A Tale of Two Mysticeti

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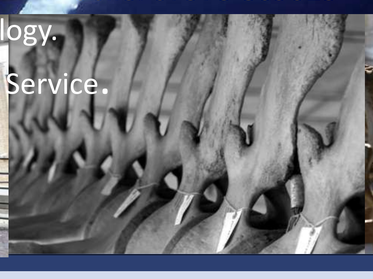
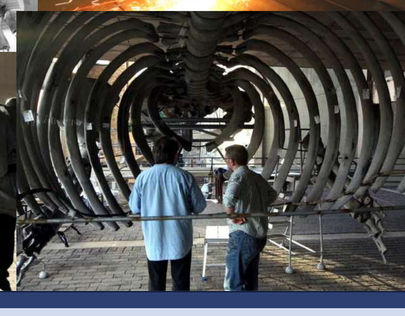




Abstract

In 2009 the partial skeleton of a large 5,200 year-old baleen whale was excavated in coastal sediments in Abu Dhabi (UAE). In 2013 a similar sized (21m long) skeleton of a 150 year-old finback whale that had been suspended from a ceiling for nearly 20 years outside Cambridge University's Zoology Museum was cleaned, dismantled and moved into temporary storage for the duration of a refurbishment project. In Abu Dhabi the 4m long, 2.3m wide, fragile skull was in a few pieces due to taphonomic processes in the burial environment. In Cambridge the 4.5m long skull was complete and weighed over a tonne.

Despite the whales' very different contexts and ages and the fact that one skeleton had to be lifted from desert sediments and transported several miles whilst the other skeleton had to be removed from its suspended mount and moved fifty metres, they are both large filter-feeding 'baleen' whales (**Suborder Mysticeti)** and some of the processes used in each of the projects were very similar. The excavated skeleton had to be cleaned and recorded, assessing the sediments and taphonomic processes evident at the site. The displayed skeleton had to be cleaned and the way it was mounted and suspended had to be recorded in detail to facilitate remounting in a couple of years. Interesting pathologies exhibited by the bones were noted in both cases. In particular, both projects necessitated constructing protective and supportive frameworks around the skulls and mandibles, bolting together lengths of galvanised steel 'Unistrut' to enable the large and heavy yet fragile specimens to be safely moved with airjacks and cranes.

Excavating and lifting the 5,200 year-old baleen whale skeleton in Abu Dhabi

This almost complete and only slightly disarticulated skeleton was exposed in a low friable sandy cliff of sabkah sediments on the edge of a tidal channel in Mussafah on the outskirts of Abu Dhabi City. First, the overburden had to be removed carefully and the general outline and extent of the bones ascertained. Then the very fragile bones (with the texture and strength of a digestive biscuit) were excavated, with much of the sediment kept for environmental analysis including the identification of molluscs, barnacles, foraminifera and ostracods *etc*.



Above left, the right dentary of the mandible in the foreground, with the skull behind (the skeleton is preserved upside-down); middle, the right limb bones in the foreground (scapula, radius and ulna) with ribs and vertebrae behind; and right, consolidating the right dentary, with parts of the skull in the foreground.

Each of the bones were carefully cleaned with soft brushes and then plotted on the site plan by surveying-in points and drawing in the detail by hand. The site is about 5,200 years old (Optically Stimulated Luminescence and C14 dating were undertaken (Stewart *et al*, 2011)) and the bones were very brittle, occasionally cracked and had little or no mechanical strength. Due to their fragile nature the bones had to be well consolidated and the reversible methacrylate co-polymer Paraloid B72 was applied at 5 to 10% in acetone. Once this had set, the larger bones and any adhering sediment were then covered with acid-free tissue paper and aluminium foil, followed by a thick covering of coarse hessian strips saturated with plaster of Paris to build up a thick protective and supportive jacket. Additional support was given by either wooden splints or a strong rigid metal frame bolted together around the specimen to which the plaster jackets were attached with more hessian and plaster so the large bones could be lifted safely and taken to off-site.




Above: the bones of the right forelimb being consolidated, plotted on the plans and surveyed-in. Below: left, the upside-down skull has been cleaned, consolidated and jacketed with acid-free tissue, foil, plaster and hessian with a few wooden splints. Middle and right, a protective and supporting cage of channelled galvanised steel 'Unistrut' was bolted around the skull, re-enforced with thick wooden batons held in place with plaster & hessian, and with a thick plywood base bolted underneath.

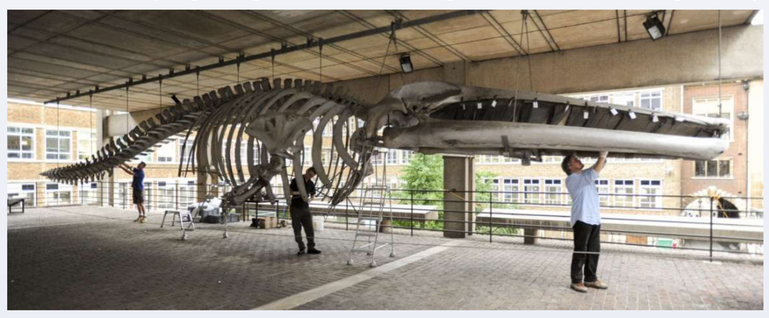


Above right: Once the skull was encased securely in its rigid cage, we had to tunnel underneath the specimen to free it from the concreted sabkah sands on which it lay, leaving it perched on pillars of sediment (far right). The two dentaries of the mandible were protected with similar rigid plaster jackets and cages (right), enabling all three very fragile specimens to be safely lifted on to a flatbed truck with a crane (far right) and taken to the Environment Agency buildings in Abu Dhabi city centre. None of the cages flexed but remained incredibly rigid, so the bones were not damaged in the lifting process.


