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On fossil beaked whales, phosphorites and ocean floors

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In 2007, the vessel Anita was fishing with bottom gillnets in about 400m-deep waters northwest of the island of Mykines in the Faroe Islands (about 62°05'N-09°28'W). One day, fisherman Bjarni Jacobsen from the village of Sumba in the Faroe Islands, observed a strange object in the nets. At first sight he thought it was a peculiar stone because stones often get entangled in the nets. However, he soon realised that it had to be something different and put the object aside. He later believed it to be a bone or a head of a large animal or reptile and – acknowledging that fossils of large mammals or reptiles are unknown in the Faroe Islands – handed it over to a local museum. After time and much travel, the enigmatic object was identified as a rostrum – the anterior part of the skull – of the 10 to 8myr-old extinct beaked whale, *Choneziphius planirostris* (See: Post & Jensen, 2013).

Beaked whales

The shy, deep diving and squid-eating beaked whales (Ziphiidae) are, after the dolphins (Delphinidae), the most species-rich family of extant cetaceans (with 22 living species). Their obscure behaviour is the reason that some of the species were – until a few years ago – never seen and just known from skulls found on distant beaches. They range from medium sized (3m – the pygmy beaked whale, *Mesoplodon peruvianus*) to up to very

large animals (12m – Baird's beaked whale, *Berardius bairdii*). All of them are specialised divers (up to depths of 2,000m and with dives lasting up to one and a half hours.) and none of them has ever survived in captivity. Many details of their morphology, physiognomy and metabolism are still unknown and/or not (yet) understood.

Fossil beaked whales

The fossil beaked whale, *Choneziphius planirostris*, is one of the first ever described fossil whales. In 1823, Cuvier identified and described a heavy, mineralised, toothless rostrum fished from the Scheldt River near Antwerp in Belgium, as being a rostrum of a beaked whale. He identified the differences with extant beaked whales (the few species known at that time) and coined its scientific name and position.

By the end of the nineteenth century, the famous Challenger expedition noted and described fossil ear bones from deep ocean floors, most of them belonging to (unknown) fossil beaked whales. This indicated that fossil beaked whale skulls were not endemic on the Dutch coast of the North Sea, but were also present in the Pacific Ocean. During the entire twentieth century, commercial fishermen from America, Chile, Holland, Japan, New Zealand, Portugal, Spain, South Africa and Ukraine were encountering these strange rock-like obstacles from the Atlantic Ocean to the sub Antarctic of

the Indian Ocean. Most of them went overboard (and back into oblivion), but some survived and were eventually stored on dark and dusty museum shelves.

In their 1986 publication, Withmore *et al.* emphasised the occurrence of fossil beaked whale skulls as a worldwide phenomenon. They also noted the fact that most of these fossils are found on deep ocean floors, between abundant outcrops of phosphate nodules. A phosphorite nodule is – generally speaking – any rock or grain formed by direct precipitation or by replacement of calcium carbonate containing at least 5% P_2O_5 . Some of these phosphorites consist of a mixture of pebbles with macrofossils and bone debris. In fact, the large rostra or partial skulls (some over one meter in length) may be considered as very large nodules by themselves and usually are fully saturated by francolite – carbonate fluor-apatite – the main ingredient of phosphorites. All are the result of massive and intense Mid-to-Late Miocene upwelling of ocean currents – upwelling which resulted in abundant and varied ocean life and, fortunately, in lots of fossils.

