Survival of the luckiest

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Opposite dynamics are behind natural selection and sexual selection. While the fittest survives in natural selection, the survivor will most likely be the luckiest when both dynamics are combined.

In episode 3 of Netflix's *Night on Earth*, it is a full-moon night in a Central American rainforest, and two male *Physalaemus pustulosus* frogs try to impress a demanding female. As their acoustic mating calls are not enough to impress her, the vocal sacs of one of the males begin to inflate and deflate like a pulsating balloon, creating ripples on the surface of the water [1]. He is on his way to winning the competition and mate. This contest exemplifies sexual selection in action. However, the propagating ripples unintentionally also serve as a target in the water echolocated by a *Trachops cirrhosus* bat. This circumstance is an example of natural selection in action. The impending winner of sexual selection has died as a result of natural selection, and the prospective runner-up frog is the one who survives and ends up reproducing. His success depended on luck.

In this particular instance of life, both sexual and natural selection act simultaneously. I note that the "survival of the fittest" refers solely to natural selection and makes sense only if we ignore its interaction with sexual selection. If we do not, the "survival of the luckiest" best reflects the condition of every living individual.

Charles Darwin did not develop his theory of natural selection simultaneously with sexual selection. The sight of a peacock used to make Darwin sick because his bright feathers did not appear to have any clear survival value. He could not explain it with his theory of evolution by natural selection. So, he felt compelled to further devise his theory of sexual selection to explain peacock plumage [2].

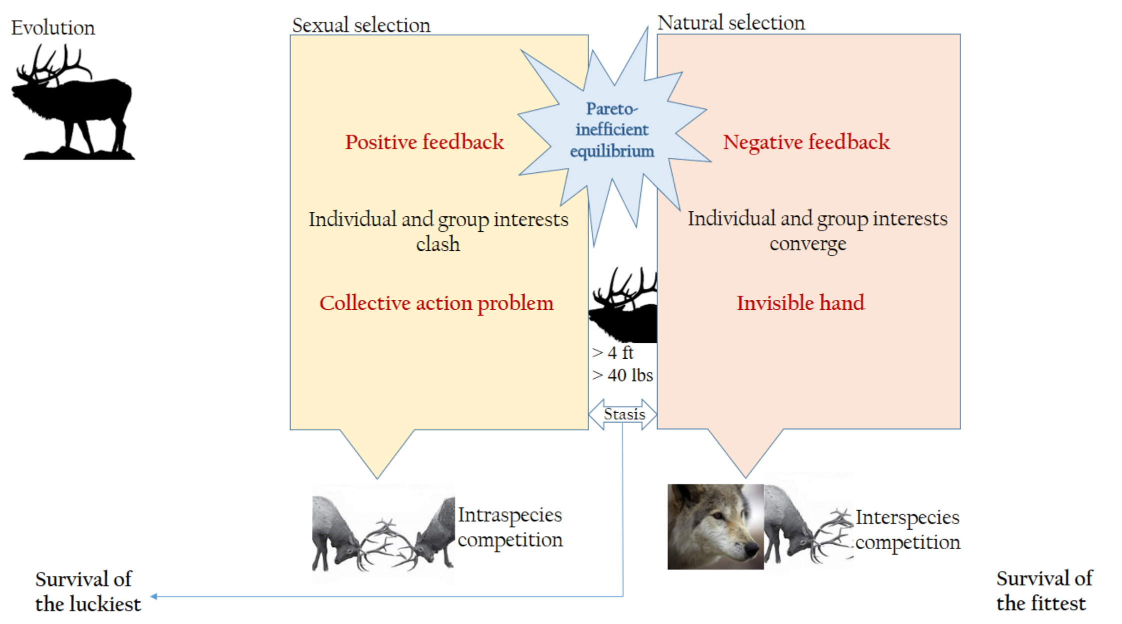
Consider another perennial drama on the theater stage of evolution. The antlers of the *Cervus canadensis* elk are used as weapons in combat between males for access to females, not against predators. The bigger the antlers, the better. This situation results in an arms race. However, large antlers render an elk more vulnerable to the *Canis lupus* wolf attacks in areas with a high density of trees. A trait that evolved to help an individual compete better in battles against conspecifics is a disadvantage to the species as a whole [3]. The species would benefit from smaller antlers on each individual. Regardless, having smaller antlers would not be in one's best interests. Individual and group interests clash. Economists refer to this as the collective action problem [4]. Therefore, we can frame sexual selection as a collective action problem.

