Introduction

Modern whales are aquatic mammals, but the fossil record indicates they have terrestrial ancestors. They began making the transition from land to water around 50 million years ago. A virtually complete skeleton of the semiaquatic whale *Maiacetus inuus* was discovered and excavated in 2004, including a tail preserved down to the tip with minimal reconstruction.

This project aimed to explore one key aspect of this major evolutionary transition: the development of specialized tail-powered swimming. Caudal morphology plays a key role in tail function, as certain shapes and relative sizes are conducive to different movements and patterns. By comparing the tail morphology of *Maiacetus* with that of modern mammals, we sought to determine the manner in which *Maiacetus* used its tail during swimming. This information will help elucidate the details of how locomotor behavior evolved as whales adapted to a predominantly aquatic lifestyle.

Methods

Up to nine different measurements were taken of all caudal vertebrae in selected fossil cetaceans, as well as in over 70 species of modern mammals. This data was divided into subsets and analyzed accordingly. Principle Component Analysis (PCA) is a statistical technique that uses patterns of variance to discover simple trends in complex datasets. While we ran numerous analyses, our key findings can be summed up and expressed through the results of PCAs that assessed the following in aquatic and semiaquatic mammals:

1. Average morphology of caudal vertebrae 1-4
2. Relative length of caudal vertebrae R-Z
3. Width to height ratio of caudal vertebrae R-Z

Conclusions

Our conclusions from the analyses are as follows:

**Average Caudal 1-4**

- The anterior part of the tail in *Maiacetus* is relatively mobile and plots among many otters on PC 2

**Relative Length Caudal R-Z**

- *Maiacetus* has a clear increase in relative length of the vertebrate at the end of its tail

**Width/Height Ratio Caudal R-Z**

- *Maiacetus* does not have especially wide or high terminal caudal vertebrae, but is in the range of other cetaceans on PC 1

*Maiacetus inuus* seems to have had a relatively flexible tail anteriorly. It also had an increase in relative length of the terminal caudal vertebrae without an increase in relative width. This suggests that *Maiacetus* had a tail that was modified in some ways for propulsion, despite lacking a well-defined tail fluke as in modern cetaceans. Given the size of its hind limbs, *Maiacetus* most likely used its tail to supplement paddling of the limbs during swimming.

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