Wildlife Ecology
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Lecture – 21
Some push and pull factors in greater detail

[FL] We will carry forward our discussion on the Distribution and Abundance of organisms.

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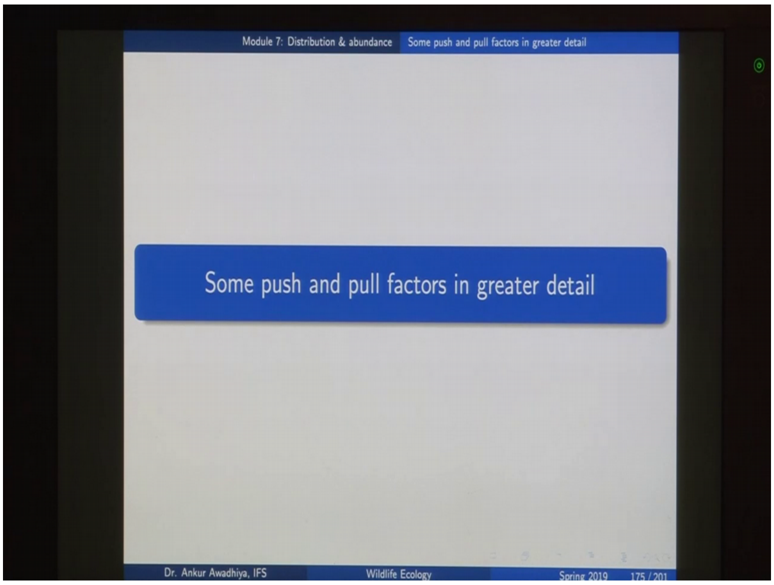

And today, we will have a look at some push and push and pull factors in some greater detail. Now in the last lectures, we had seen that push factors and pull factors govern the distribution and abundance of different organisms and we had defined push factors as those factors that make a certain area inhospitable or maybe less hospitable for a certain species. So, if an area is very hot, if an area is very cold, very moist or maybe very dry for some particular organism that organism would not prefer to live in that area and different organisms have different tolerances to all these factors.

And so, a certain factor might be a push factor for a certain organism and might be a pull factor for some other organism. Now, similarly we had defined pull factors as those factors that attract organisms to any specific area. So, if an area has abundant amount of food, it has the amiable climate; it is neither too hot for the organism nor too cold, it is neither too pit not too dry, if those are the conditions. So, the organisms would prefer to live in those areas. So, those factors are known as pull factors and today, we will look at some other push and pull factors and some push and pull factors in more detail.

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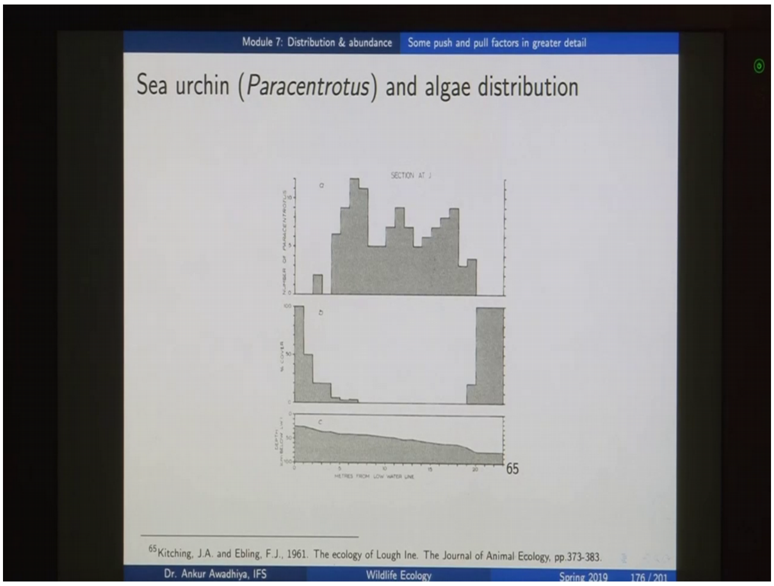

Now, one push factor is the presence of predators; now this is an observation. So, this is a field observation from an area in which we are seeing the number of sea urchins. So, in this case we are seeing looking at sea urchins and this is at a particular line which is called a section at j and here, we are looking at the algae populations. And this is the depth of the water and in this case we can see that in these two areas, where you do not have the sea urchins; you have an abundant amount of algae.

