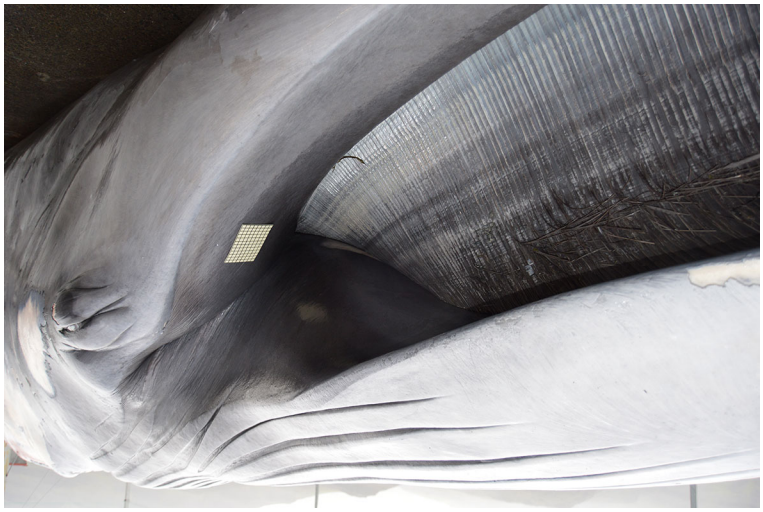
INSIDE JEB

Shock-absorbing pad protects whales' jaws when dining



A fin whale (*Balaenoptera physalus*) jaw. Photo credit: Alex Werth.

The strain put on a human jaw opening wide to crunch an apple is nothing compared with that experienced by blue whales and other rorquals engulfing massive mouthfuls of water. The world's largest mammal can enclose 70 tonnes of water in a single gulp as it propels itself through krill-laden waters. 'It's like opening the mouth of a trash bag and then quickly pulling it through the air to "push" air inside and force the bag open', says Alex Werth from Hampden-Sydney College, USA. But how do whale jaw joints withstand the enormous forces that threaten to tear the jaw free? Werth suspected that the answer may lie in the unconventional structure of the jaw joint.

'Most mobile joints in the mammalian skeleton have a fluid-filled cavity (the synovial capsule) and discs of squishy cartilage cushioning either end of the joint', explains Werth. However, the fluid-filled shock absorber is replaced by an enormous fibrocartilage pad – the same material as the discs between spinal vertebrae – in the jaws of whales that engulf massive volumes of water. 'For some time people have imagined that rorquals have some means of controlling their jaws, so they don't open too quickly, and of closing when they are filled with water', says Werth, who wondered whether the fibrocartilage pad may hold the key.

'I'm used to travelling to various coastlines when dead whales become available', says Werth, who journeyed to Iceland and along the US East Coast whenever fin and minke whales arrived on shore. 'The hard part is that really big whales are not easy to move and they don't always wash up in easy places', says Werth. Having reached the animals, Werth flexed the lower jaws to get a sense of the joints' manoeuvrability and says that the jaw 'readily bounces back to its closed position' after being opened. Then, he dissected 5 and 10 cm cubes from the fibrocartilage jaw pads for testing back in the lab.

Although pressing the cubes between circular metal plates – to measure the pad compressibility – was relatively straightforward, clamping the blocks securely while stretching them to record their extensibility was far trickier. 'We had to use clamps with sharp teeth and these can easily pull out', says Werth, who recalls playing around with different attachments until he could reliably stretch the cubes.

Amazingly, the jaw pads are extraordinarily elastic, rebounding perfectly after being compressed down to 10% of their original size and extending to more than twice their original length. 'This is really stretchy stuff!' Werth exclaims. However, it also turned out that the fibrocartilage pad is fairly stiff, based on the amount of force required to compress and stretch it. 'We think that the stiffness … slows the jaw opening a bit so that the whale can control it', says Werth; in other words, the pad behaves like a shock absorber. In addition, he suspects that it stores elastic energy as the jaws are flung wide, ready to release the energy as they clamp shut, just like a recoiling elastic band after being stretched. And when Haruka Ito from the National Research Institute of Fisheries Science, Japan, CT scanned the head of a small minke whale with its jaw in different positions, the duo saw that the pad stretched sideways while shortening from front to back.

'The unique jaw joint is just another in a long list of very stretchy materials that scientists have discovered in the whale mouth', says Werth, who hopes to investigate the structure of the shock-absorbing pad in the jaws of other whales when he gets the chance.

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