Beaked whales

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What is a beaked whale?

The beaked whales (*Ziphiidae*) belong to a little known cetacean family of more than 21 species that range in size from 3m and a few hundred kg to more than 10 meters and 8,000 kg. Even though beaked whales all belong to the suborder toothed whales, most species, ironically, have few if any erupted teeth, with these serving as tusks in male-male interactions rather than for foraging. Despite few geographical boundaries in their deep ocean habitat, superficially similar, but genetically distinct, species of beaked whales share what appear to be similar foraging niches. Beaked whales routinely dive deeper than 1km for an hour or more, and surface for such a short time that they are very difficult to sight. This cryptic lifestyle has, until recently, left us with very little information about some of the world's biggest predators beyond what can be gathered from stranded specimens. This second largest family of toothed whales is so little known that two new species, Perrin's beaked whale and the pygmy beaked whale, have been identified in the last 25 years, and a few more beaked whale species may be awaiting discovery. It is thought-provoking that there are likely elephant-sized, mammalian predators still roaming the world's oceans that science has not yet even named. However, after many years of being a largely overlooked zoological oddity, beaked whales have recently received substantial public attention after a series of mass-strandings caused by mid frequency naval sonars.

Why do beaked whales dive so deep?

The need to understand why beaked whales may respond so strongly to navy sonar has prompted the development of techniques to study these elusive predators of the high seas. Deployments of electronic tags have revealed the underwater behavior of bottlenose, Blainville's and Cuvier's beaked whales, showing that these species routinely dive to more mesopelagic depths where they hunt for small, deep-water squid and fish. These food resources are found so deep that beaked whales often dive to more than 1000m depths for around an hour (figure 1) routinely exceeding their aerobic dive limit. They therefore return to the surface with a substantial oxygen debt that is paid off in a prolonged surface time that includes a series of shallow non-foraging dives (figure 1). Recently, a tagged Cuvier's beaked whale was recorded diving more than 3000 meters during a 2 hour long dive that is by far the deepest dive recorded for any air-breathing endotherm. How a mammal can hold its breath for so long and survive a hydrostatic pressure of >300 kg/cm^2 is still very much an unsolved mystery. But a consequence of this deep water foraging is that beaked whales spend <20 % of their time foraging, which may explain why they are often found around islands and in upwelling areas that provide stable and dense patches of food resources at depth.

How do they find and catch food in the deep sea?

The task of locating, approaching and catching small, agile prey in the cold, dark abyss may seem almost impossible to us humans. Beaked whales and other toothed whales have solved that problem by emitting ultrasonic clicks and listening for returning echoes to hunt by echolocation. When the first sound recording tags were deployed on Blainville's beaked whales, we were astounded to find that not only could the tags record the emitted echolocation clicks, but also the echoes returning from prey, allowing us a unique opportunity to tap into the sensory stream of a predator hunting in the wild. Because of this, beaked whales are now among the best-studied animals that use echolocation to hunt, and they have become a very unlikely model for how toothed whales in general operate their sonars in the wild. Tagged whales emit some 3500 echolocation clicks to detect and approach about 25 prey per dive. When whales catch their prey, they accelerate the click rate to a "buzz," as is the case for echolocating bats, revealing a remarkable functional convergence of biosonars in air and water. Analysis of echo data from two species of beaked whales show that they ensonify many more organisms than they try to capture, indicating careful prey selection via echo information to optimize energy returns during intense bouts of foraging with durations that are limited by breath-hold dives.

What is their social structure?

Little is known about the social structure of beaked whales, but the smaller species seem to live in groups of females and young with a single mature male. The heavily scarred older males may be seen with different groups of females over time suggesting that they fight over access to the females using their tusks. Females are often larger than males, which may relate to the large birth weight of beaked whale calves enabling them to achieve deep diving capabilities sooner. Beaked whale groups remain close together but, unlike in other toothed whales, this is not mediated by social calls at the surface, at least in the smaller species, which seem to keep track of one another at depth by eavesdropping on one another's echolocation clicks. Blainville's beaked whales also produce social sounds but these are made at depths below 200 m, which together with long silent ascents from deep dives suggest a strategy of acoustic crypsis perhaps to reduce the risk of predation from killer whales that seldom dive deep. Species with larger body size, such as the bottlenose and Baird's beaked whales, may have a more relaxed crypsis, forming larger groups while making some sounds near the surface.

Why do some beaked whales strand when exposed to navy sonars?

