A REVIEW OF BIOLOGICAL ORGANIZATION

Before we get into an in-depth discussion of ecology, let's take a look at the levels of biological organization.

1. Cell
2. Tissue
3. Organ
4. Organism
5. Population
6. Community
7. Ecosystem
8. Biome
9. Biosphere

We've already discussed many of these levels of biological organization (cells, tissues, organs, and organisms) in previous chapters. Let's begin with the fifth level—population.

WHAT IS A POPULATION?

We've mentioned the term population before, but we never really defined it, so let's do that now.

> A **population** is a group of individuals in a particular area that interbreed and therefore share the same gene pool.

A population is sort of a subset of a species. Think about it this way: a species is a group of organisms that is *able* to interbreed, and a population is a group of organisms that *is* interbreeding. For example, a group of mice on the West Coast of the United States may belong to the same species as a group of mice on the East Coast of the United States because if they were brought together, they could interbreed. However, because they are separated by such a great distance, they are NOT interbreeding and are NOT members of the same population.

Because a population consists of a group of organisms that are interbreeding, this is the level of organization at which evolution is seen.

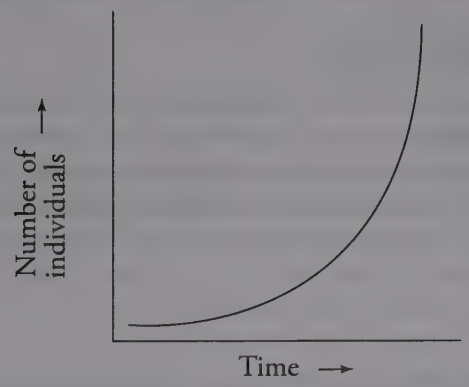
Evolution does not act on an individual; individuals cannot evolve. But populations can evolve, as their individuals (and more important, their individuals' offspring) undergo changes in phenotype and genotype.

Population Growth

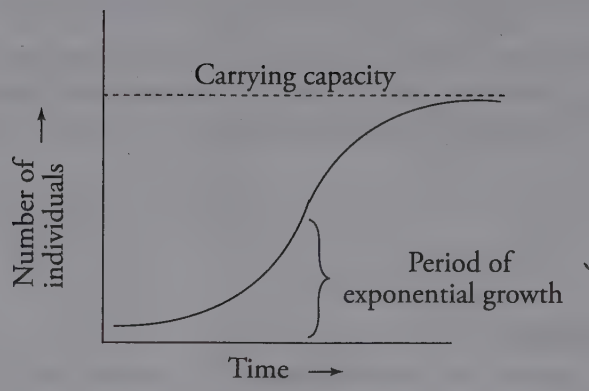
There are two types of population growth you should be familiar with for the test. The first is **exponential growth**, and the second is **limited growth**. The two types are related; a population that starts off growing exponentially will ultimately reach a level at which it is unable to sustain that rapid rate of growth, at which point growth becomes limited.

Consider a single bacterium. This bacterium can divide by binary fission to produce two bacteria. It takes the bacterium about 20 minutes to accomplish this, if all the conditions for growth are ideal. After another 20 minutes, both of the new bacteria would undergo binary fission, and we'd have four bacteria. After another 20 minutes, we'd have 8, then 16, and so on, and so on, and so on. After just one day—24 hours—we'd have more than 4×10^{21} bacteria. That's 4,000 billion billion bacteria!

In this type of growth the size of the population increases exponentially, and if we graphed it, it would look like this:



Of course, in reality this could never happen. As the bacterial population continued to grow, nutrients would get used up, space would become scarce, and waste products would accumulate. Some members of the population would die, and the growth curve would flatten out as the population stabilized.



Here, the maximum population size is limited. The maximum population size that a particular environment can sustain is referred to as the **carrying capacity**.

The carrying capacity of an environment can change if the environment changes. For example, if we provide our bacterial population with a larger container and more food, the carrying capacity would increase to reflect this.

Suppose we had a field of grasses that could support a population of 100 mice. Suppose further that a drought reduced the number of grasses that could grow. The field may no longer be able to support all 100 mice. In this case, the carrying capacity of the field would decrease.

WHAT IS A COMMUNITY?

A **community** is a group of populations that live in a particular environment. These populations can interact with one another in many different ways, including symbiotically, competitively, and predatorily, but not reproductively. We already talked about symbiosis in Chapter 15, so we won't cover that again. Instead, let's talk about competition and predation.

Battling It Out

Technically, we've also already mentioned competition, when we talked about evolution in Chapter 9. We said that organisms that were more successful competitors would be better able to survive within their environment. What do we mean when we say "competitors"?

To understand competition fully, we have to introduce a new term: the **niche**. An organism's niche is the way it lives in its environment, including its nesting behavior, what type of food it eats, and when it hunts. You can think of it like this: if an organism's environment is its address, then its niche is its job.

If two populations have similar niches (for example, if they hunt the same food at the same time), there will be a lot of competition between the two populations. The two populations become competitors against each other for the food. Usually, one population will "win out"

over the other (it will compete more effectively), and that population will grow in size (to its natural carrying capacity), while the other population will shrink. In extreme cases, the winning population will compete so effectively that it will drive the losing population out altogether. This allows the winning population to be the sole occupant of the niche.

Then What?

Well, we know from Chapter 9 that competition drives evolution. So what happens next is that the populations evolve. Generally, the winning population doesn't have to evolve too much, because the members of the population can keep on doing what they've been doing—they're now the sole owners of the niche. But the losing population has to find another way to survive. Obviously, trying to occupy the original niche was a failure. Perhaps some members of the losing population might begin hunting at a different time. This would allow them to be more successful because the winning group is temporarily out of the picture. Over time, this would produce differences in the populations' hunting times, and they would occupy different niches.

Populations and Evolution: A Quick Summary

- Populations occupy different niches within their environment.
- If two populations have similar niches, they will compete for sole "ownership" of the niche. The more similar the niches, the more intense the competition.
- The winning population retains the niche, and the losing population must evolve to survive.
- Evolution results in populations that occupy different niches, thereby reducing competition and promoting a more stable community.

Hunt or Be Hunted—Predation

When one organism eats another, we call that **predation**. The organism doing the eating is the predator, and the organism being eaten is the prey. Usually this results in the death of the prey (in the case of a hawk eating a mouse, for example), but it doesn't have to (in the case of a giraffe eating the leaves from the top of a tree—the tree itself usually does not die).

Many times predation causes the prey to evolve. The prey evolves to better escape the predator. Plants evolve to have thorns, mice evolve to have brown fur for better camouflage. In these cases, the evolution of the prey causes the predator to evolve—to better capture the prey. Herbivores evolve tougher mouth skin, hawks evolve to have better eyesight. The alternate evolution of two species based on their interactions with each other is called **coevolution**.

Predators can affect the carrying capacity of an environment. In other words, an environment without predators will have a higher carrying capacity than an environment with predators. A great example of this is the introduction of a species of perch into a lake in east Africa. The intent was to supply the locals living in that area with an additional source of income and food. At the time of introduction, the lake was filled with cichlids, a type of fish that feeds on plants, and fishing was abundant. The only problem (and it was a big one) was that the perch were natural predators of the cichlids. Because prior to this there were no predators, the cichlids had not evolved any defenses against them. The introduced perch completely destroyed the cichlid population, to the point that their own food supply was limited and their population decreased in numbers. In fact, the perch population declined so much that there were not enough perch (or cichlids, for that matter) to support the local fishing industry.