How ancient crocodylomorphs adapted to life in the open oceans

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Abstract: While the osteological adaptations that occurred during crocodylomorph evolution are well understood, the soft tissue ones are not. During their 230-million-year evolutionary history, Crocodylomorpha evolved from gracile terrestrial forms, into large-bodied semi-aquatic taxa and into bizarre 'dolphin-like' animals. The question remains, during these major evolutionary transitions what happened within the skull? In order to investigate the land-to-sea transition seen in Thalattosuchia, which resulted in the 'dolphin-like' metriorhynchids, our team CT scanned and digitally segmented the cranial endocasts of 16 extinct and extant crocodylomorphs. Our two 'sphenosuchians' had distinct brain, vasculature and sinus morphologies, noticeably different from extant species. However, our two protosuchians had the entire suite of pneumatic structures seen in extant crocodylians, suggesting modern crocodylian sinus patterns are over 200 million years old. The thalattosuchians however, had a unique array of endocranial vasculature and pneumatic anatomies; with hypertrophy of several venous sinuses and arterial osteological canals. Based on the blood flow patterns of extant species, thalattosuchians would have had far greater blood flow entering and exiting the orbital and nasal regions. This increase corresponds with their proportionally large eyes, and suggests that the salt glands of Metriorhynchidae evolved at the base of Thalattosuchia. All thalattosuchians had a less extensive pneumatic sinus system when compared with 'sphenosuchians', protosuchians and extant species. Rather than having discrete diverticula, the sinuses were confluent with the tympanic cavity and hard to individualise. Moreover, the intertympanic and quadrate diverticula were absent. The lack of the intertympanic diverticula suggests thalattosuchians had poor acoustic coupling of the middle ears, and thus more limited directional hearing when compared to extant species. Our results suggest that at least some of the major soft tissue adaptations that underpinned the metriorhynchid radiation into the pelagic

realm occurred much earlier in thalattosuchian evolution, prior to the reorganisation of the post-cranial skeleton.

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