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News & Opinion

Battle of the Sexes

Traits that help one sex but hurt the other are not sufficient for maintaining genetic variation.

By Hannah Waters | November 17, 2011

Aggressive male voles Image courtesy of Mikael Mökkönen

Genetic variation should not be taken for granted. If one trait has even a slight edge over another, it should quickly overtake a population; nonetheless, most populations have tremendous genetic variety. One commonly cited explanation for populations' ability to stave off uniformity is the existence of traits that benefit one sex but handicap the other. But such sexual conflict is not enough, according to a paper published today in *Science*, which identified other evolutionary mechanisms that are also needed, in conjunction with clashing male and female interests, to maintain diversity.

"This paper addresses one of the fundamental questions in evolutionary biology, which is why do you see variation genetically and in traits in populations that are subject to selection," said Robert Cox, an evolutionary biologist at the University of Virginia who was not involved in the research. "The really interesting thing about that study is that it combines two theories that, together, keep stirring that pot of variation."

Traits that benefit one sex to the detriment of the other—known as sexually antagonistic traits—result in a genetic tug-of-war, with the trait fluctuating in frequency and presumably generating an overall balance over time. "The idea is that this ping-pong match between the sexes will slow down the loss of variation in species," said evolutionary biologist Adam Chippindale of Queens University in Ontario, who did not participate in the study.

But Mikael Mökkönen, a postdoc studying evolutionary biology at the University of Jyväskyläin in Finland, considers this idea too simplified. If a trait benefits males more than it hurts females—even slightly—the trait should quickly become widespread. In other words, for sexual antagonism to be solely responsible for maintaining variation, the costs and benefits must remain perfectly balanced. "So far the research that has come out has implicitly assumed that the tug-of-war is balanced—that the strength of selection is about the same between males and females—but we've seen that that's not really the case," said Mökkönen. "If sexually antagonistic selection really is unbalanced, there must be something that's helping those traits be maintained in the population."

Newborn bank voles Image courtesy of Mikael Mökkönen

To investigate, Mökkönen and his colleagues designed a three-part experiment using European bank voles. When male bank voles have high testosterone, they are far more successful at mating than their low-testosterone counterparts, but at a cost: their daughters, which should also have high testosterone, are less fertile. In the lab, Mökkönen bred 31 populations of bank voles, selected for very high- and low-testosterone males and, in doing so, their less or more fertile daughters, respectively.

These voles were then released into enclosed arenas in the field during the breeding season, facing predators and the elements as they would in the wild, to evaluate how testosterone levels influence mating behavior. To Mökkönen's surprise, whether high- or low-testosterone males reigned, the rare phenotype mated more, suggesting that a male's success with the females depends in large part on the other males in the population—an effect known as frequency-dependent selection. That is, if high-testosterone males were plentiful, the low-testosterone males bred more frequently, and vice versa.

"It's often the case that there's more than one way to be a successful male," said Cox. For example, it could be that the high-testosterone males fight with one another when they abound, making way for the low-testosterone males to steal a few minutes with a female. But when a population is comprised primarily of low-testosterone males, those with high testosterone could be more likely to catch the females' attention.

An enclosed field arena in Konnevesi, Finland Image courtesy of Mikael Mökkönen

The researchers also built a mathematical model to speculate about how this interaction between sexual antagonism and frequency-dependent selection plays out in the long-term. Without frequency dependence, high-testosterone males (and their low-fecundity daughters) took over the population. But when rare phenotypes had a mating advantage in the model, genetic variation remained high over "something like a thousand generations," said Mökkönen.

The results are not "very surprising because numerous past studies (decades ago) have shown that

that frequency-dependent selection, in many different contexts, will increase the parameter space under which genetic diversity is maintained," William Rice, an evolutionary biologist at the University of California, Santa Barbara, who was not involved in the research, wrote in an email to *The Scientist*. Nonetheless, "their results represent progress in our understanding of how sexually antagonistic alleles are maintained in nature."

M. Mökkönen et al., "Negative frequency-dependent selection of sexually antagonistic alleles in *Myodes glareolus*," *Science*, 334 972-973, 2011.
