Course Name: I Think Biology

Professor Name: Dr.Jayanti Ray Mukherjee

Department Name: Biology

Institute Name: Azim Premji University

Week:9

Lecture:44

W9L44_Introduction to Ecological Interactions - Part 1

Hi, my name is Jayanti Mukherjee. As a part of this I think biology NPTEL course, today this week we will talk about ecological interactions. So let's get started. In this week's, lecture which is an introduction to ecological interactions, we will look at ecological integrity. So how life is integrated and the environment? And we will look at ecological pyramids, food chains, and food webs.

We are not going to talk too much about food chains and food webs as you already know you have an idea about that and more about ecological pyramids. Then we will go into more specific interactions, how different species interact in nature by benefiting or harming each other. So we are aware that there are some negative interactions, and there are some positive interactions. So how do these things work in nature?

And then to understand how these interactions have helped species to diversify that is most important thing or the take home from this lecture is that not only these interactions are happening these interactions have significantly determined how evolutionary pathways take, proceed and how speciation occurs in nature and develop unique features and strategies in species that we see today. So let's get started.

Let's start with this figure. How are species organized? So at the very base or the inner circle, you can see individuals. Individuals are the basic unit of life. I won't say it's a basic unit of life. Of course cell is the basic unit of life and some organelles can also be freely living. However, individuals are the ones that are basic units of form and function and in a very integrated form. So they, individuals themselves have a very integrated form and function. So at the base, they are individuals. And now if I tell you to guess what would be the interactions within individuals? How do they interact? Just think while we are progressing into the lecture.

The next form is populations. Populations are so few individuals say a hundred individuals together within an area interacting with them as well as reproducing, producing offspring, and that area, the bi, the atmosphere or the climate weather in that area is influencing their adaptation in that area. So individuals in that population in Area 1 are different or have more

different kinds of variation than individuals within a population 2 in Area 2.

So that is the integration, the next level is the integration of the population. Above that are species. Of course, many, many individual populations will consist of a species. A very good example is the humans. We have occupied the whole globe and we are still considered as a single species.

But we have several, several different populations, and look at how many variations we have, right? In Africa people look completely different compared to Asia, compared to North America and European countries, right? So populations in different areas have shaped that population very differently than others. Then the next level is communities. What are communities? So in a very human term, we often understand say I live in Bangalore. I can always say the community of Bangalore. But more or less what people will understand is that we are talking about the human community.

It's a gated community or it's a very local community. But in ecological terms, it is the same but slightly different. In ecological community now we are talking about interaction or biotic interactions that are coming together. So many different species coming together. When we talk about the interaction or when we talk about a Bangalore ecological community then we are talking about the humans there, we are talking about the birds there, we are talking about the plants there, the dogs, the cats, and everything, the bats, the insects, everything that exists in that community.
So those are the biotic interactions.

Now take another level up which is ecosystems. Ecosystems have one thing extra. I am sure you all have learned about this and that is the abiotic component. So when communities interact with their abiotic environment that forms the ecosystem. So you are not going to only talk about the ecosystem. Whatever ecosystem we talk about it has a shape and a form and ecosystems differ in how they look and that is because of their abiotic factors, the influence of the abiotic factors. The next stage would be the biomes. So I am sure you already know the definition of biomes. All the ecosystems over the globe, all the similar kind of ecosystems over the globe forms the biomes.

So for example, I can say forest biome and that would mean a particular definition of forest, and wherever they are present around the globe all those areas comprise the forest biome. Similarly, the desert biome, the pond biome, or river biome anything of that sort. So this is the form of integration in and how organisms or creatures interact. So now let us take it to the next level. If we talk about individuals, we are talking about the science that studies these organisms are called organismal biologists.

The next level is population ecology, people who study population, fluctuation in population,

how population dynamics are maintained, what are the conditions, all comes population ecology. Then we come into community ecology, the next level where species, communities, and ecosystems fall and also partly where organisms interact with themselves. So for example, the concept of niche, the concept of all the ecological interactions, competition, and predation that we are going to talk about in a while. So these all come under community ecology. The next step would be ecosystem ecology which is very integrated from not only looking at the community but also at the ecosystem.