So, essentially if you have algae in an area, you do not have sea urchins in that area and if you do not have algae in an area, this that area is having an abundant amount of sea urchins. Now, the question is can predators actors, push factors for an organism and in this case the sea urchin is the predator and algae is the pre because the sea urchin feeds on the algae. So, how do you discern if actually the distribution of algae is being governed by the presence or absence or maybe the abundance of the sea urchins in that area.

So, some experiments were conducted to establish the facts.

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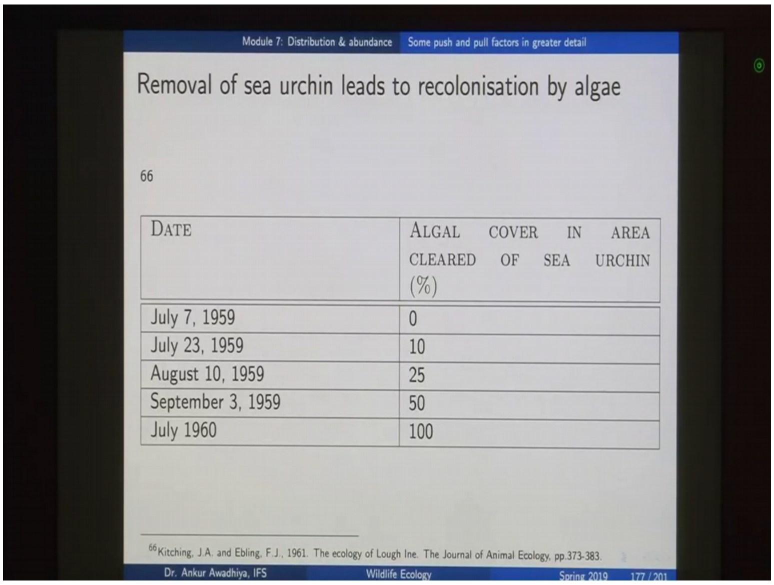

Now, this is the first experiment. Now in this experiment in early July 1959 a certain area in the seas was cleared off of the sea urchins. So, essentially all the sea urchins in that area were removed. So, we are talking about an area that is having a population something like this. So, you have abundant number of sea urchins and you do not have any algae in that area. Now you experimentally remove all the sea urchins and then, you try to see what is happening to the algae population.

So, in early July he removed that all the sea urchins. So, the algae population is 0. Now if we look at late July, the algae have covered roughly 10 percent of the area because there are no more predators to feed on these algae. Then, by August it has increased to 25 percent by September it has increased to 50 percent and by the next year 100 percent of that area is now covered by the algae.

Now, when we are looking at a push factor or a pull factor, when we said that we do not have algae in these areas; then it is possible that you do not have algae in these areas for a number of reasons. Probably it was because of high temperature or say low temperature or high salinity or low salinity or maybe some wave actions, they could be n number of reasons.

But then, when you are removing this one factor; then everything else is remaining the same. The only change that you have brought in this system is that you have removed the sea urchins and just by removing the sea urchins you see that the algae are able to come to these areas.

