

Mother-daughter conflict between killer whales can explain the evolution of menopause (Update)

January 11 2017



Killer whales, short-finned pilot whales and humans are the only species known to experience menopause

An international research team, from the Universities of Exeter, Cambridge and York (UK), the Center for Whale Research (USA) and Fisheries and Oceans Canada have found that mother-daughter conflict can explain why killer whales are one of only three known species of

mammal, including humans, to go through the menopause.

The study published today in the journal *Current Biology* builds on research showing that post reproductive killer whales have a 'grandmother' role within the pod and that they share knowledge of when and where to find food which increases the survival of their family group.

The new study led by Professor Darren Croft of the University of Exeter, which used 43 years of data gathered by the Center for Whale Research and Fisheries and Oceans Canada, found that older mothers suffer much higher costs when competing to reproduce alongside their daughters. When females of two generations breed at the same time, the mortality of older mothers' offspring is 1.7 times that of younger mothers' offspring.

Professor Darren Croft explains that "older females are more closely related to the family group than younger females. This imbalance in local relatedness between mothers and their own female offspring means that older females do best to invest more heavily in the wider family group whereas younger females should invest more in competition."

One of the main reasons for the 'reproductive conflict' between mothers and their own female offspring in killer whales, is their reliance on food sharing. They forage together and often share salmon between them, with offspring often relying on their mothers for years for food.

"Our previous work shows how old females help but not why they stop reproducing," said Professor Darren Croft. "Females of many species act as leaders in late life but continue to reproduce, but this new research shows that old females go through the menopause because they lose out in reproductive competition with their own daughters."

Earlier theoretical work by Professor Mike Cant, University of Exeter and Professor Rufus Johnstone, University of Cambridge, both co-authors on the new study, predicted that conflict between generations maybe key in explaining why females of some species go through menopause, the "reproductive conflict" hypothesis. The new study published today is the first test of this hypothesis in non-human animals.

Professor Mike Cant said "It's great that our theoretical predictions, made seven years ago, turned out to be correct. It means that we've captured a key piece of the puzzle of post-reproductive life. We can now explain not just why older females live so long after reproduction, but why they stop breeding in the first place."

Co-author on the current study Dr Daniel Franks from the University of York said "It's easy to think that an older female will pass on their genes better by continuing to give birth in late life. But our new work shows that if an old female killer whale reproduces her late-life offspring suffer from being out-competed by her grandchildren. This, together with her investment in helping her grandchildren, can explain the evolution of menopause."

The scientists studied two populations of killer whales which live off the North West Pacific Coast of Canada and the US. The populations included several pods, made up a several family groups. One of the pods - J pod which currently consists of 24 individuals was led by J2 ("granny") whose death was reported this month and who had been post reproductive for at least 40 years.

"J2 was the 'wise elder' in the Southern Resident killer whale clan" said Dr Deborah Giles, The Center for Whale Research. "I will always remember her amazing ability to call the other whales to her by vigorously slapping her tail on the water, even from miles away the other whales would turn around and come immediately to J2's side".

Both sons and daughters stay with their mothers and don't disperse in resident killer whales but they mate with individuals from a different family group. Males typically have a shorter lifespan than females - many not surviving beyond 30 years. Female killer whales, usually stop reproducing in their 30s-40s but just like humans they can live for many decades following menopause.

The paper concludes that "The lower survival of calves from older generation mothers in reproductive conflict cannot be explained due to a general effect of mother's age on offspring survival as we found no effect of mother's age on offspring survival to age 15 across all calves born during the study period."

Professor Croft and the research team are planning to use drones in the next phase of research to study the killer whales behaviour more closely, including a more in-depth analysis of the conflicts between mothers and their daughters.

The bottom line, Croft says, is that menopause is no accident. Rather, it's an evolved trait driven by both cooperation and conflict in family groups. The findings help to explain factors that are driving the whales' survival and reproductive success, which is essential information given that the Southern Resident killer whales - one of the whale populations under study - is listed as endangered and at risk of extinction.

More information: *Current Biology*, Croft et al.: "Reproductive Conflict and the Evolution of Menopause in Killer Whales"
[www.cell.com/current-biology/full-0960-9822\(16\)31462-2](http://www.cell.com/current-biology/full-0960-9822(16)31462-2) , DOI:
10.1016/j.cub.2016.12.015

Provided by University of Exeter

Citation: Mother-daughter conflict between killer whales can explain the evolution of menopause (Update) (2017, January 11) retrieved 24 April 2024 from <https://phys.org/news/2017-01-mother-daughter-competition-orcas-menopause.html>

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