# Sails at the water: ecological convergence between sphenacodontids and spinosaurids?

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*Abstract.* Spinosaurids (Diapsida: Spinosauridae) and sphenacodontids (Synapsida: Sphenacodontidae) share not only a characteristic tall neural spines, but also an atypical – compared to their close respective relatives – ecology, i.e. apparently piscivorous and possibly semiaquatic mode of life. This similarity might hold clue for the role of their sails. It is here suggested that sails of these animals 1) served thermoregulatory function, warming the animals, otherwise submerged in the water, as well as 2) enabled them to hunt for fish in a way similar to the technique of Recent diapsid, black heron (*Egretta ardesiaca*).

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Spinosaurids (Diapsida: Spinosauridae) and sphenacodontids (Synapsida: Sphenacodontidae) are the two extinct clades considered as prime examples of the development of sails from the neural spines of the vertebrae. They are not unique in this respect (e.g. *Ouranosaurus* in Diapsida; Edaphosauridae in Synapsida), but have this feature most extremely developed. Also, they apparently share a piscivorous and possibly semiaquatic mode of life (Charig & Milner, 1997, Amiot *et al*. 2010, Ibrahim *et al.* 2014, Vullo *et al.* 2016 for spinosaurids; *cf.* Zoehfeld *et al*. 2014 for sphenacodontids), so the comparison is restricted here to these two clades only.

The search for functional account of extreme features in the fossil record (sails, horns, etc.) often rely on supposedly mutually exclusive explanations (the same is irritatively true for mass extinctions). This must not be the case, as any feature is usually multipurpose.

As non-avian dinosaurs make up a stem group of endothermic avialans (similar is true for: non-mammal synapsids and endothermic mammals), there is much debate whether some of their anatomy may be indicative of "higher" or intermediate level of thermoregulation. Too often in these discussions is the endotherm-ectotherm dichotomy being equated to homoiothermy-poikilothermy, tachymetabolism-bradymetabolism, and warm-bloodedness-cold-bloodedness. It is beyond the scope of this short note to discuss the differences of these pairs of antitheses. The crocodile-like skulls of spinosaurids make it reasonable to state that these animals (may also be true for sphenacodontids) spend a lot of time submerged. It seems thus likely that, irrespective of their actual level of thermoregulation development, sails acted as sun batteries, warming the bodies under water.

The tall sails of spinosaurids and sphenacodontids would also make quite a big shade on the water surface. It is hypothesized here that this shade might attract fish and enable the animals in question to prey in a way similar to the Recent black heron (*Egretta ardesiaca*) (Fig. 1).

Fig. 1 Blach heron (*Egretta ardesiaca*) using the so called cloak & dagger fishing technique. Photography by Steve Garvie. From Wikipedia Commons under licence CC BY-SA 2.0: https://creativecommons.org/licenses/by-sa/2.0/ Source: https://upload.wikimedia.org/wikipedia/commons/f/f5/Flickr_-_Rainbirder_-_Black_Egret_%28Egretta_ardesiaca%29.jpg

In sum up, sails of both spinosaurids and sphenacodontids could be multi-functional, including – but not necessarily restricted to – thermoregulation and feeding-related behaviors of these water-dwelling animals.

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After the publication of this preprint, I was contacted by my colleague, Maciej Ziegler, who pointed out, that he envisioned a similar parallel between *Spinosaurus* and *Egretta* as me, and published the idea few years ago, in a popular text in Polish. As at that time we were working together on a project including, amongst others, his text, it is possible that I might have read his work. Yet, I don't remember doing so, and besides, I started to think about the idea only after seeing black heron on TV, sometime at the end of 2016 or beginning of 2017. Whether we acquired our idea strictly independently, or was I incepted, Maciej Ziegler should be cited as first to notice similarities between *Spinosaurus* and *Egretta*.

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