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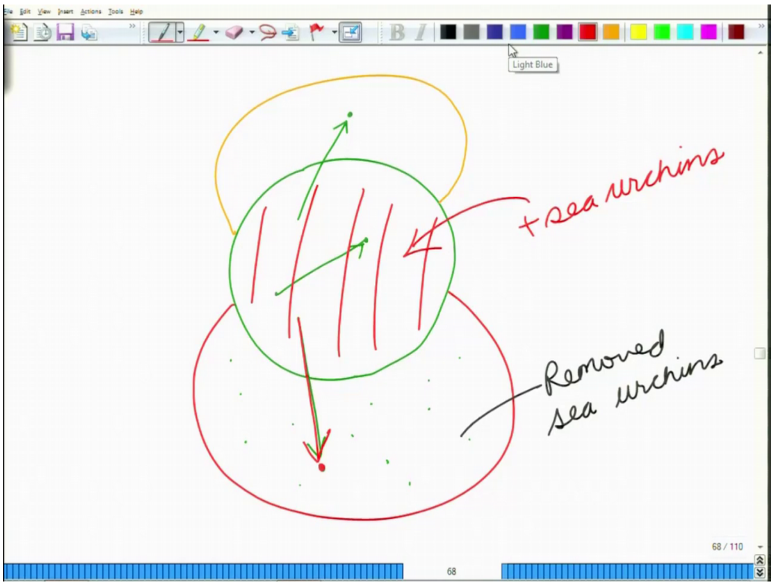

Now, as we had discussed in the case of the transplant experiments. Now, in the case of a transplant experiment, we take an organism from an area where it lives to an area where it does not live. So, essentially the green one is showing you the areas where an organism is living.

So, in this case this is showing you these areas; this one in this one. So, if you take an organism and algae from one location to another location in this green area, it is able to survive. But then, if you take it to another area and this algae now die is off, which is what will happen if you take the algae from here and you take bring it to this area.

So, because you have sea urchins; so, the algae will be eaten up by the sea urchins or if you take it to some other area and the algae is able to survive. Then, you will say that probably algae has not reached into that area. Now, in this case you were taking the algae into the red region. So, the algae was brought into the red region, but then you made just one change which was that you have removed the sea urchins and once you did that the algae was able to populate this area as well.

So, by this experiment we can say that it was because of the presence of the sea urchins that the algae was not able to colonize this area. So, sea urchin was the push factor. So, this is one way in which we can distinguish between different push and pull factors and we can tell which factor is doing what. Now, the next question would be why donot you have sea urchins in this area. Now, because you do not have sea urchins; so, we are saying that you are getting algae in this area. But then, why are you not having the sea urchins?

So, in these areas because they were close to the coast; so some amount of wave action was what does was dislodging these sea urchins. Now, what will happen if you if you try to push a sea urchin into this area? So, if you cover this area and if you put a sea urchin in that is the algae population will go down because in that case what you are doing is that you are adding your sea urchins. So, if you add sea urchins, in that case this area will also now cease to be a good locality for the algae. Now the third question is if you are able to put the sea urchin here and you put it in such a way that is just not able to eat the algae; what will happen then?

So, probably you can make use of a trap and you can put your sea urchins and then you can hang that trap in this area and probably feed your sea urchins with something else. Now, in that case if the there could be another reason probably your sea urchin was giving out some chemical compounds because of which the algae were dying off. Now, to counter such possibilities you can put your sea urchin in a trap, you can give it some amount of food from outside and you can keep the sea urchin in these areas and in those situations if the algae do not die off, then we can say that it is because of a direct predation that the algae population is being governed.

So, the researchers came up with these 4 criteria that will tell us if the predator is governing the distribution and abundance of a prey. The first criteria is that the organism does not survive when transplanted to a site where it does not normally occur, unless it is protected from the predators by the cages. So, for instance if you take the algae and you take this algae into this area and you have these predators that will go and feed into feed on to these algae. But then, you can take this algae put it into a cage so that the predators are not able to reach these algae.

So, this is also a second experiment that you can do. So, in that experiment what you are doing is you are taking; so, you are not removing your sea urchins in this experiment.

But then, you are taking your algae, you are putting it here into this area and normally it dies off.

