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Moby, can you hear me whale?

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Under the name "whale" lies an important diversity of aquatic mammals. Usually, scientists divide them into three groups. "Baleen whales", also called whales with mustache, is an extant group including the humpback whales and the largest animals that ever lived on earth, the blue whales. " Toothed whales", is the other group of modern whales. The latter has many famous representatives, notably "Flipper" the dolphin, "Willy" the killer whale and "Moby Dick" the sperm whale. The third group gathers only fossils whales with no direct extant descendant. It is called the group of "ancient wales", or archaeocetes for palaeontologists. This third group encompasses an important diversity of mammals conveying the whales' transition from land to sea. Indeed, modern whales are fully aquatic mammals that emerged from a group of land mammals called the "even-toed ungulate" that includes camels, pigs, hippos, and cows.

In underwater life, vision is limited and modern whales rely mainly on an acute sense of hearing to go about their daily business. The two modern groups of whales greatly differ from each other in their hearing capacities. The baleen whales are sensitive to low frequencies and emit infrasound (frequencies that are too low to be heard by humans) to communicate over long distances across the ocean, while the toothed whales are sensitive to high frequencies and use ultrasounds (frequencies that are too high to be heard by humans) for echolocation. Nowadays, there are two major hypotheses to explain the emergence of these remarkable hearing capacities. According to the first one, the common ancestor of whales would be sensitive to low frequencies while according to the second hypothesis, their common ancestor would be sensitive to high frequencies.

In order to test these two hypotheses, we studied some fossils of "ancient whales", retrieved in Togo, Africa. These "ancient whales", called protocetids, were the first whales to undertake an important dispersion out of India and Pakistan, the cradle of whales, around 45 Ma (million years) ago. They have the particularities of having four functional legs and are at the heart of the transition between an amphibious and a strictly aquatic lifestyle.

With a kind of "X-ray radiography" investigation of the ancient whales" skull remains from Togo, we managed, for the very first time, to virtually reconstruct the shape of their organ of hearing, called the cochlea. Thus, we were able to observe important parameters linked with hearing sensitivity and to compare them with the cochleae of a wide array of modern whales and their land relatives.

Not surprisingly, the shape of protocetids' cochlea is in between that of fully aquatic whales and that of their land ungulates relatives, which is coherent with their inferred semi-aquatic lifestyle. Furthermore, the shape of their cochlea is in between that of baleen whales, the low frequencies specialists and that of toothed whales, the high-frequencies specialists. Thus, it appears that these ancient whales were probably not sensitive to ultrasound or infrasound and that they had hearing sensitivities close to those of their fully terrestrial ungulate cousins.

Then, we were able to reconstruct the hypothetical shape of the cochlea for the common ancestor of the whales as a whole along with the one of modern whales.

Interestingly, contrary to the two previous hypotheses, it appears that the common ancestor of all whales and even the one of modern whales did not have particular hearing specializations. These results imply that the specializations towards infrasound and ultrasound evolved after the emergence of modern whales.

To conclude, modern whales live mainly in an underwater "world of sounds". Nowadays, their acoustic environment is highly polluted by anthropogenic underwater noise (due to human activities). This sonic pollution has devastating effects on whales; it deeply disturbs their communications and feeding behaviours, decreases their reproduction rate, and can also lead to tragic events like mass stranding. Still little is known about modern whales' hearing, especially concerning baleen whales. Thus, it is of crucial importance to increase our knowledge on that matter if we want that one day, Moby and the other whales will be able not to hear us anymore and sleep soundly!