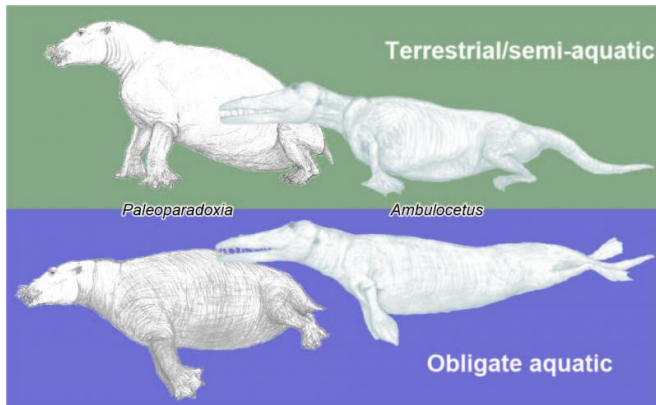


New index reveals likelihood of terrestrial or aquatic lifestyles of extinct mammals

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Paleoparadoxia (left: Desmostylia, Paenungulata) and Ambulocetus (right: Cetacea, Cetartiodactyla) in two different ways of reconstructions?top: terrestrial/semi-aquatic; bottom: obligate aquatic. Credit: Fujiwara(2016)

Researchers at Nagoya University establish a new index based on rib strength measurement, which can use fossil records to predict whether extinct mammalian species lived exclusively in the water, were occasionally on land, or were fully land-based.

Despite the extensive fossil record of mammals, it is often difficult to use fossil data to reconstruct the lifestyles and habitats of extinct [species](#). The fact that some species spent all or part of their time underwater, respectively similar to modern-day whales and seals, further complicates this.

Konami Ando and Shin-chi Fujiwara, researchers at Nagoya University, addressed this by developing a new [index](#) for predicting if a species lived its entire life in the water. The index is based on how the ribs must be relatively strong for an animal to walk or crawl over land, but not for it to swim. After establishing the index via measurements of living terrestrial, semiaquatic, and exclusively [aquatic species](#), Ando and

Fujiwara used it to predict that some [extinct species](#) could not have supported themselves on land.

Although mammals originally evolved as terrestrial organisms, cladistics shows that some returned to aquatic lives, and that this sometimes occurred independently. Examples include whales, dolphins, and manatees, which never leave the water, and seals and hippopotamuses, which split time between land and water. Studies of fossils of extinct species also suggest some species spent all or some of their time in the water. However, inability to use [fossil records](#) alone to determine a species' lifestyle has made this hard to confirm.

In their study, reported in the *Journal of Anatomy*, Ando and Fujiwara analyzed rib cages and their resistance to vertical compression in a range of mammalian species. This important factor represents an animal's ability to support its body weight against gravity while walking or crawling; a trait aquatic organisms do not need. The researchers investigated 26 modern-day terrestrial, semiaquatic, and exclusively aquatic species, including the killer whale, polar bear, dugong, giraffe, and hippopotamus. They used their data to establish an index for differentiating between groups with different habitats. They then applied the index to four extinct [mammalian species](#), all of which had retained their four limbs but showed signs of having been partially or completely aquatic, to shed light on their potential lifestyles.

"We selected mammals with different habitats from a range of taxa and analyzed fossils for which the bones in the thoracic region were well-preserved," Fujiwara says. "We focused on the fracture loads of ribs. We found the sum of the fracture loads of all true ribs directly connected to the sternum divided by the [body weight](#) effectively separated the extant species groups by habitat. Exclusively aquatic species were clearly differentiated."

After establishing that the index could correctly

classify living species with known habitats and lifestyles, the researchers applied it to extinct groups: Ambulocetus, an early ancestor of whales, and three desmostylian species, which are the keens of elephants and sea cows. This was to confirm or reject earlier hypotheses about these groups' lifestyles, which were based on other morphological findings.

"Our index lets us conclude that Ambulocetus and two desmostylians (Paleoparadoxia and Neoparadoxia) could not have supported themselves on land; they were exclusively aquatic," Ando says. "But the findings were inconclusive for the third desmostylian (Desmostylus). We may need to perform additional studies on the intermediate group of semiaquatic species, include a bone density variable in our model, or improve our data on the body mass of extinct species to refine the index."

The new index should help in both reconstructing the lifestyles and habitats of extinct mammals and clarifying anatomical changes associated with mammals shifting to a life partly or exclusively in the water.

More information: Konami Ando et al. Farewell to life on land - thoracic strength as a new indicator to determine paleoecology in secondary aquatic mammals, *Journal of Anatomy* (2016). DOI: [10.1111/joa.12518](https://doi.org/10.1111/joa.12518)

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