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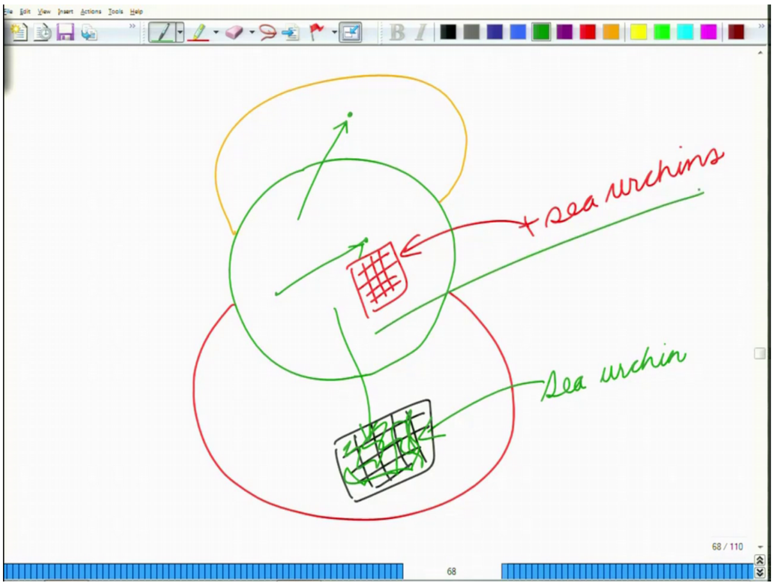

But then, what you can do is you can create a trap and in this trap because you have these wire meshes. So, the sea urchins are not able to enter inside and you are putting your algae into this trap. So, you will find that your algae is able to populate in this area and the algae is able to populate because the sea urchin is not able to feed on it or in a very similar way you can take some sea urchins and you can put those sea urchins here and probably in a trap if you put it. So, if you take your sea urchins you add your sea urchins here and maybe put them in a trap. So, in that case also they are not able to come out.

So, these two simultaneous experiments can be done.

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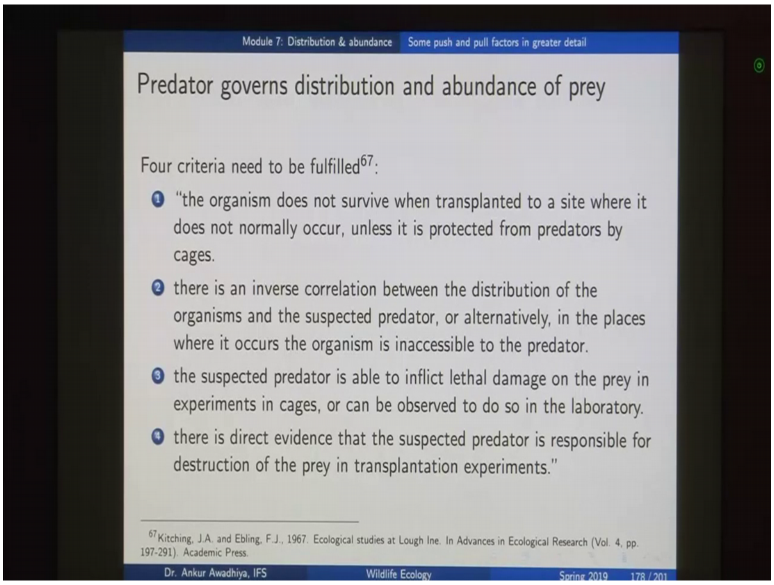

And it is telling you that the organism does not survive in transplanted to a site, where it does not normally occur, unless it is protected from the predators by the cages if you protect it. Then it will then it is able to survive in that area which will tell you that there is nothing other than the predator that is causing the absence of that particular species in that particular area.