This project was challenging in many respects. The daytime temperatures were frequently over 40˚C and the humidity was always over 90% so both sunburn and heatstroke were a real risk and simply the glare from the sun and the occasional dust/sand storm posed their own problems. The fragile bones had no mechanical strength and some were already shattered before excavation commenced (in transpired lorries and bulldozers had been moving back and forth above the site recently). The bones were like biscuit, hence the need for plenty of consolidation and the application of rigid protective plaster jackets and, where required, the construction of incredibly strong and rigid cages of channelled galvanised steel 'Unistrut'.

Dismantling the Finback Whale skeleton at Cambridge University Museum of Zoology

At 70ft (21m) long, this particular Finback Whale skeleton is one of the biggest known of this species, which is second in size only to the Blue Whale. This animal was washed ashore dead at Pevensey in Sussex in 1865 and 40,000 people are estimated to have travelled to see it on the beach within the first few days. The skeleton was prepared and subsequently bought for the museum by public subscription. It used to be mounted inside but in the 1990s it was hung from a ceiling outside the museum. After 16 years of being nested in and defecated on by pigeons, the skeleton had to be dismantled and packed away whilst a refurbishment program gutted the building and created a new glass foyer for the whale to be re-mounted in.




The task had to be approached carefully for several reasons: the pigeons had left behind a significant biohazard (not just their faeces but nesting materials and dead bodies); we would be working at height and the bones were considerably heavy; it was not clear how all the metal framework was joined together nor whether the rusty nuts and bolts would be easily undone; and we would be moving large amounts of materials, tools and equipment up a flight of stairs at the start and end of every day and well as carrying the large bones down. Because the specimen would need to be re-mounted in a new position in just a couple of years, meticulous records needed to be made of exactly how it was mounted and the order in which it would need to be reassembled. Therefore copious photos were taken and notes written, and all the bones and metalwork were labelled thoroughly before any dismantling commenced. A simple label on a bone saying what the bone was i.e. 'rib R15' was not enough – every hole where a bolt had been inserted was given it's own tie-on label describing the piece of armature that it had been bolted to, and the matching bit of armature was labelled appropriately as well. WD40 was applied to all the nuts and bolts in advance, being careful not to contaminate the bones. Various parts of the project were videoed and the whole process was recorded with a time lapse camera (you can now see the video on the zoology museum's Facebook page).



Far left: initial cleaning of the bones with a brush and 'Backuum' cleaner. Middle: removing vertebrae from the metalwork. Right: cleaning ribs with Synperonic A7.

Despite the skeleton being cleaned about 10 years previously, the accumulated pigeon faeces were over an inch deep in places. Therefore before anything was dismantled the whole specimen was cleaned as thoroughly as possible with a stiff brush and a vacuum cleaner to get rid of the worst of the pigeon droppings and nesting material as well the general, dust, dirt and cobwebs etc. After being removed from the armature, each bone was thoroughly dry brushed again before being swabbed with the mild conservation detergent Synpeonic A7 in water then the surface was cleaned of the detergent by further swabbing with water, whilst being patted dry frequently with paper towels so the water did not soak in to the bone. The baleen was cleaned very gently with small soft brushes and a vacuum cleaner, and was not 'wet cleaned'. All the rusty metalwork was cleaned with a spinning wire disk clamped to a bench, and then wiped clean with a damp rag, dried, painted and labelled. Where possible, the metal brackets were re-attached to specimens to keep them in context.

Although the skeleton was a mere 150 years old and still had some strength and mechanical integrity (unlike the Abu Dhabi whale), the 4.5m-long skull and mandible were incredibly heavy, estimated at over a ton in weight. To move the skull into position in the 1990s, it required 19 strong men, and injuries were sustained. Unfortunately the sutures of the skull are not fused and it had been sawn in half lengthways when initially prepared, so the whole structure was weaker than it might have been. Therefore, the skull itself could not support its own weight so a cage of galvanised steel Unistrut channel was built around it, bolted to a thick plywood base.

Left: a close-up of the galvanised steel Unistrut system bolted together. Right, the skull and mandible about to be moved by a crane.

The protective cage was designed so that a crane would be able to lift it using straps place underneath. Once the cage was built and Plastazote-lined wooden supports screwed securely underneath the bones, the weight had to be taken off the metal wires it was suspended from. 'Airjacks' were used (strong inflatable rubber 'pillows'). They were placed underneath the base of the cage to lift up the whole structure so that the wires could be undone and the weight transferred. Then a mobile crane moved the skull and mandible – which together with the metalwork weighed 1.6 tons!

Bespoke wooden crates were made for the baleen and forelimbs, wooden shelving made for the ribs (some up to 285cm long) and a large shed was constructed especially to house the skull for the duration of the building project. The main supporting metal beam onto which the vertebrae were threaded was in two main sections, bolted together. The larger of these weighed in the region of 170Kg and was lowered with a system of pulleys.

Conclusions Both projects presented significant health and safety risks and complex problems that required solving almost every day. But with good planning well in advance both projects were completed within the planned timeframes and within budgets. A good photographic, written and video record was made of each project, and both projects will result in publications. If Unistrut channelling had not been available to make the rigid protective and supportive cages around the skulls and mandibles in both cases, the projects would have taken much longer and the bones would have been much more vulnerable and might well have sustained serious damage. The team looks forward to repeating the Cambridge project - in reverse and at greater height , but thankfully without pigeon issues - in 2016 or 2017.

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