Museum of Utah, there is a *Barosaurus* mount in a crouching pose with a raised neck, based in part on real fossils; but the neck is cast from the ROM material (Randy Irmis, pers. Comm., 2022), so offers no new information. (The Utah *Barosaurus* mount has no single specimen number of its own, being a composite of many specimens.) It seems then, that all three mounted *Barosaurus* skeletons are based on substantially the same neck material.

Although the AMNH specimen has not been described in detail, it has been enormously significant culturally, and *Barosaurus* is universally recognised as proportionally long necked, even by sauropod standards (e.g. Bartram et al. 1983, Lindsay 1992, Lambert 2000). The exact length of the neck is difficult to determine, however, as no complete neck is known. AMNH 6341 preserves the last nine cervical vertebrae, which McIntosh (2005:45) considers to be C8–C16. (The number of cervicals is reckoned to be 16 on the basis that there are only nine dorsals, compared with ten in the closely related *Diplodocus*, and the most likely reason is that the first dorsal was recruited into the neck.) Only one known *Barosaurus* individual preserves the anterior cervicals: AMNH 7535 is a juvenile, referred by Tschopp et al. (2015:220) to *Barosaurus* sp., and consisting of cervicals 2–8. By scaling these vertebrae up to match those of AMNH 6341 (C8 is preserved in both specimens), Wedel (2007:207) estimated the total neck length at 8.5 m.

*Barosaurus* closely resembles its near relative *Diplodocus* in its postcervical skeleton, differing primarily in cervical characters. This is most notable in the elongation of the neck: it is 40% longer than the 6.1 m neck of the well known *Diplodocus carnegii* holotype CM 84, casts of which grace a dozen museums around the world. The best known *Barosaurus* specimen and the best known *Diplodocus* specimen (AMNH 6341 and CM 84 respectively) are almost exactly the same size in heir torso and limbs, differing only in that the former has a longer neck and the latter a longer tail (Figure A). Otherwise proportional differences are minor: *Barosaurus* is slightly taller at the shoulders and slightly less tall at the hips.

Since the well known AMNH 6341 specimen of *Barosaurus* is about the same size as the Carnegie *Diplodocus*, which massed perhaps 12 tonnes (Wedel 2005:220) — and since the ROM and Utah mounts are of comparable size such that AMNH material can be readily incorporated into them — it is generally accepted that all the well-known *Barosaurus* individuals massed on the order of 12 tonnes. In this paper, we will review evidence for significantly larger specimens.

## Privately held material

XXX What to say about Western Paleo Labs?

## Institutional Abbreviations

* AMNH — American Museum of Natural History, New York, New York, USA.
* CM — Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.
* ROM — Royal Ontario Museum, Toronto, Canada.
* YPM — Yale Peabody Museum, New Haven, Connecticut, USA.

## Anatomical abbreviations

XXX

# Materials and Methods

XXX Diagnostic characters of *Barosaurus* cervicals. compare our diagnostic characters with those in the Revised Diagnosis of *Barosaurus* in Tschopp et al.

XXX Jensen’s Jensen/Jensen Quarry, Jensen

XXX BYU field jacket 3GR, excavated 1966 from Jensen/Jensen

XXX Contains three ?consecutive *Barosaurus* cervicals, designated A, B and C.

XXX Why this is *Barosaurus*.

XXX Difficulty of photographing large bones. Distance and perspective distortion. Photo of me up the ladder shooting down.

XXX Why BYU 9024 is morphologically indistinguishable from *Barosaurus*.

# Results

XXX Sizes of A, B and C.

XXX Serial position of A, B and C.

XXX Size of the 3BJ animal

XXX Size of BYU 9024

XXX Serial position of BYU 9024

XXX Size of the BYU 9024 animal

XXX Comparison of neck with total height of Berlin brachiosaur

# Discussion

XXX Does this mean that *Supersaurus* is *Barosaurus*? No, it's not that easy.

XXX Ecological implications of rare super-giant individuals

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We are grateful to Rick Hunter (Western Palaeo Labs) for allowing us access to privately owned *Barosaurus* cervicals at the North American Museum of Ancient Life.

Scott Hartman has raised the bar for scientifically accurate skeletal reconstructions of dinosaurs, and we are grateful to him for allowing us to use his *Diplodocus carnegii* and *Barosaurus lentus* reconstructions for the comparison in Figure A.

We thank David Evans (Royal Ontario Museum) for information about the ROM’s mounted *Barosaurus* specimen and Randall B. Irmis for information about the composite mounted skeleton at the Natural History Museum of Utah, and for permission to cite personal communication.

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# Figure Captions

**Figure A.** Relative size and proportions of the best known *Barosaurus* and *Diplodocus* specimens. In black, *Barosaurus lentus* AMNH 6341; in grey, *Diplodocus carnegii* CM 84. Skeletal reconstructions by Scott Hartman, used by kind permission. *Barosaurus* has notably longer neck than *Diplodocus* and a shorter tail. It is also somewhat taller at the shoulders and less so at the hips. Otherwise their size and proportions are very similar. Since the neck and tail typically accounts for no more than 20% of the mass of a sauropod (see e.g. Taylor 2009: table 4), these two individuals likely weighed almost exactly the same.

**Figure B.** XXX a photograph of the AMNH mount.