



## Community Ecology: Feel the Love - Crash Course Ecology #4

Crash Course: Ecology

<https://youtube.com/watch?v=GxE1SSqbSn4>

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### ===== Introduction (0:00) =====

I wouldn't be much of a teacher if I didn't tell you that life is tough and that everyone's looking out for themselves in this world. That's just the way it is, people. You know how I always say that biology is ultimately about sex and not dying? Well both of those things are more difficult than we'd like them to be, because of competition.

There's a finite amount of resources on this planet, so evolution drives us to compete for them so that we can survive long enough to spread our genes all over the place. And naturally, competition is a really important part of how different species interact when their habitats overlap. These interactions between species are what define ecological communities. So it makes sense that community ecology studies these interactions anywhere they take place, from a tide pool to the whole ocean, from a rotting log to an entire forest.

But just because inter-species interaction is mostly competitive doesn't necessarily mean that community ecology is all about big, bloody, tooth-and-claw scenes like from cable-TV nature shows. Actually, a lot of it is, but we're not going to get there until next week.

For now, let's just note that competition, while prevalent and important, is also pretty dangerous, kind of a hassle, and can, like, really hurt. So a lot of inter-species interaction is actually about sidestepping direct competition and instead finding ways to divvy up resources, or otherwise let species just get along. Can you feel the love?

[Title Sequence]

### ===== Resources and Competition (1:26) =====

[In a garden] Careful guys! Because right now we're surrounded potentially lethal interspecific competition going on all over the place. Since we're animals, we usually think of competition as going on between animals, but really it happens between almost all members of the four kingdoms of life. Whenever species compete, they're going after the same resources that they need for their survival and continued population growth.

In this garden, the weeds are competing with the sunflower, the corn and the dill for nutrients and water in the soil. So these resources, because they're finite in this area, are the limiting factors that we've talked about. The population can only get as big as these factors will allow.

### ===== Competitive Exclusion Principle (1:58) =====

Now, a particularly nasty weed could, over time, eliminate the veggies entirely. Such elimination is known as competitive exclusion, and it's one of the most fundamental properties in community ecology, and also, like, life. Because the fact is, when two species are competing for the same resources, one of them is eventually going to be more successful and eliminate the other.

This bitter truth is known as the Competitive Exclusion Principle, and it was first identified in 1934 by Russian ecologist G. F. Gause in a study of two closely-related species of microscopic protists. When he was only 22 years old, Gause made a name for himself by conducting experiments that pitted one species of protist, *Paramecium aurelia*, against another, *Paramecium caudatum*.

First, Gause grew each species separately with the exact same resources, and found that each developed rapidly and established stable populations. But, when he grew them in the same container, *P. caudatum* was soon driven to extinction by *P. aurelia*.

*Paramecium aurelia* gained a competitive advantage because its population grew slightly faster than *P. caudatum*'s. So Gause's experiment showed that, in the absence of another disturbance, two species that require the same resources cannot live indefinitely in the same habitat. The inferior competitor will be eliminated.

### ===== Limits to Competitive Exclusion (3:08) =====

Makes sense, but if competitive exclusion is the natural law of the land, then why isn't all of earth just a crazy crap-circus of constant competition, predation, and ultimately, extinction of all those losers? Well, for a couple of reasons: first, not all resources are limiting. Two species of sharks may compete for water in the ocean, but the ocean is, you know, gigantic. So that's not what limits their population growth. Rather, the amount of food, like a specific fish that they both eat, could be limiting, while other resources are plentiful.

Second, as the overwhelming diversity of life in almost any community shows us, most species--even ones that are almost identical to each other--are adaptable enough to find a way to survive in the face of competition.

### ===== Fundamental & Realized Niches (3:47) =====

They do this by finding an ecological niche, the sum of all resources, both biotic and abiotic, that a species uses in its environment. You can think of an organism's niche as its job in the community that provides it with a certain lifestyle. We tend to keep jobs that we can do better than anyone else in our community, and if we're desperate, we do a job that nobody else wants to do.

But no matter what job we have, what it pays in terms of resources dictates our lifestyle. So finding a nice, comfy niche that you have pretty much to yourself not only provides a steady income of food and other stuff, it also allows a species to avoid competitive exclusion, and this, in turn, helps create a more stable ecological community. It's an elegant and peaceful solution, I wish that we humans could figure out something as good, but as with anything in life, this relative security and stability comes at a price.

The bummer is that it prevents some species from living the lifestyle that they could have if nobody else competed with them at all. This ideal situation is called a fundamental niche, and it's just that, an ideal. Few, if any species ever get to live that way.

Instead, because of the need to avoid competitive exclusion in order to survive, many species end up with a different job, and hence lifestyle. It's not necessarily the job that they studied for in college, but it makes a decent living, and that's called a realized niche. This, my friends, is how nature does conflict management. But it sounds kind of unnatural, doesn't it? I mean, Gause taught us that competition, and winning the competition, was the natural order of things.

So how could it be that part of the natural order actually involves letting everyone compete and win just a little bit? And how did we ever come to discover that things actually worked this way? Well, it took a special kind of person, and to tell you about him, I'm going to need a special kind of chair.

