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Oh How Selfish

Have you ever wanted to read a book that made you question every moral inclination that you hold dear? Are you looking for a book that will cause you to have an existential crisis and rail against a universe that could be so cruel? If you are, then 'The Selfish Gene' by Richard Dawkins is definitely the book for you.

In all seriousness, I believe that it is overall an excellent book, and the theory that it is named after is a brilliant explanation of animal behavior that adds a new dimension to evolutionary biology. The book is written in language that the general public can understand, but the full meaning is much better understood by those with a background in biology. Dawkins is verbose in his explanations and spends a great deal of time defending against criticisms, which detracts from the overall narrative in my opinion.

The book centers around Richard Dawkins' selfish gene theory. The premise of the theory is to shift the focus of natural selection from the organismal level to the gene level. The fundamental idea is that genes primary goal is to replicate themselves, and that the behavior of the bodies they inhabit is geared exclusively toward that goal. The emphasis here is on behavior and the genes that cause those behaviors in animals that they are contained in. Lastly, the premise is furthered by recognizing that the genes that produce the best survival machine will replicate the most effectively, and therefore become the dominant type in a population.

Throughout the book, the language suggests that genes can do things like 'prefer,' or want something, or do other characteristically human things, but these are just a useful analogy to describe blind physical processes to make them easier to understand.

The first chapter starts out with the behavior of altruism that is displayed in mammals, and how that kind of behavior can arise from the perspective of a gene. It might seem contrary to think that a gene, which we assume is geared exclusively toward ensuring the survival of its host body, can cause selfless, and even sacrificial behavior in its host. For this example, Dawkins uses demonstrations of heroism such as parents going to great lengths and personal risk to save their children. The point is made that the relatedness of the child to the parent, or of a sibling to another sibling affects the degree to which one would risk one's life to save another. By risking your life to save the life of a highly related individual, you are in effect ensuring the survival of many copies of your own genes. Because parents and children share half of each other's genes, the likelihood of altruistic behavior would be the highest. Siblings also share approximately half of each other's genes, having inherited about 50% from the father and 50% from the mother. I find that this model of genetic relatedness determining the degree of altruistic behavior to be a little simplistic. It cannot for example, account altruistic behavior in humans where there are many examples of people risking their lives for total strangers. Perhaps we humans are a special case? If this is true however, it requires that any animal that favors relatives for altruistic acts must be able to identify them to a high degree of accuracy, otherwise the system breaks down. Another factor that Dawkins brings into play is that expectation of life would logically need to be brought into account. The point is made that an older, non-reproducing individual would be less likely to be the recipient of selfless acts than a younger individual. The implication is that altruistic acts are a behavior that organisms show toward each other only if they are able to reproduce and have a high degree of relatedness.

In chapter two, Dawkins makes the point that Darwinian evolution cannot account for the emergence of the first self-replicating organisms, but that a leap of reasoning is required to come to the conclusion that inanimate molecules somehow began to self-replicate, and after that, the best replicators became the dominant type in that population, thus kicking off the traditional concept of natural selection. Over time, these replicators designed vessels for themselves that protected them and improved their mobility. There is an important idea here. We have to think of the genes, and the body that they're contained in as separate. The body that the genes create act as a survival vessel, executing a set of programs that give the genes the best chance of successfully replicating themselves. This view among others, is possibly why I have heard Richard Dawkins's reputation described as 'infamous.' It is a little bleak to think that your body is just a machine designed by your genes for the express purpose of replicating themselves.

With all this talk of 'genes' it is important to define what exactly they are. Dawkins breaks down the idea into its simplest terms. A gene is a set of instructions that can be executed by a host body. It has a high copying fidelity and serves as the simplest unit of evolution. A gene holds a set of instructions, the host executes them, there is an environmental response, and then the genes either die out, or are replicated in a new generation.

The next set of ideas covered center on information flow within a body, namely the axons and neurons. Genes by their nature are slow to replicate, and it can take several generations before a proper set of instructions can arise to respond to a changing environment. Genes need something to enable their host body to respond quickly to a fast-changing environment. In this case, that function is performed by the nervous system. With a response time of fractions of a second, the nervous system serves as a great way for an organism to sense temperature, find food, evade predators, and do other tasks that benefit the genes survival. Dawkins even argues that human consciousness, as complex as it is, is the result of just this sort of survival-driven natural selection. The argument goes that our complex language abilities and social interactions that are driven by our consciousness convey a huge benefit to our species, and thus our gene's survival. Thus, it must be the genes themselves that have selected for these traits over many generations. Another factor that may drive the evolution of a complex consciousness is the ability to simulate future events. If an organism can predict the outcome of an action as either favorable or negative to itself, it can make the best-informed decision about its own, and its gene's survival.

