Community Structure – Part 1: Species Interactions

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*Number in outline corresponds to slide number the PowerPoint presentation.

1. Community Interactions
- **a.** Now that we have explored population ecology, let's move up the chain of organization and start talking about how different populations interaction with each other.

2. An Ecological Community
- **a.** Recall that in our last lecture series, we defined and community as a group of populations that share a habitat, but we are still only taking into account biotic factors in the habitat. One of the most important aspects of community structure is the concept of coevolution.
- **b.** When populations interact with each other, they influence how successfully the other obtains resources, whether they achieve reproductive success, and how well they are able to adapt to changes in the environment. All of these factors play a role in natural selection, i.e. the individuals who are better at all of these things are the ones that will have the larger impact on the traits of the next generation.

3. Species Interactions
- **a.** Coevolution is powered by 4 different types of interactions and, although there are subcategories of each of these, they can be classified by whether the participants are helped or harmed by that interaction.
- **b.** The 4 basic types of interactions are these: Competition, Predation, Parasitism, and mutualism. And as you can see, each of these has a differing effect on the players involved.

4. Niche
- **a.** Every species has its own unique place in an environment. It has specific set of needs that it fulfills by exploiting aspects of the environment it lives in. This is known as an ecological niche, all of the things in an environment a species needs to be successful. There are two types of niches: fundamental, and realized.
- **b.** The fundamental niche is the niche a species would fill under ideal circumstances, where the species obtained everything they needed without competition or limitations. Just as the concept of biotic potential, their fundamental niche is rarely achieved in nature because it is rare that a species doesn't have limitations put on them in the habitat they live in.

5. Competition
- **a.** Competition arises when you have two individuals whose niches overlap, meaning they utilize the same resources in the same habitat. There are two types of competition that can be found in nature: Interspecific and intraspecific.
- **b.** Intraspecific competition is when two individuals of the same species compete for resources, whereas interspecific is when two individuals of different species compete. Intraspecific is much more intense than its counterpart because the two individuals that are competing occupy the exact same niche, need the exact same resources to survive. Interspecific, while still an important aspect of a community, isn't quite as intense, because two different species are going to have differences in their needs based on the biology, lifestyles, and may only have one or two aspects of their needs overlap.

6. Competitive Exclusion
- **a.** Competitive exclusion is demonstrated using a classic example involving 2 species of paramecium. When grown in separate habitats, petri dishes in the case, both species exhibit classic logistical growth. But when grown together, both species are negatively impacted, but one much more so than the other. In fact, one is squeezed out altogether. The superior competitor, in this case P. Aurelia, wins the race so to speak, in that it survives , but it's population size is dramatically reduced compared to when P. caudatum is present.

7. Resource Partitioning
   a. Competitive exclusion doesn't always occur, and in fact some species have adapted through time, or coevolved, to reduce the amount of competition that occurs between the two species. This is known as resource partitioning.
   b. RP essentially results when two or more species with similar needs seek those needs in slightly different parts of the habitat they share. In the example here, three species of plant that share a meadow habitat, have differing root lengths and obtain the nutrients they need at different levels in the soil.

8. Co-evolution of Predators and Prey
   a. Predator-prey relationships are a strong driving factor in the evolution of each other. In the never ending race to get, or get away, predators drive the types of adaptations that can be found in their prey just as prey can influence the predators traits that lend to their success. As predators pick off the weakest prey, the easiest to capture, that helps perpetuate genes in the prey population that help protect them from predation.
   b. But in response, predators who are better at being predators, who have the skills, traits to be more successful than its counterparts are the ones that will have a stronger influence on the next generation of genes passed along. There are all kinds of prey defenses: camouflage, warning coloration, chemical warfare, mimicry, to name a few. We won't cover them in much detail here, I will leave it to you to read about the specifics in your assigned reading.

9. Parasitism
   a. Parasites are a type of organism that lives in or on other species and essentially steals the resources that that host obtains for itself. Parasites rarely go so far as to kill their host, because they would be destroying their own meal ticket, so to speak.
   b. The agricultural industry can be dramatically impacted by, and spend a lot of time energy and money on preventing parasites in the animals they grow. When a beef steer, for example, that is being raised for slaughter and consumption, that animal is valued based on how much it grows in the first 9-12 months of its life. If that animal is infected with parasites such as tapeworms, the steer is not capable of reaching its maximum weight potential. Since ranchers are paid based upon how much their product weighs at the time of slaughter, a lot of income can be lost if their livestock is 20-30 pound underweight due to not growing as fast as it could.

