LAURIE CAMPBELL/NHPA/PHOTOSHOT

studies information systems at the Hanken School of Economics in Helsinki.

But the number of peer-reviewed manuscripts made free by other means has also increased, the report says. That includes those eventually made free — often a year after publication, and sometimes on a temporary promotional basis — by publishers that charge for subscription. But it also includes manuscripts that researchers themselves archive online on repositories and personal websites. Some of the articles, although free to read, may not meet formal definitions of open access because, for example, they do not include details on whether readers can freely reuse the material.

The report does not try to distinguish between types of manuscript, nor where and how they were posted, says Archambault. "The situation is so complex that it's very hard to measure."

Björk says that the latest measurements seem to have been carefully done, although he adds that because he does not have details of the robotic harvester's code, he cannot evaluate its method. "Experts on the subject would probably agree that the open-access share of papers, measured around a year and a half after publication, is currently at least 30%," he says. "Anything above that is dependent on ways of measuring, with this new study representing the highest estimate."

The report, which was not peer reviewed, calls the 50% figure for 2011 a "tipping point", a rhetorical flourish that Suber is not sure is justified. "The real tipping point is not a number, but whether scientists make open access a habit," he says.

Harnad thinks that the next step should be to obtain more accurate measures of when papers become free. "It's hardly a triumph if articles are only accessible after a one-year embargo," he says. Greater measurement accuracy is tricky to achieve, he adds, because Google routinely blocks all robotic harvesters. He believes that research on the growth of open access should be given special concessions.

The proportion of free online papers is likely to increase in the next few years. The European Commission says that, from 2014, the results of all research funded by the European Union must be open access. And in February, the US White House announced that government-funded research should be made free to read within 12 months of publication (see *Nature* **494,** 414–415; 2013). Federal agencies are due to submit their plans for achieving this to the US Office of Science and Technology Policy by 22 August. ■

1. Archambault, E. *et al. Proportion of Open Access Peer-Reviewed Papers at the European and World Levels — 2004–2011* (Science-Metrix, 2013).
2. Laakso, M. & Björk, B.-C. *BMC Med.* **10,** 124 (2012).
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Soay sheep have greatest sexual fitness when they have two versions of a gene that determines horn size.

EVOLUTIONARY GENETICS

Big horns clash with longevity in sheep

Gene for small horns lowers sexual fitness but boosts lifespan.

BY EWEN CALLAWAY

Alpha Red 78 — a ram with horns like elephant tusks — sired 95 lambs before he died at the ripe (for a ram) old age of nine. A gene with a role in horn growth explains his fertility and his longevity, finds a study of sheep on a remote Scottish isle. The work also explains how variation can persist in traits that offer big reproductive boosts.

Ample horns are a ram's ticket to reproductive success. During the breeding season, males fight for access to females, and those with the largest horns win. But if big horns are a sexual asset, the genes underlying the trait should have become ubiquitous, says Susan Johnston, an evolutionary biologist at the University of Edinburgh, UK, who led the research. Yet some male sheep have short horns or none at all. "From an evolutionary perspective, it doesn't really make sense," Johnston says.

Johnston's team turned to the sheep living on Hirta, an island 160 kilometres west of the Scottish mainland. The animals, a primitive breed called Soay (*Ovis aries*), are known for their diminutive size and their agility on cliffs.

Two years ago, Johnston's group reported that a single gene, *RXFP2*, explains horn variability in the sheep (S. E. Johnston *et al. Mol. Ecol.* **20,** 2555–2566; 2011). One version of the gene, Ho^+, is linked to large horns; another allele, Ho^P, is associated with small ones.

In the latest study, published in *Nature*, Johnston's team related the *RXFP2* genes of 1,750 sheep to three factors: horn size, reproductive success and lifespan (S. E. Johnston *et al. Nature* http://dx.doi.org/10.1038/nature12489; 2013). Males with one or two copies of the Ho^+ allele had the biggest horns. They fathered twice as many lambs as those with two copies of the short-horned allele, averaging 3 (versus 1.6) each year, says Johnston. But where lifespan was concerned, rams with two copies of Ho^P had an edge, she says, with a 75% chance per year of surviving the harsh Hirta winter, compared with a 61% chance for those with two long-horned alleles.

The scientists found that rams with one version of each allele (heterozygotes) had the best of everything: they were big-horned, fecund and long-lived. And this explains why short-horned rams persist. "I'm just impressed by the simple elegance of this story," says Hopi Hoekstra, an evolutionary geneticist at Harvard University in Cambridge, Massachusetts.

Johnston says that to learn more, scientists will need to study the gene: in humans and mice, it is involved in sexual development and bone density. She adds that heterozygotes such as Alpha Red 78 end up with more offspring largely because they outlive homozygous big-horned males, which tend to die young.

The ram probably wasn't winning on his looks. "He was quite an ugly sheep," she says. ■