Competition for resources is a major factor in the natural world. A major part of the field of ecology is based on the study of how limited resources are distributed throughout an ecosystem, but animal behavior plays an equally important part. When there are multiple species competing for the same resource, will species favor their own, or share with the other species? Intuition says that a species will favor their own and try to drive out the others if they can, but why is this? Through the lens of the genes, an organism favors its own species, because it has more genes in common with other individuals of its own species than with members of a different species. This is the sort of indirect effect that we saw earlier with sibling-sibling, and parent sibling altruism. Dawkins makes the case that even distantly related individuals may show altruism toward each other simply because they share more genes in common with them than with members of another species. If an individual can improve the survival of another individual with a significant number of copies of the same genes that itself has, then it can indirectly improve the survival of its own genes, albeit in another body.

So far, we've seen the case made that genes can execute programs in a host body, which makes is respond in a certain way, and that genes can have effects on behavior. Another point to bring up is that genes can start executing behavioral programs that form an evolutionarily stable strategy, or an ESS for short. An ESS is composed of a number of categorized behaviors, that show up in a population of a given species at a proportion that ensures the highest rate of survival of the genes that cause those behaviors. ESS's may be antagonistic or exploitive toward each other, such as in Dawkin's hypothetical case of a population of birds that show 'hawk' behavior, and 'dove' behavior. The hawks always pick a fight when competing for a resource like food, but the doves will only aggressively posture for a bit, but then give up the fight. By assigning arbitrary numbers for the cost and benefit of each strategy, a computer model can be used to determine the equilibrium number of each behavior type in our fictional bird population. If there are too many hawks, the survival of the species is diminished, and if there are too many doves, it is the same. The equilibrium that promotes the best survival in this simplistic model is a combination of the two, that is fluctuates based on the specific conditions. The model can and has been expanded to include a number of different behavior types, but this simple one gets the gist across.

Overpopulation is, (or has been) a topic of concern for some people, however, the natural world has developed some mechanisms that keep that from becoming too much of an issue. It shouldn't come as a surprise that animals regulate their birth rate. After all, the ecological consequences of overpopulating an ecosystem can be devastating for a species, so of course evolution would come up with some countermeasures. Dawkins uses as an example, female birds that show the behavior of requiring the male birds to acquire territory and to build a nest before copulating. The necessity of acquiring territory means that when resources become stretched thin, not all individuals will be able to pair up and mate. This acts as a sort of natural responsive birth-rate control. A similar line of thought involved the density of loud bird calls being used by members of a species to gauge how dense their population was and to respond accordingly. The genes are selected for these sort of mating behaviors since they prevent overpopulation in lean years and higher population in good years, giving an overall benefit to their replication. The question was asked whether birth control is altruistic or selfish. Dawkins made the case that it was indeed selfish because families that overproduced were more susceptible to starving, parents included. This means that the genes themselves have the best chance of survival if reproduction is delayed until a more opportune moment. Furthermore, if there were genes to arise in a population for producing an unusually large number of offspring, those genes would have an advantage for a short period of time, but quickly die out if resources were ever limited.

There is a stereotype that siblings will fight and compete over resources. We've all seen where two siblings fight over possession of something, and this behavior may have a genetic basis. Furthermore, children in the animal world are known to plead and beg their parents for resources to the point of annoyance and even to the detriment of siblings (human children too, in my experience). Again, this behavior, when viewed from a gene's perspective, seems to make sense. It stands to reason that an individual would be programed to do what's best for itself, after all, you are 100% related to yourself. Your sibling's genes are however, only around 50% related to yours if you share both parents. If your siblings share about 50% of your genes, your genes would have some incentive to help your sibling survive, but only if the benefit to yourself is twice as great in magnitude as the detriment to your siblings. Dawkins also argues that any genes that program for behaviors that cause resources to be diverted to that individual will quickly spread and further countermeasures may also evolve, leading to a balance that ensures most siblings will receive roughly equitable treatment. Another, more morbid case can be seen in swallows, where if one egg hatches first, the chick may push the remaining unhatched egg out of the nest. It seems that in this case, even a high degree of relatedness to its sibling isn't enough to prevent the baby swallow from killing its siblings.

The evolution of males and females in the animal world is one of the big remaining mysteries to evolution. While empirical evidence for the emergence of two sexes may never be found, the selfish gene theory provides an explanation. Suppose there are two types of gametes that must combine with each other to form a zygote. They are the same size, and indistinguishable from each other, the only rule is that two must combine. Suppose some individuals evolve genes for creating larger gametes. These larger ones would naturally be better off in creating a zygote because of their increased energy supply. Now suppose another population of this supposed organism evolves genes for decreasing in size with the benefit that it can create more of them. These also have an advantage in reproduction provided that they always combine with the larger gametes. This set of events creates a disruptive selection, which drives the size of gametes either higher, or lower, resulting in the formation of two sexes with small gametes, males, and large gametes, females. The medium sized gametes become less numerous, and then finally disappear, leading to the final stable ESS of males with sperm, and females with eggs.