The anti-predation strategies of beaked whales may also explain why some smaller beaked whale species are prone to strand in conjunction with naval sonar exercises. Recent playback studies suggest that the strandings happen as a result of strong behavioral responses that appear to be elicited by low level sonar pulses at frequencies around 3-4 kHz. Playbacks of killer whale calls in a similar frequency range also evoke strong flight responses, suggesting that the sonar pulses may trigger an antipredator avoidance behaviour with potential physiological consequences that may include decompression sickness from repeated dives to escape the perceived threat.

What is their conservation status?

Although mass-strandings of beaked whales provide a dramatic example of the vulnerability of these species to human activities, sonar exposure is not the only, nor necessarily the most important, conservation threat to these large predators. Beaked whales live in areas that are hard to survey and their diving behavior precludes reliable visual counts, leading the IUCN to list most species as "data deficient." Currently, we know next to nothing about how beaked whale populations are affected by potential environmental stressors such as toxins, shipping noise, or bycatch in fisheries, nor do we know anything about their global population sizes. However, their distinctive frequency-modulated clicks with potential species-specific differences now enable acoustic surveys to estimate habitat use and population sizes. The echolocation clicks, vital for their foraging, may thus also provide researchers with a unique window to study and protect some of the largest and most cryptic predators alive.

Where can I learn more?

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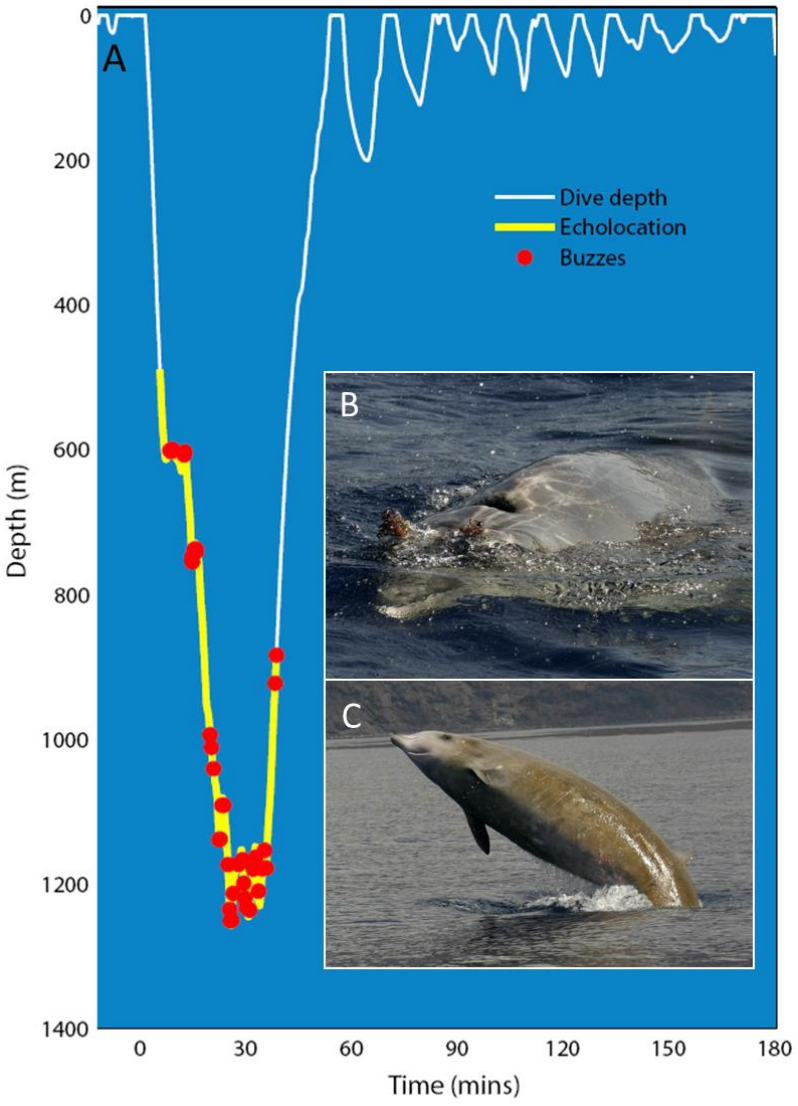

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125 Figure 1.

126 A) Dive profile of a Blainville's beaked whale. Echolocation clicks (yellow line) are only made during the
127 deep foraging dive where red dots mark foraging buzzes. B) Male Blainville's beaked whale with
128 barnacles on its large tusks (Photo credit ULL group). C) Breaching Cuviers beaked whale of El Hierro in
129 the Canary Islands (Photo credit ULL group).