Basic Principles of Ecology

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Ecology is a discipline within biology. Biology means the study of life, so the study of anything about living things is considered biology. Ecology is the study of how organisms interact with each other and with their environment. Therefore, ecology includes living things, but also looks at how non-living things affect living things. For example, an ecologist might study how populations of deer and squirrels compete with each other for acorns, in which case everything being studied is living. Or, they might study how temperatures affect the range of where are armadillos can live, in which case they're studying how the nonliving environment is affecting a living thing. Ecology is a relatively new discipline, only having been studied formally since the early 1900s. The word ecology is interesting. "Ology" of course means "study of." Eco is the Greek root for "house." So the word ecology literally means "study of the house." Early ecologists recognized that studying how organisms interact with each other and the environment was actually just us studying our own house, because we live in and are a part of the environment too. Ecology is a little different than most of the other biological sciences in that the experiments are often done out in nature instead of in a lab. Ecology itself is a huge discipline, but I want to take the time to explain a few of the basic principles in ecology.

One of the very important factors looked at in ecology is energy flow through a system. From physics we know that energy cannot be created nor destroyed, but it can be changed from one form to another – with only one minor known exception; all ecosystems get their energy from the Sun. Sunlight shines on the earth and is absorbed by plants and algae. Through the process of photosynthesis, the energy of the sunlight is captured in sugar molecules. The plants and algae then use the sugar molecules to build their bodies, grow, reproduce, and do all the other things that require energy of the plant. Because plants and algae can do this they are called autotrophs, which means self-nourishing. It's important to remember that they do not actually create their own energy but are taking in sunlight and converting that energy to a form they can use. Organisms other than plants and algae are not able to do this, and so in order to get energy, they have to eat the plants and take the energy from them. They are called heterotrophs, with means other-nourishing (in other words they have to get their nourishment from another). They then use this energy to build their own bodies grow, reproduce, and do the other functions of life. Of course, some organisms will eat organisms that have eaten plants instead of eating the plant themselves (like you when you eat a steak), but the energy used by all living things can ultimately be traced back to the sunlight.

A way of studying energy flow through an ecosystem is by looking at trophic levels. Photosynthesizers that are able to convert sunlight into sugars are called primary producers and are on the first trophic level. So, plants and algae are primary producers. Organisms that eat primary producers are called primary consumers. So, herbivores like grasshoppers, deer, and rabbits are primary consumers. Organisms that eat primary consumers are called secondary consumers. This would include carnivores like praying mantises and weasels. Large organisms that may eat a variety of other consumers, both primary and secondary, are called tertiary consumers. This is usually the level given to top predators.

When we look at the organisms in different trophic levels of an ecosystem an interesting pattern can be observed. Each trophic level is getting its energy from the trophic level below it, and so there have to be fewer members of each trophic level as you go up. If you plot the total biomass (the total weight of all the organisms at a particular trophic level) one on top of the other you end up with a pyramid, aptly called the trophic pyramid. It turns out that the trophic pyramid follows what is often referred to as “the rule of tens.” What the rule of tens says is that only 10% of the energy from a trophic level is available to move up to the next trophic level. In other words, if you have an ecosystem with 1 million pounds of plants or primary producers, then only 100,000 pounds (10% of 1 million) of primary consumers could be supported by that. Furthermore, only 10,000 pounds (10% of 100,000) of secondary consumers could be supported, and only 1,000 pounds (10% of 10,000) of tertiary consumers or top predators could be supported in this ecosystem. The rule of tens has been looked at in ecosystems all around the world, terrestrial, aquatic, and marine, and seems to hold true in all situations.

Another way of looking at energy flow through an ecosystem is by building food chains and food webs. A food chain simply starts with the primary producer and then an arrow is drawn to the organism that eats the plant. Likewise, an arrow is then drawn to the organism that eats the primary consumer and so on. A food web is simply multiple interacting chains put together for a particular ecosystem. Food webs seem very simple, but any ecologist will tell you that one of the dangers in trying to understand nature is that all of the interactions among organisms are hard, if not impossible, to detect, and that most systems are much more complex then we can figure out, including many food webs.

Another important ecological concept is “range of tolerance.” Individuals of a certain species are adapted to certain conditions and the temperature, moisture, kind of terrain, and several other factors affect whether they can live in an area or not. I recently visited the Rocky Mountains for the first time and even though I had seen it on TV many times, one of the things that was the most amazing to me was the tree line. As you go up a tall mountain, the species of trees change. In the lower elevations where I was in the Rockies, there were lots of broadleaf deciduous trees like aspens. As we moved up to higher elevations, the trees changed over to entirely pine trees. The reason the species of tree changed is because of their differences in their range of tolerance to temperature. Pine trees can withstand an average lower temperature than aspens can, and this has affected where they are able to grow on the mountain. The tree line is a point on tall mountains where no trees can grow above. This is because at that point the average temperature has gotten too cold for any species of tree to grow. It amazed me how that point actually makes a line across the mountain where you go from Pine Forest to Alpine Tundra which has short plants and shrubs, but no trees. This also affected the animal species we saw. Mountain goats, picas, and American pipits were found in Alpine Tundra areas on the top of the mountains, while mule deer, moose, and golden mantled ground squirrels were found at lower elevations in the trees.

The niche an organism occupies is actually a fairly complicated idea but it is often simplified to saying the job or role the organism plays in the environment. It is really more complex than this and has to do with all of the activities of the organism from feeding to habitat requirements to movements and a myriad of other things. Many species have what are called overlapping niches with other species. That is, two different species will have some of the same habitat requirements. This may be the amount of sunlight needed, a particular food or several foods that they eat, or the need for a particular kind of habitat, just to name a few. The interesting thing is that two species cannot live in the same area if they have the exact same niche. This is known as "the competitive exclusion principle." Now, two species can live in the same area if their niches overlap. What will happen is one species will out-compete the other. That species will continue to use whatever the overlap is. The other species in the area where the two occur together will shift and start using a different resource instead. But, if there is a complete overlap in niches so that neither species is able to shift and use something else, then one of the two species will go locally extinct leaving only the other species in that area.

This only scratches the surface of ecology, which is a wide and varied discipline. Several more interesting concepts are covered in your book. I hope you enjoy them.