This the second criterion is that there is an inverse correlation between the distribution of the organisms and the suspected predator or alternatively in the places where it occurs the organism is inaccessible to the predator which is what we had seen in this case. So, there is an inverse relationship if you have the sea urchins in large numbers, you do not have algae. If you do not have the sea urchins, you have the algae or you can tell it in the reverse way as well. If you have the algae, you do not have the sea urchins and if you do not have the algae, you have the sea urchins. So, you can put it in both of these ways, but there has to be a negative or in inverse correlation between the prey and the predators.

The third criterion is that the suspected predator is in is able to inflict lethal damage on the prey in experiments in cages or it can be observed to do so in the laboratory. So, if you are taking your predator and in this area suppose after you have let us say that. You take a cage in this area and in this cage you add a number of algae. So, your algae have grown up in this cage. Now inside this cage you also put a sea urchin. So, once it has entered into this cage or we can have a very similar experiment here as well. If you have a sea urchin in a cage and you also have the algae, then it should be seen that the predator is able to inflict a lethal damage that is the predator is able to kill the prey or eat the prey either in experimental case cases in the case when you are doing it in the wild or you can see it in the laboratory.

So, there has to be this condition that your predator is actually able to kill the prey and the force is that there is direct evidence that the suspected predator is responsible for destruction of the prey in transplantation experiments which means that we when you are transplanting your algae into this area, you are taking your algae into this area and you see that when you are taking this algae, the sea urchins are you are going to feed on these algae and so all these algae die out.

So, it should be seen even in the case of the transplantation experiments that this is the reason that your algae are not able to survive in this area. So, if all these 4 criteria are fulfilled, then we will see that it is the predator that is governing the distribution and abundance of the prey as a push factor.

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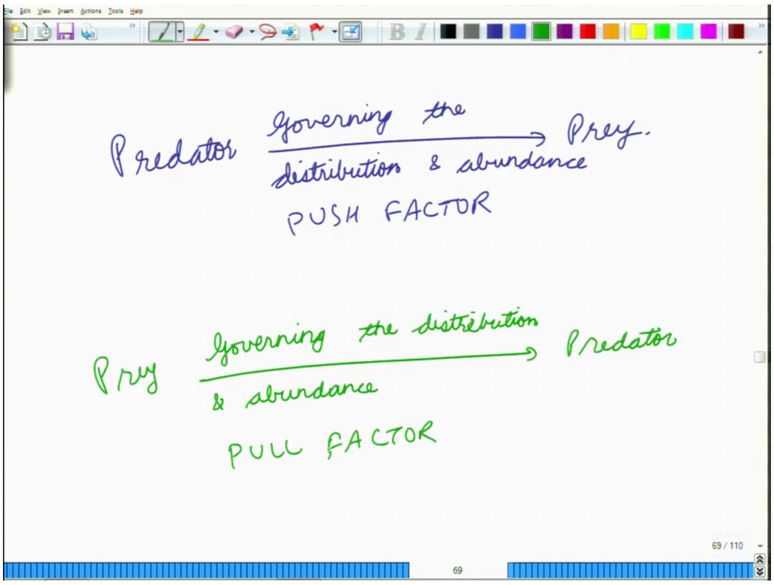

Now, this case we observed that there is a predator which is governing the prey. So, it is governing the distribution and abundance of the prey as a. Now, the one other question that we can ask is do we have also situations in nature, where the prey can govern the abundance and distribution of the predator that is the prey can act as a pull factor for the predator.

So, what we are saying is do we have situations, where you have the prey and it governs. So, it is governing the distribution and abundance of the predator say as a pull factor and the answer is ‘yes’. So, we can have a look at this particular study.

