Competition In Nature

Blithering Genius

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1 Introduction

Competition is intrinsic to life. Every type of life requires resources to survive and reproduce. Every environment has limited resources. Every type of life can reproduce to excess, and so the population of any type of life will grow until it is limited by competition for resources.

There are four types of competition in nature:

1. Competition between individuals.
2. Competition between populations.
3. Competition between genes or traits.
4. Competition between social groups.

These types of competition are all different. Many errors in biological thought are due to confusing or conflating different types of competition.

The competition for resources takes place primarily between individuals. Individuals compete with other individuals of the same or different species. For example, imagine a meadow that contains grass plants and clover plants. Each of the plants competes with adjacent plants for water and sunlight. There is competition between plants of the same species and between plants of different species.

Not all individual interactions are competitive. There can be cooperative relationships between individuals, such as the symbiosis between algae and fungus in a lichen, or when male and female

birds cooperate to build a nest and raise their young. There are also predator-prey interactions, which are neither cooperative nor competitive.

Biologists often use the metaphor of competition to describe population dynamics. A population is the set of all individuals of a certain type in a certain place, such as all the caribou on Banks Island. When we're talking about ecology, the type is usually a species, but that's not always the case. We could be comparing the populations of different subspecies, the populations of carnivores and herbivores, or the subpopulations of a species that have different traits (white moths vs. gray moths of the same species, for example). Let's assume that we're talking about species. A species has a population in an environment. That population can change over time. Populations are also distributed in space, so we can talk about the population density in one environment versus another, or in one niche versus another.

2 Competition Between Individuals

Populations "compete" by individuals being more or less adapted to the environment. Suppose that individuals of two species, A and B, compete for resources. If A is better adapted to the environment than B, the population of A will increase, and the population of B will decrease. This will continue until B is completely replaced, or until A is no longer better adapted to the environment than B.

In the clover and grass meadow, for example, there might be some areas that favor clover and other areas that favor grass, because of local soil conditions. So, in some areas clover will be more common than grass, and in other areas grass will be more common than clover. The distribution of the two species is determined by individual competition for resources. In some areas, individual clover plants out-compete individual grass plants. In other areas, individual grass plants out-compete individual clover plants. In both cases, the winning plant simply grows faster and shades out the other plant. The populations could vary over time as well as space. Suppose that clover needs more water than grass. During a dry year, the clover population will decrease and the grass population will increase. During a wet year, the opposite will occur.

We can view the changing distribution of the two species through the metaphor of "competition", but we should understand that this is a metaphor. The metaphor lumps individuals into populations, and it hides the competition between individuals of the same species. Viewing the ecosystem in this abstract way, we only see one population increasing and another decreasing. At the individual level, each plant competes with neighboring plants, regardless of their species. Clover plants compete with both clover plants and grass plants. Grass plants compete with both grass plants and clover plants. The competition to survive and reproduce is between individuals, not groups. But when we look at the populations in aggregate, the individual competition is hidden.

Suppose that grass completely replaced clover in the meadow. There would still be a harsh struggle for existence. Each grass plant would compete with its neighbors to survive and reproduce. But we would see no competition at the level of species, because there would be only one species. There would be no increase or decrease of one population relative to another, just a single, static population. However, the total amount of competition in the meadow would be the same as before.

3 Competition Between Populations

Competition between populations is just a metaphor for thinking about ecosystems. It can be convenient, but it can also be misleading. Populations don't compete with each other in the same way that individuals do. Populations aren't entities that act in the world to increase their sizes. A population is just an aggregate view that we create by classifying individuals into types. That view hides the competition between individuals of the same type, and aggregates the competition between individuals of different types.

4 Competition Between Genes Or Traits

Just as we can think about ecology as a competition between populations, we can think about evolution as a competition between genes. Populations "compete" within an ecosystem. Genes "compete" within a population or genome. The same potential for confusion exists with this metaphor.

A gene is a nucleotide sequence that is expressed in the phenotype, typically by coding for a protein. Genes are copied by reproduction, and affect the ability of organisms to reproduce. When we talk about competition between "genes", we are usually talking about competition between alleles of the same gene. This "competition" is a way of talking about selection: how alleles increase or decrease in frequency, depending on how they affect the reproduction of individuals.

For example, suppose that there are two alleles of a certain gene that affect the leaf shape of clover. One variant causes the leaves to be narrower, and the other causes the leaves to be wider. Suppose that the narrow leaves are better at competing for water (because they have less evaporation), but worse at competing for sunlight (because they have a smaller surface area). The two alleles compete simply by existing and affecting the shape of leaves. In drier times and places, the narrow leaves will become more common. In wetter times and places, the broad leaves will become more common. The two alleles compete in the sense that they are mutually exclusive (at least in the same chromosome) and so if one increases as a percentage of the population, then the other must decrease. The distribution of the two alleles is determined by individual competition in a variable environment. That's the type of competition that occurs between genes/alleles.