So what is the nutrient influx, what is the nutrient outflux from the system, how are this phosphorous cycle, nitrogen cycle, and all these cycles that we know of influencing these organisms and their interactions in an ecosystem? So these are what ecosystem ecology studies and it is a very, very important field of research especially currently when we talk about climate and climate impacts on organisms and communities. Now just to wrap up from here, we will say that an ecosystem, a community is a group of populations of different species living close enough to interact with each other and this different species is important to keep in mind. And here we are emphasizing more on the biotic interaction between different types of organisms in an area. Ecosystems as we already talked about are a community of organisms including different life forms interacting with their non-living components or the abiotic components.

Here both interaction between abiotic and biotic is emphasized. So now let us see how these things are organized and every one of you in the audience knows what this is, right? Yes, it is an ecological pyramid and we all know this is an ecological more or less summing up the ecological pyramid of biomass where we have at the basal section the producers or the autotrophs generally the plants, land plants, water plants, whatever you say whichever organisms are producing food by or capable of producing food by themselves, they are mostly the autotrophs. Second is the primary consumers who feed on these autotrophs; in the next slide, we will see how these work in a little more detail. So, primary consumers, if producers are producers or autotrophs if you go, is a grass, a primary consumer is a cow, and if a primary consumer is a cow then the secondary consumer would be what? A secondary consumer could be a tiger or a lion even that even though they are wild animals but I am just giving you an example. So later you will understand why this example is important. Then the tertiary consumers.

So, tertiary consumers can also sometimes be the, they are also apex predators like tigers or lions or they can be vultures or eagles which also not only feed on carcasses. So, they are kind of decomposers with circle backs to every stratum that decomposers will eat primary consumers also, secondary consumers, and also they will feed on carcasses, okay? So, this is how it is tied up and parasites as I have put parasites on the side, you are seeing parasites can affect all these different levels of the ecosystem, right? So, if you take this as a basis, now let us proceed to the next slide. This is what you have been studying, right? Decrease in biomass from bottom level to higher level giving it a pyramid shape. Now, let us take a keen look at this, okay? In the

producers, here we have trees, grass, flowering plants, and crops. So, till now whenever, that is why my previous slides become relevant.

Till now, whenever we have been talking or thinking about the pyramid, we always think that a grasshopper is eating grass, you know, or something is eating the producer. So, if you see this particular basal strata, the producers have trees, butterflies do not eat trees, and grasshoppers do not eat the trees, right? So, grasshoppers eat grass, but butterflies do not eat grass, butterflies do not eat flowering plants, and they do not even eat crops. Similarly, ants, feed some parts of it, but they do not eat fully. So, why have we put it here? The basic concept is the energy transfer, right? So, the grass is producing, taking atmospheric carbon dioxide, and solar energy and they are producing food, and carbohydrates, right? That carbohydrate is available in various forms. For example, if a grasshopper is eating grass, it is formed by a structural component.

So, they are eating the cellulose or anything that has given the grass a structural component. On the other hand, butterflies are not herbivores of that kind, but they are still feeding on the nectar of flowering plants which is also sucrose, a part of the carbohydrate. So, they are also getting the energy from these flowering plants. So, not to confuse all these different organisms fall under primary consumers, whether they fully consume or partly just consume these autotrophs, right? Secondary consumers are rats, parrots, and frogs. So, of course, another thing very important thing to keep in mind is that the biomass is decreasing from bottom to top and not the other way around.

For example, one sparrow can eat lots of grasshoppers and it's not that lots of grasshoppers and lots of sparrows can eat one grasshopper. Okay? So, everything now when we go up, is the energy requirement. How much energy does a sparrow need and how many grasshoppers can fulfill that energy requirement? So, let's then talk about the pyramid of energy. As you can see primary producers, if you consider the energy they contain is 100 percent, only 10 percent of that is getting transferred to the next level of primary consumers. Okay? So, they are taking solar energy, they are doing productivity, everything is happening, only 10 percent is getting transferred to the next level.

