

PROBLEMS WITH SAUROPOD NECK POSTURE

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Neck posture in sauropods remains controversial. The anatomical argument for horizontal necks presumes that habitual posture follows a neutral cervical articulation with fully overlapping zygapophysis, and centra facets paralleling one another. Although an S-curve results from this method in theropods and some sauropods, the inverted U-curve restored in *Apatosaurus* is so strong that the head is well below ground level. Neutral neck posture consequently does not necessarily match normal posture in sauropods, or in giraffes whose cervicals articulate horizontally although the neck is often held near vertical. The neck base of *Brachiosaurus* is too poorly preserved to restore its posture, but the presence of well developed withers and stress analysis suggest it was carried erect. In multiple camarasaur, mamenchisaur and euhelopid specimens the neck base is kinked upwards even when the rest of the neck is not dorso-flexed. Cervicals remain functionally articulated when vertical in most sauropods, except diplodocids which had to rear up to hold the neck vertically.

The common claim that the sauropods ultralong necks saved energy by working like a ground level vacuum cleaner has never been verified. Just 1 kg worth of browse powers a 50 tonne animal for 400 m, and walking 7 m requires only 20 g of browse. Such trivial energy savings do not compensate for the extra energy needed to grow and maintain long necks, or breathe through long trachea. Tall necks would have required overly large, very high pressure sauropod hearts, but such inefficiency is similar to the high cost of elevated metabolic rates, the energy expensive brains of humans, or massive flight muscles. Sauropod necks probably evolved to reach floral resources beyond the reach of shorter herbivores, and lack of grit wear on sauropod teeth confirms that they rarely low browsed.