Variation in pneumatic features in vertebrae of sauropod dinosaurs

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# Abstract

XXX to be written last, if at all.

# Introduction

The vertebrae of sauropod dinosaurs have complex pneumatic features such as fossae and foramina, in both the centrum and neural arch, and laminae connecting landmarks such as the zygapophyses, diapophyses and parapophyses (Wedel 2003). For this reason, they are unusually diagnostic and are frequently used in species determination (McIntosh 1990).

While these features can be characteristic of a species, genus or clade, they are also highly variable: not only between individuals, but also invariably along the column of an individual (e.g. *Diplodocus carnegii*, Hatcher 1901:plates 3 and 7), and even sometimes between the sides of a single vertebra (e.g. *Xenoposeidon proneneukos* holotype, Taylor and Naish 2007:1552; vertebrae in the tail of *Giraffatitan brancai* MB.R.5000, Wedel and Taylor 2013:5–7). In contrast, the vertebrae of mammals, non-dinosaurian reptiles and even other dinosaurs are much more uniform, exhibiting less individual, serial and chiral variation. Why are sauropod vertebrae so much more variable?

XXX illustrate Xeno left and right

XXX re-use Giraffatitan tail illustration

# Discussion

It has been generally assumed that variation in pneumatic features is essentially random: as Witmer (1997:64) wrote of the antorbital paranasal air sinus in archosaurs, “pneumatic diverticula are viewed simply as opportunistic pneumatizing machines, resorbing as much bone as possible within the constraints imposed by local biomechanical loading regimes”. However, here we develop another explanation.

Bremer (1940:200) demonstrated that in extant birds, developing diverticula follow blood vessels as they radiate through the body: “Into this loose tissue, along the vein, the air sac finally grows in the form of a long tube … The actual entrance of the air sac into the main marrow cavity is effected at first at the internal opening of the vein”. It is parsimonious to assume the same was true in sauropods.

XXX Matt’s croc specimen

# Conclusions

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# Acknowledgements

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