

## A unique Morrison-Formation sauropod specimen with biconcave dorsal vertebrae

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AMNH FARB 291 is a unique sauropod dinosaur specimen, excavated in 1898 from the Bone Cabin Quarry of Wyoming (Upper Jurassic; Morrison Formation). It consists of a sequence of five contiguous dorsal vertebrae, all with biconvex centra: a morphology not previously observed in any sauropod, and which is very rare even in other amniotes.

The specimen was initially catalogued as *Brontosaurus*, one of only half a dozen sauropods then known. But it lacks diplodocid features such as bifid neural spines, short centra and dual centroprezygapophyseal laminae. Instead, it resembles *Brachiosaurus* in its elongated centra, forward-shifted neural arches and lobe-like transverse processes. Centrum lengths (from anteriormost to posteriormost) are 207, 205, 232, 222 and 207 mm, about 60% those of the *Brachiosaurus* holotype.

This specimen could represent:

1. normal development: the condyle would have ossified separately but the individual died before this could happen;
2. a developmental anomaly;
3. a *Brachiosaurus* with a rare variation not previously seen due to paucity of specimens;
4. a bizarre taphonomic event;
5. a unique taxon in which this is a normal, inherited trait.

Vertebrae typically ossify as rings of bone around the notochord, which sometimes persists as a tunnel through the centrum. There is a developmental continuum from biconcave centra with a persistent notochordal tube (as in most fishes), through biconcave centra with the notochord persisting as intervertebral cartilage balls, to the normal amniote condition. However, all known baby sauropod presacrals have already ossified opisthocoelous or amphiplatyan centra, so the present specimen remains mysterious.



**Figure 1.** AMNH FARB 291, five consecutive posterior dorsal vertebrae of a probably brachiosaurid sauropod, in right lateral view. The vertebrae are embedded in a plaster block, which has been desaturated in this image.