Course Name: I Think Biology

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W9L46_Ecological Interactions - Part 3

Hi, welcome back. This is Jayanti Mukherjee and as a part of I Think Biology NPTEL course, I am going to talk about Ecological Interactions. This lecture is the third or the last in the series of introduction to ecological interactions where I am going to talk or take you further into the ecological interactions after competition and predation. Let us get started with our recap slide. So we started with these negative interactions, competition, predation. Now in this lecture, we are going to elaborate on herbivory.

Herbivory is an interaction very similar to predation where one is plus and other is negative. I am going to talk elaborate on this particularly because in the i Think Biology book, we haven't spoken about this particular interaction anywhere. And then I am going to talk about parasitism, a little bit about it. In future lectures, Dr. Divya Uma is also going to talk about parasitism in the fig system. Then, Amensalism, comensalism, these are two positive and negative interactions. Among positive, I am going to briefly deal with mutualism. What you mean by mutualism? What are the different mutualistic interaction? However, in future lecture series, Dr. Divya Uma is also going to cover mutualism in great detail using the case study of fig-wasp systems.

The last one which is facilitation as you can see here is plus and plus in both cases and this is one unique interaction. However, I am not going to speak much about this in this lecture because this is very specific or unique only to plants and sometimes it is actually goes hand in hand with competition. Now why do I say that? So, scientists or researchers have found that in many cases, competitive interaction can actually turn to facilitative interaction depending on how much resources are available in the environment. For example, studies have shown both ways that sometimes when resources are very limited, competitive interactions can turn into facilitation where each other facilitates their growth. Whereas also studies have found that when resources are plethora, very lot of resources are available, then plants should not worry about competition, they can rather facilitate each other.

So, lot of scientists have found these kind of continuum of competition to facilitation and that's the reason we are not going to cover it in detail here because it is very linked. Let's proceed to our next interaction which is herbivory. Herbivory in true sense is a

plant and animal interaction. It is a positive negative interaction in which an organism eats part of the plant or alga also sometimes and the negative interaction is most commonly not fatal, but predation on plants significantly reduces growth and reproductive fitness. So, this is a true plant-animal interaction where the plants are the negative part which is being eaten and herbivores are the animals or the positive part which is eating the plant.

So, predation on plants has been reduces fitness and growth significantly, but in extreme cases it also could be detrimental or fatal to the plant. So, here what do we see? These pictures all of them are from South Africa or Southern African continent. Here you see a grassland or typically it is called a savanna and this is a wildebeest. You might have seen in National Geography wildebeest running through the landscape. This is a particular wildebeest grazing on the grasses there.

This is a zebra, two others are here. This is also grazing on the grasses. This is a giraffe also a savanna animal. And here in the middle is one of the monkey like animal which is actually a chacma baboon. It is called a chacma baboon.

It is a baboon, it is not typically or it is not obligate herbivore, but it actually eats a lot of different things. It can be even predator in certain cases, but it also is feeds on plant leaves and is generally a folivores or a browser. So, let us proceed. Types of herbivores. That is the reason we had all those pictures beginning.

Grazers are one type of herbivore which actually feeds very closer to the surface. So, generally it constitutes feeding on grasses or herbs. As you saw in the last slide, the wildebeest and the zebra would comprise these grazers. Secondly would be browsers, animals that feed closer to the surface, but well above the substrate. So, it will be feeding on the plant or a shrub or a liana or something a small tree.

Those are called browsers. However, unless and until they are obligatory grazers or browsers, they often feed on grasses as well as branches too. So, it can, you know, they can interchange. It is not that I am feeding on grasses, I will only feed on grasses, but there are certain obligatory grazers. They definitely prefer grazing than browsing for some reasons are there, but we are not going to go into those reasons in this lecture.

Frugivores, the third type which is particularly goes for fruits for its nutrition in the fruit and often can be damaging to seeds. Granivores that actually predates on seeds which can be very detrimental to the animal and reduce its fitness. Folivores which mostly feeds on leaves like I was giving the example of some of the monkeys. Baboon in this case is not a folivore, but in India we found find different species of langurs like Hanuman langur or Paman langur and Nilgiri langurs. These langurs are generally known to be folivores.