Sexual selection exhibits a positive feedback mechanism in terms of dynamics. As in an arms race, there is an amplification of an initial disturbance in the presence of positive feedback [5]. Natural selection, on the other hand, has a negative feedback mechanism in which a system responds in the opposite direction to a disturbance. A mutation that improves one hawk's eyesight, for example, is likely to spread through natural selection, making it suitable for the group of hawks as a species. The individual's and the group's interests are aligned.

In their metaphor of the "invisible hand," economists preferentially prioritize negative feedback [5]. They exploit this property to demonstrate that the market functions well, extending to all forms of collective behavior [4]. As a result, more production adapts to change whenever demand rises or supply falls. However, while commodity and service markets often exhibit negative feedback, financial markets may show positive feedback. For example, when the price of an iPhone rises, the number of people who want one decreases. However, if the price of Apple stocks rises, the demand for them may rise as well!

I draw attention to the fact that positive feedback occurs in *intra*species competition and negative feedback occurs in *inter*species competition.

A typical *Cervus canadensis* antler is more than 4 feet in diameter and weighs slightly over 40 pounds. In the interspecies competition, one elk with antlers larger than this equilibrium value has become or will become wolf food. In the intraspecies competition, an elk with smaller antlers is less likely to mate. Biologists call this equilibrium stasis, whereas economists term it steady-state. It is Pareto-inefficient, which means that trimming every elk's antlers in the same proportion will improve the position of all elk. Therefore, surviving individuals' antler size is not optimal. (See the infographic.)



In arms races, individual incentives lead to waste. Peacocks with exaggerated tails result from competition for females with positive feedback. Peahens prefer a flamboyant tail because this signals a healthy immune system and progeny. However, peacocks with oversize tails are more visible to predators. To see that those overly large tails mean waste to the group, imagine we chop off 2 inches of the tail from all group members. Every male's relative position remains unchanged as a result of this procedure. The experiment reveals a collective action problem, in which the invisible hand fails. It also reveals that one individual's interest in the intraspecies competition clashes with the group's interest.

In human affairs, collective action problems abound. For example, a hockey player prefers to play without a helmet because she gains a competitive advantage by seeing, hearing, and speaking more clearly. However, this increases her chances of being hurt. If players are free to choose whether or not to wear helmets, each chooses to do so. If they vote, however, they choose the mandatory helmet for everyone [4]. The situation in hockey is analogous to that of job security. Workers who chose lower-paying, safer occupations are less likely to send their children to the best schools. A positional benefit is the second benefit of a higher wage in the wage-security trade-off. It would be beneficial for everyone to have more security while earning less money. Still, no one will want to stay in a more secure job if it means jeopardizing their children's future. Because the invisible hand fails in such a collective action problem, governmental regulation to impose occupational safety standards is a legitimate justification [3].

The collective action problem is ubiquitous and extends to any goal dependent on relative income. Many objectives in life are dependent on relative purchasing power. When you earn more money, you improve your ability to achieve your goals while decreasing the ability of others to achieve the same goals. As a result, activities that increase one's personal income impose what economists refer to as negative externalities on others [3]. This fact justifies market intervention because, as John Stuart Mill observed, the only legitimate reason to limit one's freedom is to prevent harm to others.

While we should encourage negative feedback competition in the economy, we should discourage positive feedback competition. We should free the invisible hand under negative feedback dynamics, limiting the market power of monopolies and oligopolies. However, there is a need for regulation in positive feedback dynamics to tame the collective action problem and protect us from the consequences of excessive competition among ourselves. After all, rewards based on relative performance create collective action problems, which leads to market failure. Because rewards are based on rankings, there is no way to assume that individual and collective interests are aligned. In an arms race, no more than half of the contestants can be in the top half [3].

The existing literature on success weights the role of talent and luck in human affairs and boils down to two formulas: 1) success = talent + luck, and 2) great success = a little bit more talent + a lot of luck [6]. However, disentangling talent from luck is a difficult task. Despite this fair reward problem [7], one point has been established: skill alone cannot explain the top rewards [3] [8].

Returning to nature, what role does the lucky one play in evolution? It has been established that the three products of evolution are: 1) adaptations, 2) by-products, and

3) randomness [2]. However, an adaptation begins as a mutation, or randomness that occurs in a single individual. It may give the individual an advantage (or disadvantage) in terms of survival and reproduction. If the mutation is beneficial, it will spread throughout the group and become a species adaptation [2]. However, one implication of what I am showing is that evolution is ultimately just randomness. Its products are 1) the adaptations that result from successful mutations (randomness), 2) its by-products (second-degree randomness), and 3) mutations (randomness) that do not translate into adaptations. The runner-up frog fits this third scenario: despite being less fit, he took the trophy by sheer luck.

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