We could have described the competition without knowing anything about genes or alleles. We could just have talked about the two traits: narrow leaves versus broad leaves. Just as genes compete within a population, traits compete within a population.

Whether we are talking about genes or traits "competing", the competition is metaphorical. Neither genes nor traits have independent purposes. They don't compete in the same way that individuals compete to reproduce. They are differentially selected, depending on the environment. As with competition between species, competition between alleles or traits is a metaphor that we use to understand an abstract process.

Competing alleles don't cause individuals to fight each other. You contain many competing alleles, because you have two copies of most genes. You aren't being torn apart by that competition. The alleles aren't actually fighting each other. They are just being differentially selected.

Many people think of genes as little agents that control organisms. They believe that "the selfish gene" makes individuals work "for the good of the genes", and that individuals with common genes will cooperate toward their common genetic interests. This view anthropomorphizes genes, projecting agency and purpose onto them. A shared gene does not make organisms act for the good

of the gene.

See: Does Evolutionary Theory Imply Genetic Tribalism?.

Genes do not act in the world. Action consists of doing one thing versus another, such as fighting or running away. Genes have no capacity for action. A gene cannot do one thing or another. Instead of thinking of a gene as "doing" something, it is better to think of a gene (or variant of a gene) as being "expressed" in the phenotype of an organism.

The metaphor of genes as agents comes partly from anthropomorphizing them, and partly from confusing the abstract conceptual gene, which consists only of information, with the specific physical copies that exist in different organisms. (There is a type | individual distinction between the conceptual gene and its copies.)

Individual competition is the mechanism by which genetic competition is carried out, but that doesn't mean that genes are using individuals as pawns in some kind of genetic chess game. Genetic competition is a metaphor for the changing distribution of genes that is caused by individual competition.

5 Competition Between Social Groups

Competition between social groups is the last type of competition I want to consider. This is a rare type of competition in nature, but very important for human beings.

Many species have social behaviors, but very few have organized social units. A herd of bison, for example, is a social group, but herds don't compete or otherwise act as units. A herd is just a loose association of individuals. It doesn't act as a unit to solve problems.

Shared genes do not make a group of individuals into a coordinated unit. For a group to act as a unit, it must have an internal power structure that coordinates and incentivizes individuals to work together.

Only a few highly intelligent animals have evolved social organization beyond simple herding/flocking behaviors. Some examples are: dolphins, wolves, lions, elephants, chimpanzees and humans. Some birds, such as crows and ravens, might also qualify. Certain types of insects, such as ants and bees, are considered to be social by some biologists, but that is an error. (See Bees are not Social.)

Only humans create large, complex societies. We use our large brains and language to construct social power structures that coordinate the behavior of individuals. This gives human beings a much greater capacity for group action than other species. Today, we have social organization on a planetary scale, but that is a very recent development. Before 10,000 years ago, human societies rarely contained more than 100 people. However, even those relatively simple societies were capable of group competition, such as war.

Group competition occurs in a few other species, but not to the same extent that it occurs in humans. War is a very important part of human behavior. It is a human universal, and we have been doing it for a long time. Since chimpanzees engage in group conflicts that are analogous to wars, our ancestors have probably been fighting wars for millions of years, at least since our last common ancestor with chimps. As we developed larger and larger societies, war also increased in scale.

Group competition is not an expression of an underlying competition between races or genes. Group competition arises out of individual competition. Individuals compete over scarce resources, and individuals can win those competitions by cooperating with other individuals. Big gangs tend to defeat small gangs. The advantage of numbers has driven us to find ways to cooperate on larger and larger scales. We cooperate to compete.

Because group competition is so important to us, we find group competition metaphors intuitive and emotionally engaging. For that reason, we often use group competition metaphors to think about other types of competition, such as competition between genes, or competition between populations. We also find it easy to think about agents acting toward goals, and hard to think about abstract processes. So, we often use agent metaphors to think about evolution and ecology. Those metaphors can be misleading. Genes and populations do not compete in the way that individuals and societies do.

6 Conclusion

Competition metaphors can be useful for thinking about nature, but you have to be careful not to project the properties of individuals or societies onto populations, species, genes or traits. It is important to know the four types of competition in nature:

1. Competition between individuals.
2. Competition between populations.
3. Competition between genes or traits.
4. Competition between social groups.