

Beaked Whales Perform Extreme Dives to Hunt Deepwater Prey

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A study of ten beaked whales of two poorly understood species shows their foraging dives are deeper and longer than those reported for any other air-breathing species. This extreme deep-diving behavior is of particular interest since beaked whales stranded during naval sonar exercises have been reported to have symptoms of decompression sickness. One goal of the study was to explore whether the extreme diving behavior of beaked whales puts them at a special risk from naval sonar exercises.

Scientists from the Woods Hole Oceanographic Institution (WHOI) teamed with colleagues from the University of La Laguna in Spain, the University of Aarhus in Denmark, BluWest and the NATO Undersea Research Centre in Italy. The team studied Cuvier's beaked whales (*Ziphius cavirostris*) and Blainville's beaked whales (*Mesoplodon densirostris*) in Italian and Spanish waters using a non-invasive digital archival tag or D-tag developed at WHOI by one of the authors, engineer Dr. Mark Johnson. Their findings are reported in the current online issue of the *Journal of Experimental Biology*.

The D-tag, about the size of a sandal, has a variety of sensors to record sounds and movements, and is attached to the animals with four small suction cups using a handheld pole. It is programmed to release from the animal within a day and is recovered with help from a VHF radio beacon in the tag. The 3-6 gigabytes of audio and sensor data are then off-loaded to a computer for analysis.

Dr. Peter Tyack, a senior scientist in the WHOI Biology Department and lead author of the study, says they found some similarities with the much better studied sperm whales and elephant seals, but also some major differences. “These two beaked whale species make long, very deep dives to find food, and then make shallow dives and rest near the surface. By contrast, sperm whales and elephant seals can make a series of deep dives without the need for prolonged intervals between deep dives. We think that beaked whales return to the surface after deep dives with an oxygen debt and need to recover before their next deep dive.”

Tyack said the team's analysis suggests that the normal deep diving behavior of beaked whales does not pose a decompression risk. “Rather, it appears that their greatest risk of decompression sickness would stem from an atypical behavioral response involving repeated dives at depths between 30 and 80 meters (roughly 100 to 250 feet),” Tyack said. “The reason for this is that once the lungs have collapsed under pressure, gas does not diffuse from the lungs into the blood. Lung collapse is thought to occur shallower than 100 meters (330 feet), so deeper parts of the dive do not increase the risk of decompression problems. However, if beaked whales responded to sonars with repeated dives to near 50 meters (165 feet), this could pose a risk.”

The Cuvier's beaked whales were tagged in June 2003 and 2004 in the Ligurian Sea off Italy, while the Blainville's beaked whales were tagged in October 2003 and 2004 off the island of El Hierro in the Canary Islands. Both field sites were in deep water, between 700 and 2,000 meters (2,300 to 6,500 feet) with steep bottom topography. Tags were attached to seven Cuvier's beaked whales and three Blainville's beaked whales, and they remained attached to the whales for an average of 8 hours and 12 hours, respectively.

“Although this study was limited to ten animals, it provides the first detailed information available about the diving, acoustic, and movement

behavior of two species of beaked whales,” Tyack said. “Shallow dives seem to be performed between deep dives, and both species dive very deep to hunt for prey. They seem to spend equal time ascending and descending in shallow dives, but take longer to ascend from deep dives.”

The slow ascent from deep dives is a major mystery. “Why don’t they stay longer at depth to feed, and then come up more rapidly?” Tyack said. “Avoidance of decompression problems by slow ascent, as in scuba divers, cannot account for this behavior if the lungs of these breathhold diving marine mammals are collapsed at depths greater than 100 meters (330 feet).”

Very little is known about these two species of beaked whales since they spend little time on the surface and it is difficult to tag them. The much better studied sperm whale can dive for more than one hour to depths greater than 1,200 meters (roughly 4,000 feet), but typically dives for 45 minutes to depths of 600-1,000 meters (1,968 to 3,280 feet). Elephant seals, another well known deep diver, can spend up to two hours in depths over 1,500 meters (nearly 5,000 feet), but typically dive for only 25-30 minutes to depths of about 500 meters (1,640 feet). Marine mammals seem to have adapted to the effects of diving deep and optimizing their oxygen supplies.

The Cuvier’s beaked whales dove to maximum depths of nearly 1,900 meters (about 6,230 feet) with a maximum duration of 85 minutes, while the Blainville’s beaked whales dove to a maximum depth of 1,250 meters (4,100 feet) and 57 minutes in duration. The dives near 1,900 meters constitute the deepest confirmed dives reported from any air-breathing animal. While people often focus on the maximum dives of breathhold diving animals, breathhold divers are not at a track meet and it is the average of the deep foraging dives that is more important. Regular echolocation clicks and buzzes and echoes of what appears to be prey were recorded on the tags, suggesting the whales were hunting for food

on the deep dives. The average foraging dive for Cuvier's beaked whale went to a depth of 1,070 meters (about 3,500 feet) with a duration of 58 minutes, while the Blainville's beaked whales dove to an average depth of 835 meters (2,740 feet) and 46.5 minutes in duration. These represent the deepest and longest average dives reported for any breathhold-diving animal.

These two beaked whale species have been reported to mass strand during naval sonar exercises in the area. It is unclear how these beaked whale species respond to the sonar sounds and whether their responses cause physiological changes that increase the risk that they will strand and die. This study suggests the paradoxical result that even though beaked whales are extreme divers, their normal diving behavior does not seem to put them at greater physiological risk for sonar exposure. Rather it suggests that physiological risk would stem from a specific behavioral response to the sonars.

“No matter what the precise cause of the strandings is, we need to develop effective mitigation strategies to reduce the accidental exposure of beaked whales to bay sonar,” Tyack said. “The information in this study provides critical data to design efficient acoustic and visual detection methods for these at-risk species of marine mammals.”

Source: Woods Hole Oceanographic Institution

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