Evolution myths: Evolution promotes the survival of species

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In fact, evolution sometimes results in individuals or populations becoming less fit and may occasionally even lead to extinction.

The phrase "survival of fittest" is widely misunderstood (see *'Survival of the fittest' justifies everyone for themselves*). Many wrongly assume it means that evolution always increases the chances of a species surviving.

There are several ways in which evolution can reduce the overall fitness of individuals or of populations. For starters, natural selection can take place at different levels - genes, individuals, groups - and what promotes the survival of a gene does not necessarily increase the fitness of the individuals carrying it, or of groups of these individuals.

For example, parasitic DNA elements, or transposons, can spread through a population even though they make their host organisms less fit. Transposons are one cause of genetic diseases such as haemophilia.

Similarly, selfish individuals may thrive at the expense of altruistic individuals in a group - making them the "fittest" - even though they make the group as a whole less competitive. Such cheaters can have disastrous consequences.

In 1932, J. B. S. Haldane suggested this could even lead to the extinction of populations - a phenomenon called evolutionary suicide. Models and some experimental evidence suggest he was right.

For instance, when nutrients run low, individual myxobacteria (slime bacteria) may come together to form a fruiting body to produce spores. Lab studies have shown that cheating myxobacteria that only produce spores and never help form the non-spore producing parts of the fruiting body can drive populations to extinction.

Genes capable of driving populations to extinction might have a practical use, however. Biologists are exploring the possibility of releasing engineered parasitic DNA into populations of malaria-carrying mosquitoes.

There is concern that something similar could happen accidentally. Fish that have been genetically modified to produce a growth hormone grow faster and larger, mature earlier and produce more eggs. But they are less likely to survive in the wild than unmodified fish. According to the Trojan gene hypothesis, a gene variant that produces such characteristics could spread rapidly through a wild population despite reducing individual fitness, and eventually drive the population to extinction.

Another way in which evolution can reduce a species' chances of survival is through the accumulation of detrimental mutations. Mutations provide the vital raw material for natural selection, so if the mutation rate is too low a population will not be able to evolve fast enough to keep up with environmental changes.

If, on the other hand, a population's mutation rate is too high, detrimental mutations may accumulate faster than natural selection can eliminate them. Eventually, the number of mutations can exceed the "error catastrophe threshold", again leading to the extinction of a population.

In theory, any species with a very small population could accumulate deleterious mutations faster than it can eliminate them. The problem is especially severe for asexual organisms such as the Amazon molly - an effect known as Muller's ratchet.

It is far less of a problem for sexually reproducing species because the exchange of genetic material between chromosomes can separate good and bad mutations. Some unlucky offspring get saddled with lots of nasty mutations and die out, while the lucky ones get hardly any.

In theory, a mutation catastrophe can also occur as a result of linkage. This refers to gene variants that are inherited together because they sit next to each other on a chromosome. Suppose a mutation that greatly increases the mutation rate somehow ends up next to a new mutation that greatly increases fitness. The immediate fitness benefits of the beneficial mutation will initially mask the deleterious effects of the "mutator" mutation, meaning both mutations will rapidly sweep through a population, ultimately with disastrous consequences.

A few doctors hope to exploit mutation accumulation to treat diseases. Certain viruses such as HIV are already close to the error catastrophe threshold. Drugs that increase the mutation rate of the viruses still further might push them over the threshold and drive a population of viruses inside a person's body to extinction.

Finallly, it has long been recognised that the competition between members of the same species to reproduce - sexual selection - can favour traits that reduce a species' overall fitness. Male peacocks with the biggest and brightest tails might get the females' attention, but lugging around a heavy, conspicuous tail reduces their chances of survival.

Studies of threatened bird species suggest that sexual selection can indeed drive populations to extinction. Some biologists go so far as to blame sexual selection for the conspicuous consumption that threatens humanity's future.

According to the handicap principle, features such as peacocks' tails evolve precisely because they are disadvantageous. Consider an individual who is trying to signal to females how fit and strong he is. If the signal is easy to make, weaker males can easily cheat by making the same signal. But if making the signal is costly - such as growing a large, clumsy tail or giving away food - there's no way to cheat.

Proving that any of these phenomena have ever led to extinctions in the wild is far from easy, because any species to which this has happened are, of course, no longer around to study. The indirect evidence is growing ever stronger, though.

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