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 frogs *Physalaemus pustulosus* 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 about to win the competition and mate. This contest shows the sexual selection in action. However, the propagating ripples unintentionally also serve as a target in the water echolocated by a bat *Trachops cirrhosus*. This circumstance is an example of natural selection at work. The impending winner in sexual selection is now dead due to natural selection, and the prospective runner-up frog is the one who survives and ends up reproducing. His success depended on luck.

In this selected incident of life, both sexual and natural selection act simultaneously. I note that the "survival of the fittest" refers exclusively to natural selection and only makes sense 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. Darwin used to feel sick at the sight of a peacock because his bright plumage did not appear to have any obvious survival value. He could not explain it using his theory of evolution by natural selection. So, he felt the urge to subsequently develop his theory of sexual selection to explain peacock plumage [2].

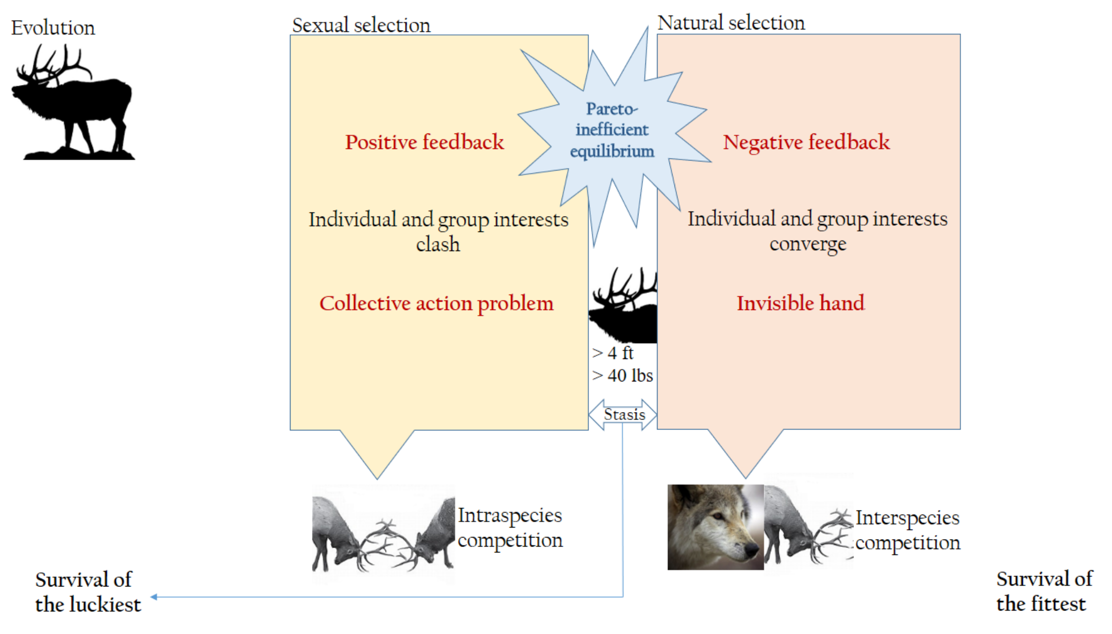
Consider another perennial drama on the theater stage of evolution. The antlers of the elk *Cervus canadensis* function as weapons not against predators but in competition between males for access to females. The bigger the antlers, the better. This circumstance leads to an arms race. However, large antlers make an elk more vulnerable to the wolf *Canis lupus* attacks in areas with a high density of trees. A trait that has evolved to help the individual better compete in battles against conspecifics is a handicap to the species as a whole [3]. The species would be better off if each individual's antlers were smaller. Despite that, it would not be in one individual's interest to have smaller antlers. Individual and group interests clash. Economists call this the collective action problem [4]. Therefore, we can frame sexual selection as a collective action problem.

From a dynamics point of view, sexual selection shows a positive feedback mechanism. In the presence of positive feedback, there is an amplification of an initial disturbance, as in an arms race [5]. By contrast, natural selection exhibits a negative feedback mechanism, where a system responds in the opposite direction to a disturbance. For example, a mutation that improves one hawk's eyesight is likely to spread by natural selection, making it suitable for the group of hawks as a species. The interests of the individual and the group coincide.