They feed predominantly on leaves and some other types of herbivores are also found with xylophages which eats mostly or feeds mostly on wood and also dead wood, mostly dead wood. They are scavengers and but they are still considered as herbivore because

they only feed on wood which is a part of the plant. Now, let's see what is herbivory and how can plants cope with herbivore. Okay, so cafeteria example close your eyes and I have given a smiley there. I often do this example with my students in class where I tell them to close their eyes and think while I tell them to think about a situation.

Why don't you also close your eyes and think about a situation here. Say you have an exam, if you are a student you have an exam, if you are not a student say you have a big assignment or deadline coming up in few days and you really have to focus on your work. However, you also need to eat or you also feel like going to the cafeteria, so you go to the close nearby cafeteria and try to work there while you are having some food. In the meanwhile, a group of kids you can say or group of people comes to the cafeteria where they are very noisy, they are shouting or having fun and they are also listening to loud music. Close your eyes and imagine this situation, you are sitting there and this is the scenario around you.

Now, how are you going to respond? What are the different ways that you are going to respond? You will be surprised that there are you will come up with three broad different strategies and that's what exactly my students also see. Here are those three strategies. Ma'am, I will turn on my own headphones. So, if they are playing loud music, I will put a bigger headphone and I will sit there and try to concentrate. Second, ma'am, I will get up from that area. Why to confront them? I will get up from that area and I will find another quieter place where I can go and sit and work. So, here that second, in the second category that person is kind of compromising its own, their own wish and moving out from that place. Third and very important, ma'am, I will confront them. I will try to have a dialogue with them or put up a fight and argument if needed. Right? You will be very, very surprised that plants exactly use these strategies to defend themselves against herbivores.

What do I mean by that? The first, it is called tolerance. You are sitting there, the herbivores are in the neighborhood, however, you have evolved or you have developed some strategy to not be bothered by the herbivores. Okay, that is you are sitting there and tolerating them. Second, avoidance. I get up and move out from that area, find another place.

You are avoiding herbivores. Okay, you are moving out of that place. Third, I confront them, I resist them, I put up a fight or an argument. Plants also have evolved with lot of resistant strategies. Now, let's take one by one and see some of these strategies and how they work in nature. As I said previously, I am going to elaborate this a bit especially because we don't talk about it in the book.

Okay. Tolerance, let's see what that is. Plant rates that help sustain tissue damage with little or no fitness decrease. If you remember the example of the cafeteria, you are putting the headphone and sitting there, you are compromising less and you are sustaining, so with less damage you are sustaining that ambience stain. So, in case of plants and herbivory, people have done actually, you can test this with experiment.

How? Here is an example. Let me explain this a bit first. If you are doing an experiment as you might already know that there are two different things that you can do. One is you have to have a control, right? So, where it is a null, where no treatment is given, right? No treatment in this control and D is equivalent to defoliation. So, you will ask why we are talking about defoliation, but here you are saying herbivory. So, scientists or researchers who actually work on this question, they call it defoliation because here they are imposing or cutting off leaves, they are not bringing a full cow here to get their grasses eaten and test on them, but lot of these cases are done artificially in an experimental setup where you actually can cut these plants and let it grow and see the potential of its regrowth.

So, potential mechanisms of tolerant is faster regrowth of tissue. That is what the researcher will be looking for. So, now let us see in time 0, if this is C, let me put my pointer out. Yeah, in C this is the height of the plant in time 0. In time 0, for the defoliated plant you may go and make it half.

So, you cut it off. Time 1, this grows, the control plant grows a little bit more till here and the defoliated plant also can grow very similarly as the control. Then it is actually known as full compensation. So, it is fully compensating for the loss of the tissue that it had. Next, overcompensation. Certain plants in certain environments can actually even overcompensate for example, it will grow even more than the control.

How is that possible? In areas where there are lot of moisture, lot of resources, after defoliating what happens is the apical buds of the plants are cut off and hence there is vigorous growth from the side through lateral meristems. So, it can actually trigger even more growth in plants. So, it can overcompensate provided the area has lot of resources available. However, if lot of resources are not available then it could also undercompensate which means it will not grow till the, how much the control is growing, but it still has some kind of regrowth. This also depend on how often this is eaten by herbivores and lot of other factors, but for you this is enough to remember from this slide.

