

43: Population Dynamics

We have already noticed that all organisms on Earth reproduce. If they didn't, they would become extinct in one lifetime. Some organisms reproduce quickly, while others reproduce slowly. For instance, bacteria may double in number every 15 minutes. If we started with just one bacterium, and it divided into two cells after 15 minutes, then each of those cells divided into two cells in 15 more minutes, in 30 minutes we would have four cells. But notice what happens afterwards. Within 40 hours we would have generated enough bacterial cells to fill the whole volume of the Earth!

Then why don't bacteria take over the Earth? It seems like a simple question, but the answer turns out to be fairly complex. Nature has a built-in balancing effect that keeps these kinds of hazards in check. We could talk about any organism here, but since we started with bacteria, let's keep on.

The first reason bacteria don't take over the Earth is the effect of **nutrient limitation**: there isn't enough food to go around. As bacteria grow, they remove all of the food from their immediate surroundings. Because that food comes into their surroundings at a specific rate, if the rate at which they consume it ever exceeds the rate that it comes in, the food source will become scarce, and the growth of the bacteria will not be supported. It will slow down. If you noticed, we were talking about nutrients coming in from other places. This represents the second reason bacteria don't take over: even if the food supply were unlimited, the food isn't right where it needs to be when it is required. This is the problem of **nutrient distribution**.

The third reason bacteria don't take over the Earth is because when there are limited nutrients and the number of organisms exceeds the availability of nutrients, bacteria have to compete with each other for nutrients. Some bacteria are good competitors, and others are poor. Only the good competitors will reproduce quickly, and the poor competitors will reproduce slowly, if at all. So **competition** for a nutrient source is an important factor in limiting the growth of an organism.

Another important reason that bacteria don't take over the Earth is their limited length of life. One factor that we must consider when we think about taking over is that we all die at some time. Sometimes organisms die at a rate higher than the rate at which new life is generated. In these cases the total number of organisms living at a given time actually decreases. We have to compare the **growth rate** with the **death rate** to see if the population is growing, shrinking or staying about the same.

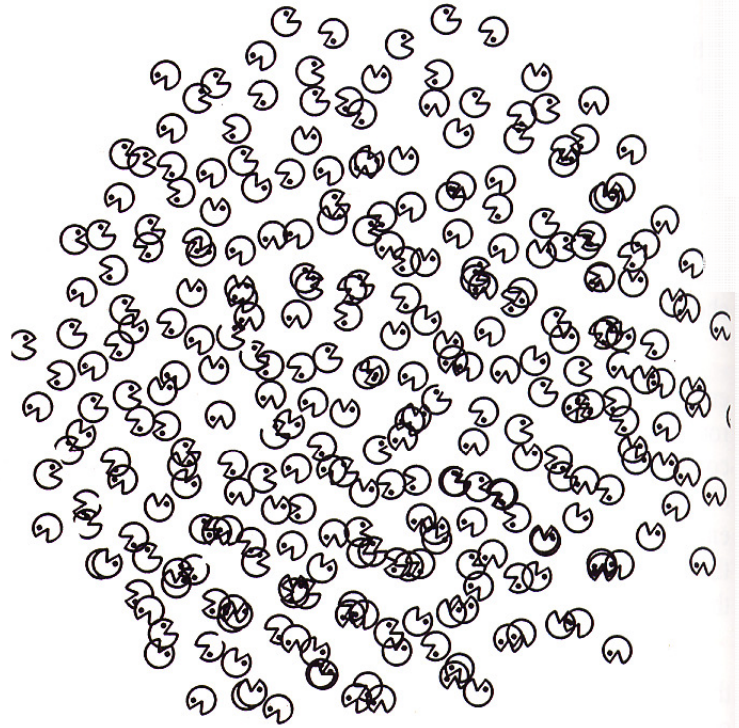
There are many reasons why organisms die. One reason is **senescence**, that is, old age. Many cells reach a certain age and simply stop maintaining themselves. They get old, and they die from poor upkeep. Another reason for death is **starvation**. Many cells simply can't get the nutrition they need, so they can't maintain themselves properly. As we know, life exists at a high potential energy; keeping us up there costs a lot of energy. If we can't obtain enough fuel molecules to supply that energy, then we will return to our ground state—our molecules will become disorganized or “degrade.”

Another reason organisms die is from **predation**. That is, they are eaten by other organisms. This happens a lot with bacteria. If a bunch of them grow close together, ciliate organisms (microzoa that love to eat bacteria) notice, and *whammy*—they start a feast. Before you know it you have a lot of fat, silly ciliates and we're back to just a few bacteria. The ciliates will graze on bacteria until the bacterial numbers are too low for the ciliates to be interested in hanging around; then the ciliates will go away until the numbers come back up.

BIOLOGY

Other organisms die from **disease** or damage caused by outside influences (like chemical toxicity), harsh environments or parasites (even bacteria can have them). These influences can wipe out an entire population living in a certain area. They are especially problematic in areas already stressed from starvation or senescence.

Back in the 1970's there was a scare generated by the scientific community and the media because the world's population was increasing so rapidly. The fear was that we would soon become so numerous that we would overpopulate the Earth. Some people predicted that tragedy would strike as early as the 1980's. The year 2,000 is now upon us and our numbers are still growing, but there is no immediate fear in North America of tragic overgrowth. The reason the so-called "**population explosion**" didn't happen is because of the food distribution problem. Those areas of highest population growth began to suffer from malnutrition causing the **birth rate** to slow down and the death rate to increase from starvation and disease. The length of life decreased in those places, too. As long as these forces continue to act, malnutrition will continue to be a problem, and so will disease and low birth rate, but overpopulation is less threatening.



Were it not for limitations present in the environment and for competition for these limited resources, a single bacterium could divide to fill the volume of the earth in less than two days.