Another next level now, another only 10 percent of the primary consumers, other secondary consumers, okay. So, this is how the energy is reduced. Why? Because 99 percent of the solar energy is lost by plants, 100 percent they are producing, you can see 99 percent of the solar energy is lost either through their respiration or something they are doing, it is lost. So, only 1 percent is going for gross primary productivity. Okay, and of course, grass primary productivity also includes net primary productivity and then respiration.

So, you can see only 40 percent of that 1 percent is utilized for net primary production, and from that other 60 percent is lost in respiration. Plants also respire, it's not that many animals do,

plants also respire, so 60 percent is gone. That is how only 10 percent is going to, only that much 1 percent is going to the next level. So, this is how the pyramid of energy is integrated and if you think a bit more about this then I can ask you a question, why do elephants eat a lot? It's not that I am going to answer this question here completely because this is a very very complicated thing. Elephants normally on average are 4 tons, like 4 tons of weight but their food requirements, I think they eat probably 150 kilos per day for each individual, on average.

So, scientists have seen that most of it, almost 70 percent is, they are utilizing whereas 60 to 70 percent, whereas 30 to 40 percent is just waste. Okay, and they also excrete a lot, right? So, their energy requirement is fulfilled through 150 kilos of biomass of plants but why do they eat a lot? Because a lot of the plants' nutrition is not fulfilled through a smaller amount of biomass. So, a lot of the plant biomass they are eating is also waste. So, this is the question that is driving everything food chain, food-wave relationship, and everything that is integrated.

So, food chains are an integrated relationship between body mass, energy requirement, and metabolic rate or digestive issues. This question is what drives how grasses and grasshoppers are eating, how many grasshoppers are eating them, how many lizards are eating these grasshoppers as well as how many kites are eating the lizards. So, by what I mean is that you know this length of this food chain, say this is a food chain, the length of this food chain will depend on the energetic efficiency and requirement, digestive efficiency, and the requirement of energy of these organics. Okay. So, who eats what and how big are these food chains or how vast this food web will depend on that.

Okay. For example, if you see, if the grasses are highly nutritious or some plant they are using which is highly nutritious then a small amount of biomass of the plant only is sufficient, should suffice for the grasshopper. They don't need to eat, are low cost don't need to you know, devour the whole environment. They can eat a little bit and they can have. So, like that it depends on what eats what and how they can digest it. So, now you can think more and more about this question and more and more detail because this is a very interesting question that a lot of researchers ask.

Now, let's go to the different introductions that we know which is the main topic of this lecture. So, I have started with negative which is fine, and then the positive interactions. A competition where member 1 you can see it's a two-level we are seeing just now, just two members. The competition is harming both the members. One is competing and the other is enduring the competition.

Because one is competing that is also there is a cost to that competition. Predation, predation is one is benefiting, one is eating the whole thing and the next other member is fully either dying or severely their fitness or survival is reduced. Herbivory which is mostly plant-specific, it's kind

of known as the predation in plants. So, that is similar to predation we will talk about a little bit. Parasitism also is now coming to a symbiotic relationship.

Negative symbiosis, symbiosis means when two organisms live very close to each other like in association with each other. Then the next is amensalism, you have heard of amensalism and commensalism. So, one here is negatively impacted whereas the other is neither harmed nor nothing happens to them.

Next will be positive, positive mutualism. Mutualism again both are positively impacted. So, both are benefiting from here. B. pollinator very basic example of mutualism. Dr. Divya is going to talk about fig wasps and figs which is a very good example of mutualism and she will also talk about parasitism.

So, then we come to facilitation. Here mutualism is also another form of symbiosis where two organisms live in very close association. Whereas facilitation mostly has been seen in plants under different conditions. So, it is not very talked about but it still exists in nature and the opposite of amensalism is commensalism where one organism is benefited whereas the other is not impacted. So, now let us take a look at in-depth what are these.