This is a general overview. Now, avoidance. Traits that decrease the eating probability and events. A plant or grass or a herb that could grow as a shrub is now actually growing. Physical avoidance, it can become a prostrate habit. Flat, flat on the ground which makes it very difficult for the herbivore to actually chew on it.

So, it is sending a lot of storage underground, it could that also be because it can totally diminish the above ground biomass and put all the resources underneath. It can avoid that grazing season by storing resources underground and when the grazing pressure is gone it will come up again. So, it can physically avoid or life history wise also it can avoid. If it is an annual plant, I will grow the season where I get a lot of resource, but I will disappear producing a lot of seeds before the herbivores come to feed on me.

Some cases this works very nicely. Okay, so this is an avoidance strategy. Our next and very, very important strategy is resistance. Any plant traits that reduce the number of damage or the sorry the amount of damage created by herbivores. Physical defense, many

cases you have seen spines, thorns, seeds with hard core or seed shells, bark that is very hard which definitely herbivores will avoid. Okay, so if there is a lot of thorns or spines in the tree or shrub, herbivores won't like it because it will prick your mouth.

But you will be surprised in the African savanna the acacias have, that's the reason they have evolved a lot of thorns, spike as well as lot of chemicals also. Okay, but still the giraffes managed to eat them, some of the elephants managed to eat them. Okay, they have reached a place where they have reached a coexistence, harmonious coexistence with each other. Second form of defense, chemical defense where they produce secondary metabolites. This is very, very important for us because if these metabolites come in form of alkaloids, phenolics, terpenes and often it has turned out to be a boon to humanity where we have used these alkaloids from nature in forms of stimulants or medicines as you can see, morphine, caffeine, nicotine all these things are secondary metabolites which plants produce for their defense, but we have come to use it for our own benefit also.

So even without knowing actually plants are benefiting us so much, right. It's a kind of commensalism here, right. So the question, I think question that you should think about is, do these strategies that plants has evolved with work only as defense against herbivores or are they very similar for other stressors also? Are they similar? For example, if there is a drought stress in the environment, if there is a fire damage in the environment or if there is some other kind of disturbance or stress, will these same strategies work in the same other stressors too? So when we have a live session, you can actually think of some of these questions and come up with discussing with me and I would be happy to answer your questions. Our next interaction is parasitism. So parasitism is a symbiotic interaction in which one organism, the parasite, derives its nourishment from another organism, the host.

So parasite and the host which is harmed of course it's a positive and negative interaction but you have seen, you see that I have highlighted this symbiotic in red. Why? Because in most cases this parasites are, is a symbiotic relationship. Symbiont means, sym is same and biota is life. So where life is in the same place means these two organisms are actually in close association with it, with each other, most mostly or more commonly throughout their life cycle. Some parasites have been seen to have more hosts like one or two hosts but generally they stick to one host.

So parasites can be broadly classified, described into two categories. Ectoparasites, parasites that are outside the body. Ticks, mites, other insects that kind of sucks blood, thrives there and completes its life cycle. Okay, lot of cases you will see ticks, mite, infection can be so severe that it even compromises the reproductive capability then also it can endanger the plant's survival. Lot of cases it has been shown that when prey, a prey species, a deer or something else has lot of parasites, it can actually not be very careful or vigilant where the predator is coming or where is it coming from.

Okay, so in that case it misses that and I mean that's the reason it gets eaten or predated upon. So this ticks and mites can be also imposing lot of dangerous consequences to the

organism it is on. Endoparasites, of course it is harmful because it is actually inside the body of the host. So you are, humans definitely have a lot of parasites in us and malarial parasite as you can see, you know, it feeds on us and then goes into the bloodstream and as the malaria chapter talks about you will see that how malaria parasite works, right. That is a significant interaction for humans, lot of life is lost because of that.

Broadly, parasites could be a virus, a bacteria, a fungi, protozoa, helminth or insects, insects, mites and ticks, virus, you know, COVID-19, bacteria, it could be I think chlamydia or something, lot of bacterias could be parasitic, fungi too. Okay, so these are the broader classification of different types of parasites that we know of today. Now coming to mutualism. Here you see I have given mutualistic symbiosis or mutualism. So it can be both ways, actually not or it should be and because mutualistic interaction could be either symbiotic or non-symbiotic.