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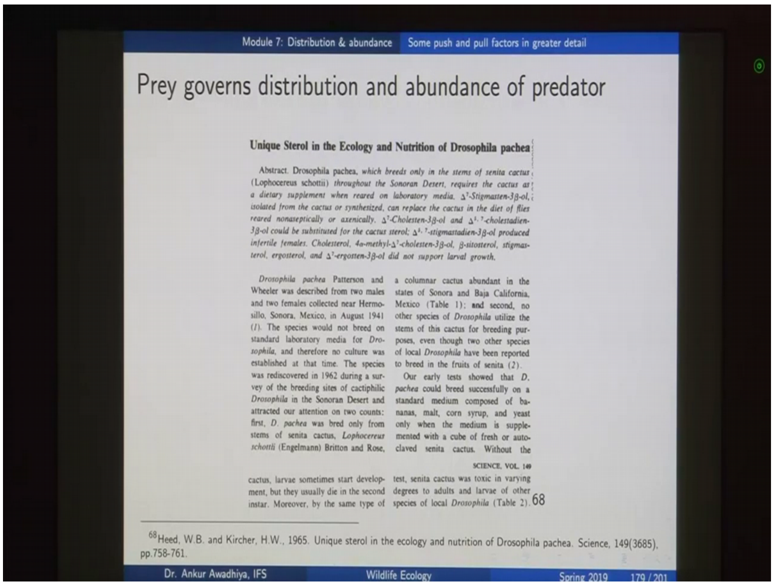

Now, in this study we have a species of drosophila by the name of Drosophila pachea. Now drosophila are very small fruit flies that we normally see in and around our fruit stalls. Especially, if you go and take a bunch of bananas; you will find very small flies that are hovering around or say if you go in to take some mangos, you will very easily find these flies. Now, these flies are known as fruit flies and they normally feed on certain fruits and they are also used as experimental animals as model animals in the laboratories.

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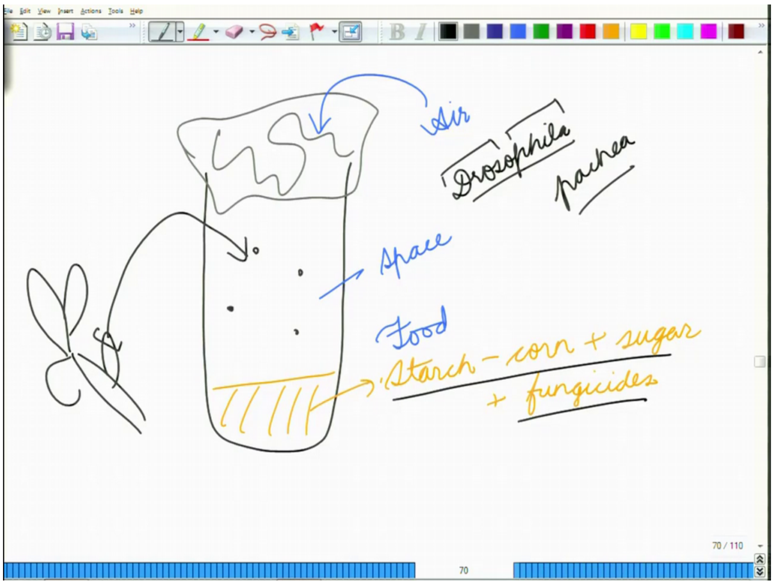

Now, if you want to rear a fruit fly, what you do is that you take a vial. So, in this vial, you will put some amount of food in the bottom and typically this food is starch in the form of corn plus some sugar and maybe plus some fungicides. So, that it stays fresh for a long period of time and then, you will put these fruit flies into this vial and then you will cover the top with a piece of cotton. So, in this case the flies have access to air from outside. So, the air is able to reach inside there good exchange of air.

So, oxygen can come inside; carbon dioxide can go outside. The fruit flies have access to the food here and they also have ample space here and in that case they will be able to feed on this food and they will multiply in their numbers. So, this is a very commonly used model organism. Now, the model organism that we use in the laboratory is Drosophila melanogaster.

Now here, again if you look at the word roots it has a very interesting name Droso means due; Philly is affinity. So, when we say that something is hydrophilic it means that it absorb water; it has a love of water. Now, similarly this drosophila has a love of droso and droso in this case refers to the due. So, this is called drosophila because it typically comes out of its pupil stage when it is very early morning.

