Choreography of submerged whale lunges revealed

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Returning briefly to the surface for great lungfuls of air, the underwater lifestyles of whales had been a complete mystery until a small group of pioneers from various global institutions – including Malene Simon, Mark Johnson and Peter Madsen – began attaching data-logging tags to these enigmatic creatures. Knowing that Jeremy Goldbogen and colleagues had successful tagged blue, fin and humpback whales to reveal how they lunge through giant shoals of krill, Simon and her colleagues headed off to Greenland where they tagged five humpback whales to discover how the animals capture and consume their prey: krill and agile capelin. Attaching individual tags behind the dorsal fin on three of the whales – to record their stroke patterns – and nearer the head in the remaining whales – to better measure head movements – the team successfully recorded high resolution depth, acceleration and magnetic orientation data from 479 dives to find out more about the animals' lunge tactics. Simon, from the Greenland Institute of Natural Resources, Madsen, from Aarhus University, Denmark and Johnsen from the University of St. Andrews, UK, report how whales choreograph their foraging lunges at depth in *The Journal of Experimental Biology*.

Analysing the whales' acceleration patterns, Simon saw that as the whales initiated a lunge, they accelerated upward, beating the tail fins (flukes) twice as fast as normal to reach speeds of 3m/s, which is not much greater than the whales' top cruise speeds. However, while the animals were still beating their flukes, the team saw their speed drop dramatically, although the whales never came to a complete standstill, continuing to glide at 1.5m/s even after they stopped beating their flukes.

So, when did the whales throw their mouths open during this sequence?

Given that the top speed attained by the whales during the early stages of the lunge were similar to the animals' cruising speeds and the fact that the whales were beating their flukes much harder than usual to maintain the speed, the team conclude, 'The implication is that the mouth must already be open and the buccal [mouth] pouch inflated enough to create a higher drag when the high stroking rates… occur within lunges'. In addition, the team suggests that the whales continue accelerating after opening their mouths in order to use their peak speed to stretch the elastic ventral groove blubber that inflates as they engulf water. Once the buccal pouch is fully inflated, the whales continue beating their flukes after closing their mouths to accelerate the colossal quantity of water, before ceasing fluke movement and slowing to a new speed of 1.5m/s. Finally, the animals filter the water and swallow the entrapped fish over a 46s period before resuming beating their flukes as they launch the next lunge.

Considering that humpback whales and other rorquals were thought to grind to a halt after throwing their jaws wide and that reaccelerating their massive bodies from a stationary start was believed to make lunge feeding extortionately expensive, the team's discovery that the animals continue gliding after closing their mouths suggests that lunge feeding may be cheaper than previously thought. However, the team concedes that despite the potential reduction in energy expenditure, lunge feeding is still highly demanding – the whale must accelerate the 30 tons of water held in its mouth – although they suggest that the high-speed tactic is essential for the massive hunters to engulf their nimble prey.

More information: Simon, M., Johnson., M. and Madsen, P. T. (2012) Keeping momentum with a mouthful of water: behavior and kinematics of humpback whale lunge feeding. J. Exp. Biol. 215, 3786-3798. jeb.biologists.org/content/215/21/3786.abstract

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