We sometimes come across instances where the males of a species will acquire territory and create a harem of females. Elephant seals are one such example. What is surprising however is that elephant seals create equal numbers of males and females, even though only one male in a population is allowed to mate. Most male elephant seals simply lounge around and eat, but never mate (not a bad life except for the 'not mating' part). Why wouldn't the elephant seals eventually evolve a skewed sex ratio where more females than males are made so as to use resources more effectively? The solution as Dawkins puts it, is again to look at things from the gene's perspective. Suppose we do create a situation in where elephant seals produce this skewed sex ratio. In this world, any female elephant seals that produce males are at a special advantage reproductively. They can be assured that their genes will be spread far and wide and have numerous grandchildren. Now suppose that a small perturbation in the number of females that have a higher chance of bearing a male child happens. Suppose the chance increases, and now each of those males that are born go on to reproduce and further spread the genes for having slightly more male children. You can see that evolution would take this to its furthest extent and then finally fall back to an equilibrium number, which happens to be about 50-50 males to females. In the book, there are many other examples of this sort of dance around an equilibrium. The equilibrium ratios then constitute an ESS for the genes involved.

Dawkins has much to say about mating relationships in the animal world, and perhaps a few things about the human world as well. Again, we explore the idea of ESS's and stable ratios of behaviors, but this time dealing with behaviors shown by the males and females regarding mating. In this case, suppose there are two types of males, philanderer, and faithful, and for females, coy, and fast. Their names describe exactly their behaviors. The philanderers experience a benefit in increased number of offspring, but a penalty in that a greater number of those won't survive because of too little parental investment. The faithful males experience the benefit of higher survival rate in their offspring, but lower total number. The coy females experience a higher survival rate among their offspring due to higher parental investment but suffer because they need a prolonged courtship ritual that takes time and lowers the number of offspring. The fast females experience higher total number of offspring, but a lower survival rate. Each strategy with its ups and downs, has their own equilibrium proportions in a given population. Furthermore, the proportions can oscillate between different equilibriums, meaning that the proportions of these behavior types will always oscillate in a population. Human society says that only one of these strategies is acceptable, however does evolution say something else?

When animals live in packs, it's easy to imagine that competition for resources can be fierce. Why would animals choose to live in such proximity to each other? The answer, Dawkins proposes is that the benefit gained by the genes from this is higher than the cost. In the specific case of flocking birds, why do individuals give out alarm calls if they spot a predator? By giving out a call, they can potentially expose their location and attract the predator to themselves. One way to consider it is to look at the cost of other strategies. If the bird does nothing, the predator may attack the flock and individuals, maybe even ones that the bird is related to, will get captured. Another strategy is to simply fly away without giving a warning. This too could have a negative effect. By flying away alone, the bird makes itself a target. The best way to respond would seem to be to give an alarm call and have the whole flock fly away as a group. This makes each individual harder to target and gives all the birds in the flock the best chance to survive the encounter.

I think it is appropriate to end with the topic of memetic transmission and evolution. We all know about internet memes; those funny pictures and videos people send to each other on social media. A meme is essentially an idea or set of information that can be transmitted from individual to individual. It may be surprising to think of ideas as something that can be transmitted in a way analogous to genes, but that seems to be exactly what happens. In the case of songs for example, if you hear a song and like it, you might whistle the tune, and subsequently transmit it to someone else. Again, with songs, if you hear the lyrics to a song, but misremember a word or two, and then sing it incorrectly, people who hear you singing it that way may learn that song incorrectly. In this case, the songs are memes, and they are being transmitted to another person's brain, in a way analogous to the way genes are transmitted through generations or through viruses with mutations. Memes may also be subject to a type of natural selection, where ideas that are easy to transmit and remember get passed on more often and become more common, whereas memes that are harder to remember and transmit tend to die out. This isn't only seen in humans, but in birds, and other animals as well. If you expand from only songs, you can also think of any useful information such as how to evade a predator or how to find food in a certain place as memes. If it can be remembered and transmitted, it can be a meme.

Can books be thought of as a meme, how about this paper? The selfish gene is a set of ideas that illuminates so much of animal behavior. I believe that it will become fundamental to understanding and predicting how animal behavior is affected by evolution and the ecosystem. It may even affect the field of ecology where animal behavior has a substantial effect on the landscape. Having covered everything from the origin of life, ESS's and behaviors, to memetic evolution, I bring this to a close.

References

Dawkins, Richard. 2006. *The Selfish Gene*. Oxford: Oxford University Press.