===== Eco-graphy: Robert MacArthur (5:25) =====  
[Eco-graphy Intro]



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Canadian born ecologist Robert MacArthur was in his late 20s when he made a discovery that made him one of the most influential ecologists of the 20th century. While researching his doctoral thesis at Yale University in 1958, he was studying five species of warblers that live in coniferous forests in the northeastern United States. At the time, because there were so many different species of warblers that lived, fed, and mated in such close quarters, many ornithologists thought that the birds occupied the exact same niche and thus, were an exception to Gause's competitive exclusion principle.

But MacArthur was not convinced. A mathematician by training, he set out to measure exactly how and where each kind of warbler did its foraging, nesting, and mating. In order to do this, he studied each tree the birds lived in, dividing them into zones, 16 zones to be exact, from bare lichen at the base of the trunk, to new needles and buds at the tips of the branches. After many seasons of observing many birds in many trees, he found that each species of warbler divided its time differently among the various parts of the tree.

One warbler, called the Cape May, for example, spent most of its time toward the outside of the tree at the top. Meanwhile, the Bay Breasted fed mostly around the middle interior. MacArthur also found that each of the warblers had different hunting and foraging habits and even bred at slightly different times of the year, so that their highest food requirements didn't overlap. These differences illustrated how the warblers partitioned their limiting resources, each finding its realized niche that allowed it to escape the fate of competitive exclusion. The phenomenon he observed is now known as resource partitioning, when similar species settle into separate niches that let them coexist.

Thanks in part to this discovery, MacArthur became known as a pioneer of modern ecology, encouraging curiosity and hypothesis driven research, championing the use of genetics in ecological study, and collaborating with biologists like E. O. Wilson and Jared Diamond. Sadly, he died of renal cancer at the age of 42, but his study of northern warblers remains a classic example of community ecology that is still taught today.

### ===== Character Displacement (7:29) =====

So, if organisms can do this, if they can behave in ways that help minimize competition while increasing their odds for survival, it follows that traits associated with this behavior would start being selected favorably. After all, that's what natural selection is for. When this happens, it's known as character displacement.

To demonstrate, let's go back to some other famous ecologists, our favorite couple of evolutionary biologists and love birds, Peter and Rosemary Grant. I told you before about how they observed the process of speciation among Darwin's famous Galapagos finches. Well on the same island, Daphne Major, in 2006, they witnessed character displacement in action. For a long time, a small population of finches had the island to themselves, where they ate a variety of seeds, including seeds of the feverplant, which were bigger and more nutritious than the smaller seeds that were available but were harder for the little finches to open.

Then in 1982, a group of much bigger finches showed up on the island, and they began to commandeer the island's abundant supply of feverplant seeds. Within just 20 years, the Grants found that the small finches' beaks shrunk to allow them to specialize in eating only the smaller, less nutritious seeds. But now the little finches had those seeds all to themselves. The traits of the two populations had actually diverged to help facilitate the partitioning of resources.

### ===== Interspecies Cooperation (8:43) =====

See? Competition can be hard on us, but it also can make us better people, or you know, finches or warblers or kangaroo mice. But there are also kinds of interspecies interaction in which species actually join forces in the fights for survival. This is the ultimate in conflict-avoidance. In these cases species in a community actually manage to avoid competition altogether by forming downright tight relationships that benefit one, if not both, of the parties involved.

You may have heard of both of these cases: First, mutualism, where both species benefit, and commensalism, where one species benefits and the other is kind of like, "Whatever." Mutualism abounds in nature, and for those who've been paying attention to *Crash Course*, you've heard me talk about it many, many times before.

### ===== Mutualism (9:21) =====

A prime example [of mutualism] are mycorrhizae, the fungal root that we talked about a few weeks ago, where fungi and plant roots get tangled and essentially rub each other's backs for nutritious favors. Others you may have heard about include flowering plants that produce nectars to attract pollinators, and that bear fruit to attract animals to help spread the seeds inside.

Oftentimes these relationships become rather needy, like in the case of termites--they can't break down the cellulose in the wood they eat without the enzymes produced by the microorganisms that live inside their digestive systems. Without the little critters, the bigger critters would die. Such a needy relationship is called obligate mutualism.

### ===== Commensalism (9:56) =====

By contrast, commensalism is where one species definitely benefits and the other isn't really hurt or helped. Such neutrality, of course, is difficult to prove because even a seemingly benign interaction probably has some effect. Barnacles, for example, hitchhike on gray whales, getting a free ride through swaths of plankton-rich water for feeding. While clearly a benefit to the barnacles, the relationship is often considered commensal because the whales probably don't really care whether the barnacles are there or not.

Or do they? The barnacles might slow down the whale as it swims through the water, but on the other hand, they might also serve as a type of camouflage from predators like orcas, in which case they confer an advantage. So it probably comes down to "meh" for the whale, and when you consider all the other possibilities out there when species interact, "meh" isn't such a bad option.

Especially considering that next week, we're going for the throat, by which I mean we'll be investigating the kill-or-be-killed world of animal predation and all of the fantastic evolutionary changes it can trigger that lead to even greater diversity in ecological communities. There probably is going to be a lot of blood though, so you might want to bring your poncho.

### ===== Credits (10:57) =====

Thank you for watching this episode of *Crash Course: Ecology*. If you want to review anything, there's a table of contents over here for you to click on any of the parts that you may want to review.



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Much love and appreciation to all the people who helped us put this episode together, and if you have any questions or comments or ideas, you can leave them for us on Facebook or on Twitter, or of course, down in the comments below.