So, in the very early mornings you will see these flies coming out of their pupil stages, when there is due everywhere around. So, which is why we call it Drosophila. Melano is black; Gaster is stomach. So, if you look at its stomach you will have a black color; so, which is why it is called Drosophila melanogaster. But then, Drosophila comes in a number of species and in this case there is this particular species of drosophila that is found only in the deserts and even in the deserts it is found only near a particular species of cactus.

So, there is this cactus on which this drosophila is feeding and it is living there. Now, if you take this drosophila. So, you take this Drosophila pachea and you try to grow it in this vial. So, you have added corn, you have added sugar, you have added fungicide. So, you have given it everything that you give to a normal drosophila melanogaster and this drosophila is not able to breed. So, at the young ones who do not come out; so in one generation it is all gone, but then if you take a piece of the cactus. So, if this is the cactus, you just take a piece of this cactus and probably you put a piece of this cactus inside. Once you do that the your drosophila will start to reproduce. So, you will be able to maintain a population.

Now, you can also take this small piece of cactus you can autoclave it. So, in which case you have heated it to as high as 120 degrees for as long as same 15 to 20 minutes so that all the living organisms that are there on that piece of cactus they are all dead and if you put an autoclave piece of cactus here, still your drosophila will be able to breed. Now, another interesting case is that if you take this cactus piece and if you put it into a vial and you are adding some other drosophila.

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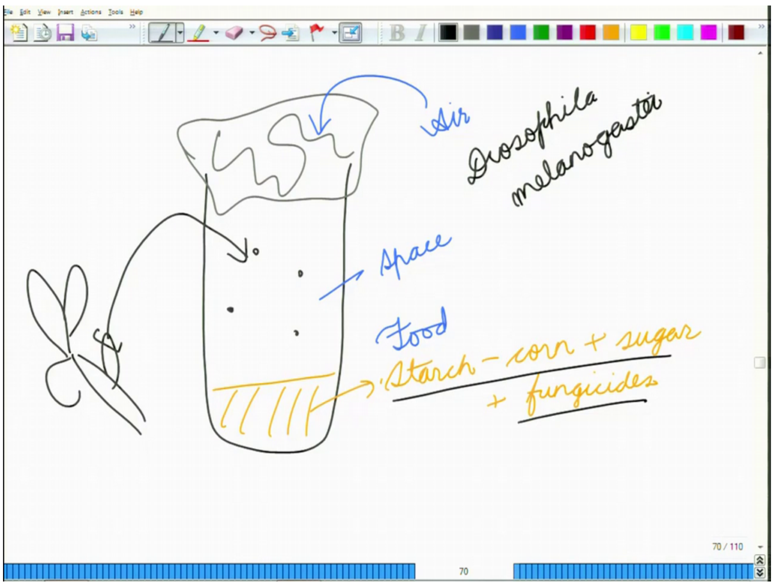

So, let us say that you are adding your normal drosophila; your drosophila melanogaster and you are raising it along with this particular cactus.

So, what will happen is you will see that your drosophila start dying off. So, this is a very curious case that you have this drosophila pachea that is only able to grow when you have this cactus around and if you have any other drosophila that that will die when you have this cactus. Now, what is the reason? Now, on the reason is that this particular cactus gives out certain sterol molecules. Now, sterols are the molecules that are typically used in the making of several hormones. Now in this case the sterol molecule is toxic to the drosophila species, but then this drosophila pachea uses this particular sterol to make its own hormones.

So, what has happened in this case is that because of co evolution, this drosophila has been living on these cactuses for a very long period of time and because of this co evolution it is now able to make use of the chemicals that are given out by this particular cactus and every other drosophila finds it toxic and so, every other drosophila dies. But then, that this co evolution has is happened to such an extent that if you do not give this cactus, your drosophila pachea is going to die; why? Because it is now so much dependent on this cactus that it now obligately or it 100 percent it needs this sterol from outside from this cactus so that it can make its own hormones.

