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## Sheep shrink on Scottish isle as world warms

BY LOUIS BERGERON

Wild sheep on the Scottish island of Hirta have been diminishing in size for over 20 years and now researchers have puzzled out why: It's the heat. Like wool socks run through the dryer, the sheep have shrunk.

More precisely, the average size of Soay sheep on the island has declined about 5 percent in both body weight and stature since researchers began taking measurements of the herd in 1985.

The finding is the exact opposite of how researchers would have expected the sheep to respond to the consistent warming trend that global warming has brought to the island.

"Since the trend has been for milder winters, that should actually make things much happier for everybody, because they don't have to cope with that severe winter," said [Shripad Tuljapurkar](#), a professor of biology at [Stanford](#) and one of the co-authors of a paper describing the research, published online July 2, by [Science](#).

Hirta lies in the Scottish archipelago of St. Kilda, the western-most of the remote Outer Hebrides Islands, which lie at the same latitude as Hudson's Bay in Canada and are renowned for harsh, stormy winters. But, with less punishing winters and a longer growing season, the sheep have more grass available for grazing and more time in which to shovel it in before winter hits, all of which would be expected to produce bigger sheep. Except the gentler climate has had an unexpected side effect.

"Survival rates have been lifted for everyone, including the smaller sheep, so sheep that might simply have not made it 20 or 30 years ago are definitely making it now," said Tuljapurkar. With more runts surviving, the size of the average sheep in the herd has declined.

The size-decline trend is exacerbated because with more sheep surviving, there is more competition for the available food. And Hirta, being just under a square mile, only has so much grass to offer its resident sheep, even with a longer growing season.

"When you start looking at the population effect, it's very clear that what is driving the decline in growth rates is simply that there are more sheep jostling for the resources that are at hand. They're simply not putting on as much body mass as they used to between this first and second year of life," Tuljapurkar said. Even if the sheep pick up the pace of their growth after that, it isn't enough to make up for the lower birth weights and slower early growth, so the trend toward a decline in average size persists.

While there is ample evidence to indicate that the long-term effects of global warming will be negative, there has been some indication that in the short term, in certain regions and for certain species, there might be a temporary positive effect, as longer growing seasons could enable some plants and animals to flourish over a broader area than they normally inhabit. But this sheep finding suggests it isn't necessarily that simple.

The researchers gathered annual data by making measurements each August on the female members of the flock. In teasing out the environmental effects on the sheep, the researchers also discovered another surprising effect at work.

Natural selection generally works to favor animals growing larger over time, as bigger animals are better equipped to survive hard times and are thus more likely to reproduce successfully.

Tim Coulson



Soay sheep graze on the Scottish island of Hirta.

"We also know that body weight is heritable," Tuljapurkar said. Thus, one might expect that mothers would give birth to daughters of about the same weight at birth, or slightly larger, as the mothers had been when they were born. So, the researchers analyzed the data to see if it was the case that the average birth weight of offspring is the same as the average birth weight of their mothers.

"It turns out that is not true for young mothers," he said. Unlike more mature mothers, the young mothers have offspring that typically weigh less than the mothers did and also stay smaller as they grow. And every year, a significant percentage of the new lambs are born to young mothers.

Tuljapurkar said that this "young mother" effect, as the researchers have dubbed it, pushes down the distribution of birth weight in the population, counteracting the increase in birth weight that would be expected to result from natural selection favoring bigger animals through survival and reproduction.

"When you add those two effects, they pretty much cancel out," he said. "Even though there are evolutionary forces at work, they are sort of neutralized by this 'young mother' effect. Which is quite a surprising thing in the context of what evolutionary biologists and ecologists generally believe."

Although Tuljapurkar and his colleagues don't know how many other species might exhibit the "young mother" effect, they have also documented it in a species of red deer that live in northern Scotland.

"Sometimes people will say to me, 'Why the heck do you guys wander around studying sheep in the middle of nowhere for 25 years?'" Tuljapurkar said, reflecting on the study.

"There really is a tremendous amount that you can learn from studying the same thing in the same place for long enough so that you can see what happens across changes of climate regime," he said. "This is one of those payoffs for long-term research."

Tuljapurkar's work was funded by the U.S. National Institute on Aging. His principal collaborator, Tim Coulson of Imperial College London, was funded by the UK National Environment Research Council. Other collaborators involved in the study are from the universities of Leeds, Cambridge and Edinburgh in the United Kingdom.