Although beaked whales are the most common and striking fossils within this phenomenon, remains of other cetacean families (for example, Squalodontidae, Eurhinodelphinidae and Cetotheriidae) have been found. Sharks' teeth (mainly of *Carcharocles*

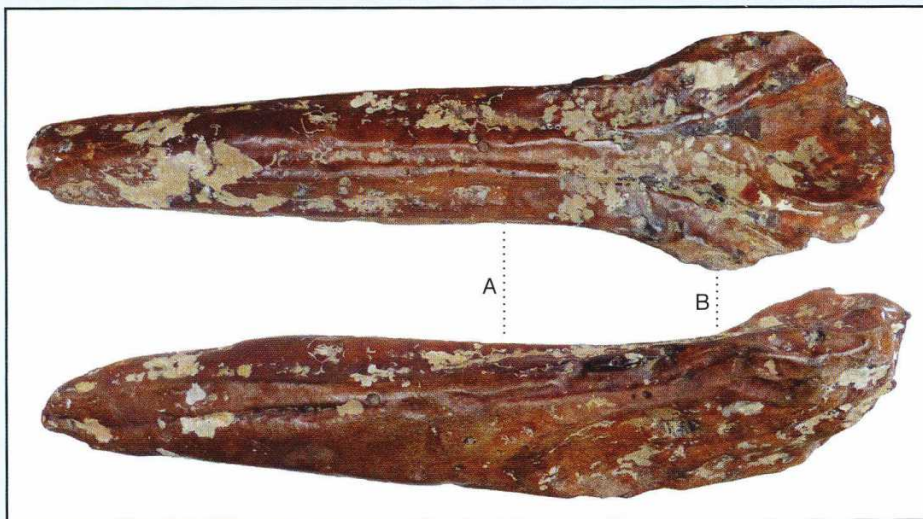


Fig. 1. The Anita rostrum; dorsal and lateral view.



Fig. 2. Cuvier's beaked whale on the ocean surface.

megalodon), crabs, and the inner casts of gastropods and bivalves are sometimes encountered as well.

Amazing abundance of Miocene species

Until a few decades ago, only a few fossil beaked whale species had been described, simply because there were almost none known to science. However, during the last decade a wealth of fossil species have been identified, mainly based on fossils fished from deep seafloors (see Bianucci *et al.*, 2013). This enormous volume and variety of fossil beaked whale species and morphologies is changing and improving greatly our knowledge of these mysterious animals and their phylogeny.

The first fossil beaked whale known to science (*Choneziphius*) showed no traces of teeth, which was unusual then for fossils of whales. The lack of fossil species (at the time) was the reason that this peculiar observation received limited scientific attention. Nowadays, the recent descriptions of dozens of Miocene beaked whales underline that, already sometime around the Middle Miocene, the family had developed its deep diving and suction feeding habit. The very early specialisation of members of this family to deep water and (suction) feeding on cephalopods is probably the reason why this family is – despite its ancient history – still successful and contains so many extant species.

Extant beaked whales frequent deep waters (of more than 300m in depth) and so did fossil beaked whales. Therefore fossils are usually found on (former) deep ocean bottoms. A spectacular example – a large beaked whale skull of a scientifically unknown genus and species – was encountered (and pictured) by the US submarine USNS Eltanin at 3,914m depth in a mass of phosphorite pebbles on the ocean floor, south of Tasmania.

Important fossil sites

The North Sea. The first beaked whale fossil from the North Sea came to shore during the early nineteenth century. And, today, remains of *Choneziphius planirostris*, *Mesoplodon longirostris* and several *Ziphirostrum* species are occasionally encountered by fishing activities and scientific

fishing trips. Land based construction activities in Belgium (near Antwerp) also regularly unearth several other genera and species, and confirm that the Mid-Late Miocene North Sea was housing a large and varied beaked whale fauna.

The coast of South Africa. During 2005, scientists studied an amazing and very large collection of beaked whale skull fossils in the Iziko museum in Cape Town, as a result of which, eight genera and ten species were described that were new to science (Bianucci *et al.*, 2007). The large variety of extant beaked whales on the steep slopes

of both bordering oceans is even surpassed by the ancient variety of species. Beaked whales could obviously establish several niches along certain depths on the slopes of the long coastlines. Cephalopod prey in the Miocene must have been diverse and – above all – plentiful.