10. Specialized Parasites. There are two types of specialized parasites that are worth mentioning
   a. Social parasites (AKA brood parasites) are those such as the cuckoo. The cuckoo will lay its eggs in the nests of other bird species, thereby tricking the unsuspecting parent to rear their young. Often times the young of the victim are squeezed out by the young cuckoos, thereby hurting the host family's reproductive success. Cuckoos are a significant threat to some threatened song bird species So these social parasites take advantage of the social behaviors of other species to successfully reproduce.
   b. The other type is specialized parasite is known and a parasitoid. Parasitoids are different from other types of parasites in that they often result in the death of the host individual. An example of a parasitoid would be an insect that lays its eggs inside the body of its victim. As the eggs hatch, they will literally eat their way out of the host's body as it gains enough strength and energy to break out and fulfill its own reproductive lifecycle. The zombie cockroach is a particularly horrifying example of this type of parasite.

11. Mutualisms
   a. The last type of interaction to talk about is mutualism. And as with our other interactions, there are different types of mutualisms. At the beginning of the lecture we said that mutualism is a type of interaction where both species benefit from the interaction, but that isn't quite accurate when you start looking at the three types of mutualism.

b. First let's compare facultative and obligatory mutualism. Facultative mutualism is a relationship where when these species do interact with each other, both are benefited, but that relationship is not required for one or the other to survive. The sea anemone and the clown fish are a good example here. Clown fish often live in close association with sea anemones. Remember Finding Nemo? Although Disney was way off the mark on several aspects of clown fish biology, they did get that aspect correct. Clown fish will live in and around the sea anemone, both for protection from predators, but also for a food source. Clown fish will keep the anemone free from harmful bacteria that can grow on the anemone. So both species are benefited here, the fish gets food and shelter, and the anemone stays clean and parasite free. But, they don't need each other to survive. Both can still go along their merry way, and be reproductively successful, but it is just easier on both of them when they do associate together.

c. This is in contrast to organisms that NEED to associate in order to survive, or obligatory mutualism. This type of relationship is demonstrated by the yucca moth and yucca plant. These species, found in desert regions of N. Amer. Rely solely on each other for food and reproductive success. The moth's only source of food is the pollen produced by yucca flowers. The plant in return gets the reward of getting pollinated when the moth moves from plant to plant collecting pollen, as well as spreading its own pollen in the process. But the moth only feeds on yucca pollen, and no other species of insect eat that particular brand of pollen. So without each other, moths have no food source and the yucca has no way of spreading their pollen. One cannot live without the other, therefore making it an obligatory relationship.

d. The third type of mutualistic relationship is a bit different from facultative or obligatory relationships. In the previous relationships, both species involved were benefited in some way. But in commensalism, one species is benefited, and the other is neither harmed nor helped by the association. Barnacles are a good example here. Barnacles are sedentary animals, meaning they find a spot early in life, attach themselves and that is where they live out the rest of their life. It is in the best interest of that barnacle then, to attach themselves to a surface that gives them the most of the environment they live in so will often see them living on whales. By doing so, they have just turned their sedentary lifestyle into that of a world traveler, being able to expand their feeding grounds to where ever the whale takes them. But the whale is completely unaffected by the presence of the barnacles that live on them. They are still able to get food resources and reproduce just as well as without the barnacle attached to them. So they are completely unaffected by this association.

12. Keystone Species

a. The last aspect of community structure we will consider in this lecture is that of keystone species. We got a taste of how species interactions can influence an environment in our biodiversity lab, when you learned about keystone and invasive species. The presence or absence of a single organism can have a dramatic effect on the community!

b. The example we have discussed previously is that of the sea otter. In this graphic, we are looking at the influence that a species can have in an environment relative to the amount of space (or biomass) that it takes up in its environment. Biomass can be measured either by the population size, or by the size of the individual, but ultimately, they equate to the same thing. In the sea otter example, based on this graphic we can see that as a population, they take up a relatively small amount of space, but have a large impact on the habitat it lives in.

c. A common question when learning about keystone species is why don't things like trees or grass count as a keystone species? A habitat can't survive without the plants that bring nutrients into the food chain, and create oxygen that all animals need to survive, right? It all goes back to the amount of space. Yes, plant species are integral to the health of a community, but they take up a lot of space in that community as well, therefore don't fit the definition of keystone.