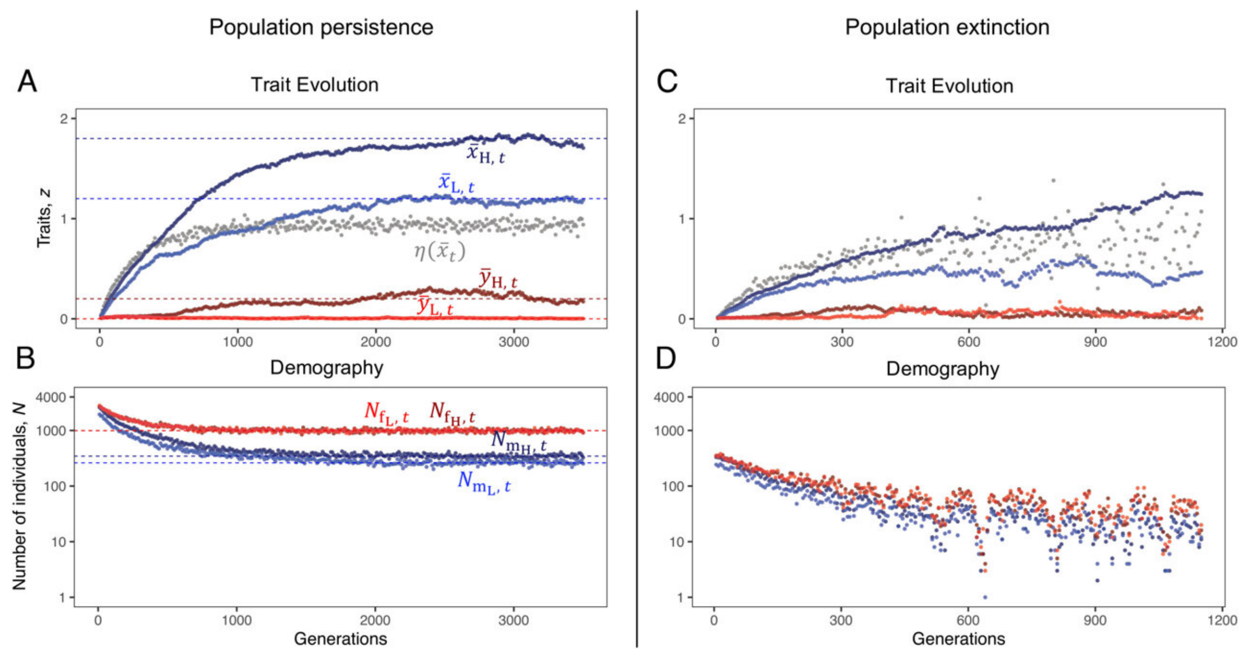
# When 'good genes' go bad: How sexual conflict can cause population collapse

March 3 2023, by Hayley Dunning




Evolutionary dynamics of trait values and their population effect when condition is environmentally determined. (*A* and *B*) respectively, show trait expression and population sizes from a simulation where intrinsic female fecundity is high ($b$ = 50, Eq. **5**), so that the population persists at an ecoevolutionary equilibrium. (*C* and *D*) respectively, show trait expression and population sizes from a simulation where intrinsic female fecundity is low ($b$ = 10), so that the population goes extinct due to male harm (evolutionary suicide). In trait evolution panels (*A* and *C*), dots show trait values of high- and low-condition males and females (dark blue for high-condition male trait, $x_{H, t}$; light blue for low-condition male trait, $x_{L, t}$; dark red for high-condition female trait, $y_{H, t}$; light red for low-condition female trait, $y_{L, t}$). Dashed lines show expected trait expression at ecoevolutionary equilibrium ($x_H^*$ and $x_L^*$ from Eq. **8**, and $y_H^*$ and $y_L^*$ from Eq.

**10**), using the same color scheme as for dots. In demography panels (*B* and *D*), dots show numbers of high- and low-condition males and females (dark blue for high-condition males, $N_{mH,\,t}$; light blue for low-condition males, $N_{mL,\,t}$; dark red for high-condition females, $N_{fH,\,t}$; light red for low-condition females, $N_{fL,\,t}$). Dashed lines show expected population sizes at ecoevolutionary equilibrium (calculated by plugging phenotypic equilibria from Eqs. **8–10** into Eqs. A-1 and A-10). Values for all dots are calculated every tenth generation of individual-based simulations (*SI Appendix*, Appendix A.4 for details on simulation procedure). Other parameters used in all panels: $r = 0.5$, $\beta = 0.002$, $v_H = 0.8$, $v_L = 0.2$, $k = 2$, $\kappa_z = 1$, $\kappa_\alpha = 1$, $\chi_m = 1$, $\chi_f = 1$, $\gamma = 1$, $d = 0.8$, $P_m = P_f = 0.5$. Credit: *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2211668120

Males of a species evolving traits for sexual conflict can cause problems for females, and, ultimately, the whole population.

A new model by Imperial College London and University of Lausanne researchers, published in *Proceedings of the National Academy of Sciences*, shows how so-called 'good genes' can sometimes cause a population to collapse.

Males of any species may compete for females, either by fighting other males for access or impressing females to win their approval. In both cases, males expressing the most competitive traits—such as the best ornaments, like peacock feathers, or the best weapons, like big body size—access more females.

To have the best traits the males must be in good condition, for example to be in better shape or carry less disease. Over time, as better-condition males mate with more females, the prevalence of 'good genes' increases throughout the population of the animal, leading to the population as a whole to improve in condition.

However, it can also backfire. Traits than improve a male's competitive prowess can also damage females. For example, some insect males have evolved penises that tear the females' insides, and in many species, including mammals, males have evolved to harass females to induce mating. These behaviors reduce female fecundity or may even kill them.

The team's model tested theories of sexual competition where males harm females, and compared the results with data for various population experiments. Previous experiments have shown conflicting accounts as to whether sexual selection is positive or negative for the population as a whole. The new model provides an explanation for why some experiments show male condition improving, without female fitness or population viability improving alongside.

First author Dr. Ewan Flintham, from Imperial College London and the University of Lausanne, said, "Where males evolve selfish traits that help them individually win, they can actually end up causing the population to crash—it's a form of evolutionary suicide. Even when females evolve to counter male harm and prevent population collapse, the population still decreases significantly, reducing its viability."

Sexual interactions like these are an important component of understanding population demographics and conservation. For example, where there are more males, sexual competition intensifies, meaning harm towards females is more likely. This is also true in human-managed populations, for example domestic carp, where males and females must be isolated during spawning season.

Dr. Flintham completed the research as part of the Centre for Doctoral Training in Quantitative and Modelling Skills in Ecology and Evolution at Imperial.

His project supervisor and study co-author Professor Vincent

Savolainen, Director of the Georgina Mace Centre for the Living Planet at Imperial, said, "Male harm evolved in nature as something that was supposed to be good, but is detrimental to females and the whole population. Questions like how and why this happens can only be answered with quantitative methods—data and mathematical models—which can be just as important as field studies."

**More information:** Ewan O. Flintham et al, Male harm offsets the demographic benefits of good genes, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2211668120

Provided by Imperial College London