The coast of Portugal and Spain. The steep canyons in front of the coast of Portugal and Spain do house several extant beaked whales (*Ziphius cavirostris*, several species of *Mesoplodon*), but, in the past, they also frequented its deep waters. A recent study on about 40 fossil skulls resulted again in the



Fig. 3. Fossil beaked whale rostrum on deck of a fishing vessel between phosphorite pebbles.



Fig. 4. *Choneziphius* fished out on the Scheldt River.



Fig. 5. Scientists at work in the Iziko museum.

identification of many genera and species new to science, but, most of all, in bizarre and hitherto unknown skull morphologies (Bianucci *et al.*, 2013). The most bizarre of these species (*Globicetus hiberus*) has a skull of about 1.25m in length, with an enormous and heavy circular prominence on the base of the rostrum. This is a feature which – at first sight – seems to block the functions of echo location systems that extant beaked whales use to find their ways in the deep dark.

Diamonds

The rostrum on the deck of the Anita was not only the first large fossil mammal of the Faroe Islands, and marks not only the northernmost occurrence of a beaked whale, but also represents a clear proof

of a (possibly large) exposure of phosphate nodules on the seafloor at the fishing site. Similar exposures caused the South African government at the beginning of the twentieth century to finance extensive marine expeditions to measure the viability of harvesting these ‘wet resources’. More recently, these deep ocean floor exposures worry the twenty-first century Namibian fishing industry, because the Namibian state is starting to harvest the nodules. Whether this is for the nodules or for the diamonds – which seem to coexist in Namibia with fossil beaked whales – remains unclear. However, it is clear that a wealth of fossil beaked whales, with unknown, unexpected and exiting features, are waiting for us on the deep ocean floors of the world.

About the author

Klaas Post curates the fossil mammal collection at the Natural History Museum of Rotterdam, The Netherlands.

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Fig. 6. Locations along the South African coastline.

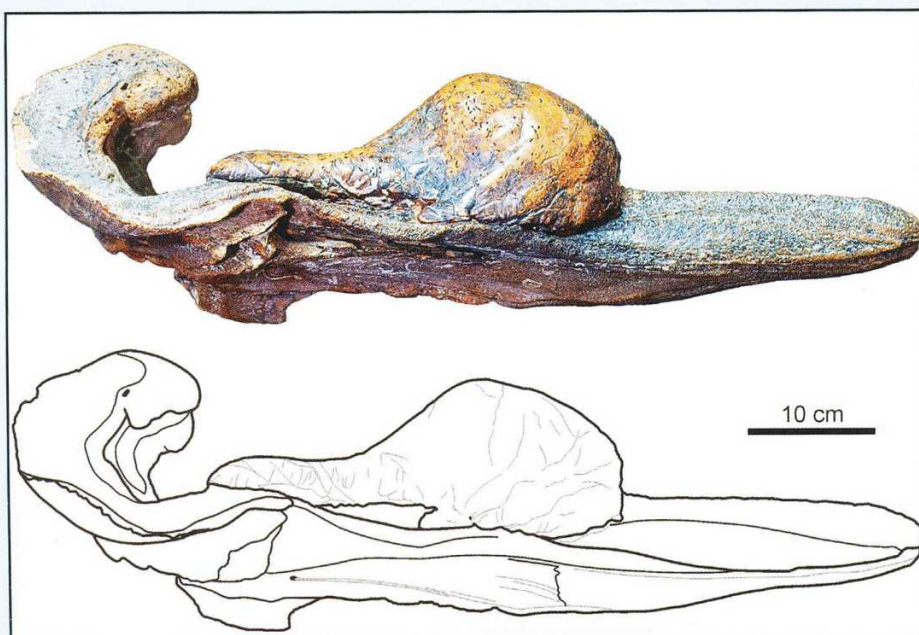


Fig. 7. *Globicetus hiberus*; lateral view.