Economists preferentially consider the negative feedback in their metaphor of the "invisible hand" [5]. They use this property to show that the market works well, extending to all forms of collective behavior [4]. So, more production adapts to change whenever demand increases or supply decreases. However, while commodity and service markets generally exhibit negative feedback, financial markets may show positive feedback. For example, when the price of an iPhone goes up, the quantity demanded usually goes down. However, when the price of Apple stocks rises, the quantity demanded may increase!

I call attention to the fact that positive feedback occurs in *intra*species competition, while negative feedback takes place in the *inter*species competition.

The antlers of a typical *Cervus canadensis* measure more than 4 feet across and weigh just over 40 pounds. One elk with antlers larger than this equilibrium value has become or will become wolf food in the interspecies competition. And an elk with smaller antlers is unlikely to mate in the intraspecies competition. This equilibrium is called stasis by biologists and steady-state by economists. It is Pareto-inefficient, meaning that it would be possible to improve the situation of all elk by cutting off every elk's antlers in the same proportion. Therefore, the antler size of living individuals is not optimal. (See the infographic.)



Individual incentives lead to waste in arms races. For example, peacocks exaggerated tail in competition for females results from positive feedback. Peahens prefer an overelaborate tail because this signals a sound immune system and healthier offspring. However, peacocks with oversize tails are more visible to predators. Moreover, to see that those overly large tails mean waste to the group, suppose we cut off 1 foot of tail across all group members. This procedure leaves unchanged the relative position of every male. The experiment reveals a collective action problem, where the invisible hand fails. It also discloses that one individual's interest conflicts with the group's interest in the intraspecies competition.

In human affairs, collective action problems abound. For example, a hockey player prefers to play without a helmet because she gains a competitive advantage: seeing, hearing, and speaking better. But that increases her risk of getting hurt. Making players free to choose, each chooses to play without a helmet. However, if they vote, they choose the mandatory helmet for everyone [4]. The hockey situation is analogous to that of security in the job market. Workers who prefer safer, lower-wage jobs fail to send their children to the best schools. A second benefit to a higher wage in the wage-security trade-off is a positional benefit. It would be suitable for everyone to have more security with lower salaries. Still, individually no one will want to stay in a more secure job, jeopardizing their children's future. Because the invisible hand fails in such a collective action problem, there is genuine justification for governmental regulation to impose occupational safety standards [3].

The collective action problem is ubiquitous and extends to any goal dependent on relative income. Many objectives in life depend on relative purchasing power. When you earn additional income, this improves your ability to achieve those goals but simultaneously reduces the ability of others to achieve the same goals. Therefore, activities that increase one's pocketbook income impose what economists call negative externalities on others [3]. This fact justifies market intervention because, as John Stuart Mill observed, avoiding harm to others is the only legitimate reason to restrict one's freedom.

While we should encourage competition with negative feedback in the economy, we should curb competition with positive feedback. Under negative feedback dynamics, we should set free the invisible hand, limiting the market power of monopolies and oligopolies. Under positive feedback dynamics, there is a need for regulation to tame the collective action problem and protect us from the consequences of excessive competition among ourselves. After all, rewards that rely on relative performance create collective action problems that cause market failure. The fact that rewards depend on rankings precludes any presumption of harmony between individual and collective interests. There cannot be more than 50 percent of competitors in the top half in an arms race [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 hard work. Despite this fair reward problem [7], one issue has been settled: skill alone cannot explain the top rewards [3] [8].

Back to nature, what is the place of the lucky one 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 is initially a mutation, randomness that occurs in a single individual. It may confer an advantage (or not) on the individual in survival and reproduction. If advantageous, the mutation will spread throughout the group, becoming an adaptation of the species [2]. But one implication of what I am showing is that evolution is ultimately mere randomness. Its products are 1) the adaptations following 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 case: even being less fit took the trophy by sheer luck.

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