How? Symbiosis as I said close association, one of the most common example of mutualism is a lichen, right. A lichen you have seen grows on the barks and it is a mutualism or symbiosis of an algae, and a fungi, right. And similarly mutualism could be plant pollinator. In case of lichen, both are always existing together. If one goes, the other will die, that whole organism or the lichen form won't be there.

But in plant pollinator, they can survive without each other also, but when the season of flowering comes, the pollinators comes to the flower to feed on the nectar and in case or it carries the pollen with it and pollinates. So, it does the job. So, this is a different kind of mutualism. As you can see again in mutualism, broad classification could be obligate mutualism, plant pollinator systems, dispersive plant and seed dispersal, facultative where you can be mutualistic but certain parts you are not, you don't need them, the other partner or it could be defensive. Generally, ants and aphids is a very interesting and important example which is very, very common in nature where you will see that the ants give the, sorry, the aphids give the ants certain kind of juice or watery substance whereas the ants actually fight the predator for the aphids, so that the aphids are not getting eaten.

So, this is a very interesting mutualism that works in nature. If you see in Hindu culture, we use a plant called calotropis, right, for Shiva's flower, we put that flower. If you go outside in the backyard or somewhere you have this tree calotropis, if you go and see there, you will find these ants and aphids. You can observe, do those kinds of observations if you like just outside your house or in the backyard somewhere. So, this is all about mutualism that we are going to talk about.

Another very important example is the plant mycorrhizal association, where fungi or the mycorrhizae which actually found in the roots, it can also be found on the leaves where it is called endophyte. Whereas mycorrhizae association which is on the root is partially inside the plant and partially outside the plant and what it does, it gives, the plant provides or helps to gather nitrogen and phosphorus for its food making and on the other hand, plant makes the food, cooks the food and gives it to the fungi. So, this is a very nice win-win situation and very happy relationship where mycorrhizae really helps the plant. In lot of cases, it has been shown that it can help plant to even defend against herbivores

and lot of other things, similar things, okay. So, this is covered in a bit more detail in our Kingdom of Fungi chapter in i Think Biology.

If you want to know about it more, please go and look it up there. Now, we come to our last interaction, Comensalism and Amensalism. As I said, these also are not very common as competition, predation and herbivory and all the things, but these do occur in nature. It's one, it's an interaction interspecific where one benefits and the other is remain unharmed. Remora fish and the whale, the hitchhiking partner, is a very interesting example of commensalism. Here you see this fish has some kind of a sucker type of mouth where it actually, it might look a little bit scary here, but it actually uses that sucker to get itself attached to the lower side of the whale just for the benefit of being carried longer distance.

So, it is not actually sucking blood out of the, of the whale or taking any nutrition, but it is getting attached to it and just traveling with it because traveling in the ocean could be highly costly energetically. So, it is using it as a vehicle. Similarly, barnacles on whales are another example which does that. Orchids which grows on mango tree is known to be a commensalism. okay.

So, these kind of things also you may see in nature. Amensalism on the other hand is interspecific interaction where one species is harmed while the other remains benefited. Penicillin produced by some fungi can kill certain bacteria or even allelopathic chemicals. Okay, but lot of times scientists, some scientists consider this as amensalism, something that it is actually a competitive interaction other than an amensalism. So, there is a bit of debate around this. Feel free to think about it more and come with your questions in the live session.

We can talk about it more there, right. So, I hope you got some bits of interaction, how species interact in nature. We talked about in this lecture what is ecological integrity, how different organisms and species are connected from individuals to the level of ecosystems through ecological food webs or food chains, how are these food webs and food chains all interconnected. We talked about ecological pyramids, pyramids of biomass and energy, and then we came talking about these different interspecific interactions and how species coexist with each other in nature and how these strengths of interaction actually shapes the evolution or speciation even in certain cases of these species. For example, we looked at the predation where lot of species have evolved because of this predation pressure which act as a selection force on these species.

So, I hope you enjoyed this lecture. We will see you next time. Thank you very much.