Immature spinner dolphin calf SCUBA tanks spell disaster in tuna fisheries

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Dolphins that live in the deep ocean have well developed oxygen storage, but now it turns out that spinner dolphin calves do not develop their SCUBA capacity any faster than coastal species, despite their deep diving lifestyle. Shawn Noren from the University of California, Santa Cruz has also calculated that delays in developing their oxygen storage could place spinner dolphin calves at risk of separation from their mothers during high speed tuna purse seine-fishery pursuits.

Just because dolphins are born in water doesn't necessarily mean that their in-built SCUBA system is fully prepared for action at birth; it can take between 1 and 3 years for the oxygen carrying capacity of whales and dolphins to mature sufficiently. Shawn Noren, from the University of California, Santa Cruz, USA, explains that the muscles of fully developed diving species - including dolphins, whales, birds and seals - contain more of the oxygen carrying protein, myoglobin, than land-based animals and are better prepared to neutralise lactic acid produced in the muscles when divers switch to anaerobic respiration after exhausting their oxygen toward the end of a dive.

"We wondered if pelagic (offshore) living promotes rapid postnatal maturation of muscle biochemistry", says Noren. In other words, might deep-diving ocean-going whales and dolphins develop large reserves of myoglobin and the ability to buffer muscle against acid earlier in in life than species that remain in shallow coastal waters? Noren and her colleagues measured the oxygen storage capacity and muscle biochemistry of spinner dolphin swim muscles and discovered that they

matured no faster than the muscles of coastal species. They also publish their calculations suggesting that the muscles' slow development could place calves at risk of separation from their mothers during pursuits by commercial fishing fleets in *Journal of Experimental Biology*.

As it is almost impossible to collect muscle samples from spinner dolphins in the open ocean, Noren depended on Kristi West, from Hawaii Pacific University, USA - who set up a dolphin stranding program in Hawaii 11 years ago and attends all strandings on the island - to collect the essential samples. Over 7 years, West collected small portions of the swimming muscle from 17 spinner dolphins that her team had been unable to rescue - ranging in age from a foetus that died during birth to newborns, adolescents and fully grown males and females. She then shipped the samples to Santa Cruz, where Noren painstakingly analysed the muscles' myoglobin content and how much sodium hydroxide she had to add to 0.5g of minced muscle to raise the pH from 6 to 7 to measure the muscle's buffering capacity against anaerobic acid production. Plotting the animals' body lengths (which correlate well with their ages) against their muscle myoglobin content, Noren could see that the dolphins' abilities to carry oxygen continued increasing as the animals aged. The ability of the muscle to buffer against pH changes also increased gradually; however, it reached the capacity of the mature dolphins and plateaued at an age around 1.6-2 years, when the dolphin youngsters are weaned, which is similar to the age at which the diving apparatus of some coastal species reaches maturity.

So ocean-going spinner dolphin calves do not develop the physical characteristics that are essential to sustain deep dives any faster than shallow-diving coastal species, such as bottlenose dolphins. However, the youngest spinner dolphins already had higher concentrations of muscle myoglobin than coastal bottlenose dolphins at the same ages, and the adult spinner dolphins' myoglobin concentrations (6-7.1g of Myoglobin/100g of wet muscle mass) matched those that had been

measured previously for other champion divers, including short-finned pilot whales and Gervais' beaked whales.

But what implications might the relatively slow development of their diving apparatus have for young spinner dolphins in the Eastern Tropical Pacific? Knowing that tuna purse-seine fisheries in this region specifically target dolphin pods - they pursue the animals to exhaustion before encircling them in enormous nets to capture the tuna shoals that reside beneath - Noren calculated that an immature calf that cannot keep up might be adrift of its mother by up to 15.4km by the end of a 100min pursuit. Noren says, "The relatively underdeveloped muscle biochemistry of calves likely contributes to documented mother-calf separations for spinner dolphins chased by the tuna purse-seine fishery", and this could affect dolphin populations dramatically if our hunger for tuna continues to separate dolphin calves from their mothers.

More information: Noren, S. R. and West, K. (2017). Muscle biochemistry of a pelagic delphinid (Stenella longirostris longirostris): insight into fishery-induced separation of mothers and calves. *J. Exp. Biol*. 220, 1490-1496. DOI: 10.1242/jeb.153668

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