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EVOLUTIONARY BIOLOGY

DNA Suggests Cultural Traits Affect Whales' Evolution

Students of animal behavior seeking something akin to human culture could do worse than to look at whales. These social creatures have the biggest brains of any animal on Earth, long lives, and a complex repertory of calls, sung in distinct dialects. Now on page 1708, marine biologist Hal Whitehead of Dalhousie University in Halifax, Nova Scotia, suggests that in sperm whales and some other species, cultural traits—learned behaviors passed on to family members—are affecting the course of genetic evolution, a situation thus far documented only in humans.

Whitehead has found a pattern of genetic markers in sperm whales implying, he says, that some whale matriarchs teach their groups as-yet-unidentified behaviors that give them a substantial survival advantage. Other marine and evolutionary biologists are greeting the proposal with great interest—and some caution. "It's a provocative idea, a really neat idea," says marine biologist Bernd Würsig of Texas A&M University, Galveston. But it's hard to make a strong case for such a radical notion because so little is known about whale behavior and genetics, whale experts say. "The idea is intriguing but speculative," says marine biologist Sarah Mesnick of the National Marine Fisheries Service in San Diego.

Whitehead admits that a cultural influence on genetic evolution in whales "certainly isn't proven" but says his explanation "fits the data better than any other explanation at the moment." The idea formed, he says, during a sabbatical spent sailing around the South Pacific with his wife, marine biologist Linda Weilgart, and two young children. Seeking a geographical pattern in order to understand the effects of locally intense hunting of sperm whales, Whitehead and Weilgart collected data on whales' vocalizations as well as tail scars, which may indicate how well an animal fends off predators such as killer whales and sharks. They also collected sloughed-off skin samples for genetic testing.

The researchers found no clear geographical pattern, but they did find a genetic one: The whales' mitochondrial DNA (mtDNA), which is inherited only from the mother, indicated that groups with similar calls and markings were related. "The only mechanism that made much sense was that the vocalizations were being passed down through the mother's line like mitochondrial DNA," Whitehead says.

Aquaculture? Sperm whale mothers and aunts may teach key survival traits to their young.

He concludes that whales learn these and presumably other behaviors from their maternal relatives and that the behaviors affect survival patterns. When he studied published genetic analyses of other whales, he found that species such as sperm, pilot, and killer whales—all of which have matrilineal societies in which offspring spend their lives with maternal relatives—have very low mtDNA diversity, less than one-fifth that of other whales such as humpbacks or bottlenose dolphins. Whitehead proposes that the diversity must have narrowed in the course of whale evolution as mtDNA "hitchhiked" on the success of behaviors passed from older females to calves, such as feeding techniques, methods for fending off predators, and babysitting. In a computer model, he shows that a cultural behavior that gives a 10% reproductive advantage and is passed on to 95% of daughters will reduce mtDNA diversity to almost zero in 300 generations.

Because these whales live as long as humans and travel in stable groups, it makes sense that their social behavior could affect evolution, Mesnick says. But whale genetic data are so sketchy that it's too early to be confident that the reduced mtDNA diversity is real in all species, she says. And even if the data hold up, it's hard to be sure that cultural transmission is responsible, she and others say. A dramatic, temporary drop in population could reduce genetic diversity as well—although Whitehead argues that because killer whales and sperm whales are global species, they are less likely to have suffered a long-term bottleneck than whales with more restricted habitats, such as humpbacks.

Researchers also question two assumptions Whitehead makes about cultural transmission. In his model, "lateral transmission"—in which an unrelated female learns the behavior and passes it to her relatives—has to be below 0.5%. Otherwise it would dilute the effect of transmission from a mother to her own family, and mtDNA diversity would not be reduced. Whitehead's number is too low to be realistic, say several marine biologists, especially as matrilineal species like sperm whales often have unrelated females in their group. "It's difficult to imagine a mother secretly clicking to her daughter, 'Feed on squid,' " Mesnick says, while not sharing the information with a nearby unrelated female. Whitehead counters that, as in humans, whales might tend to join groups with similar cultural behaviors, so lateral transmission would not matter.

Researchers also question whether learning a specific behavior could boost a female's reproductive success by as much as Whitehead assumes. The 10% figure is "optimistic," says evolutionary biologist Marcus Feldman of Stanford University, even though human cultural practices such as the domestication of animals can confer considerable advantage. Despite all the caveats, whale biologists are fascinated by the proposal. They will now be testing it by studying learned behaviors and their effects on whale survival and genetics, hoping to learn whether whales, like people, are creatures of culture as well as biology. —GRETCHEN VOGEL

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