If you do not give this cactus, this drosophila is completely unable to make this hormone by itself. Now, if you have such a relationship, where your predator. In this case the predator is the drosophila and the prey is the cactus. So, your predator and prey have co evolved to such an extent that your predator can live only on the prey population. In that case you will have a situation, where your prey will govern the distribution and abundance of the predator; why? Because in the desert if you have this cactus, you will have the drosophila; if you do not have this cactus, you will not will not have this drosophila.

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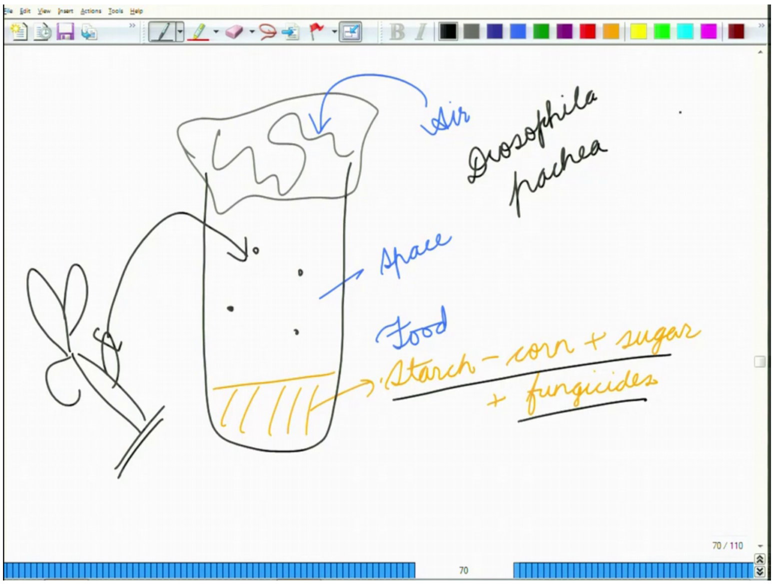

So, we are talking about the Drosophila pachea. So, if you have your cactus, you will have Drosophila pachea. On this cactus if you do not have this cactus, Drosophila pachea will not be there. So, in this particular case, it is the prey that is the cactus which is governing the distribution and abundance of the predator by acting as a pull factor and instances such as these are very important.

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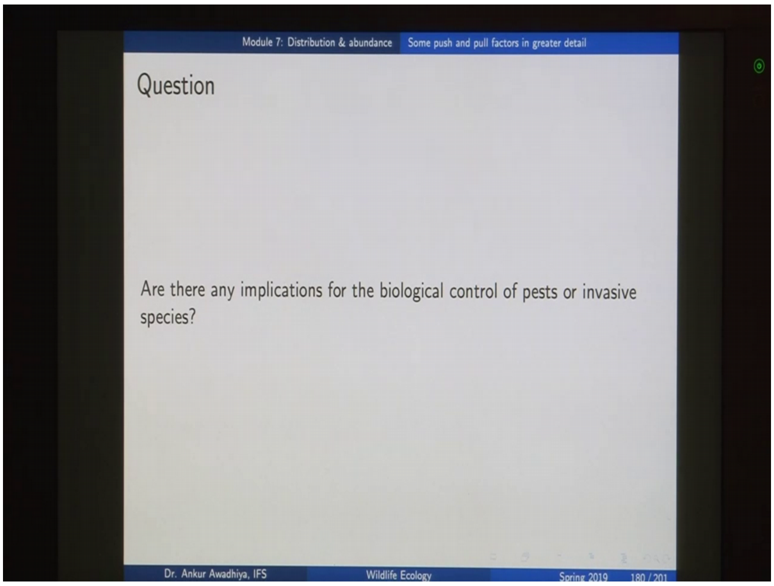

Because we can make use of these instances as biological controls. So, there are huge implications for biological control of pests or invasive species. Now, we look at one such example now.

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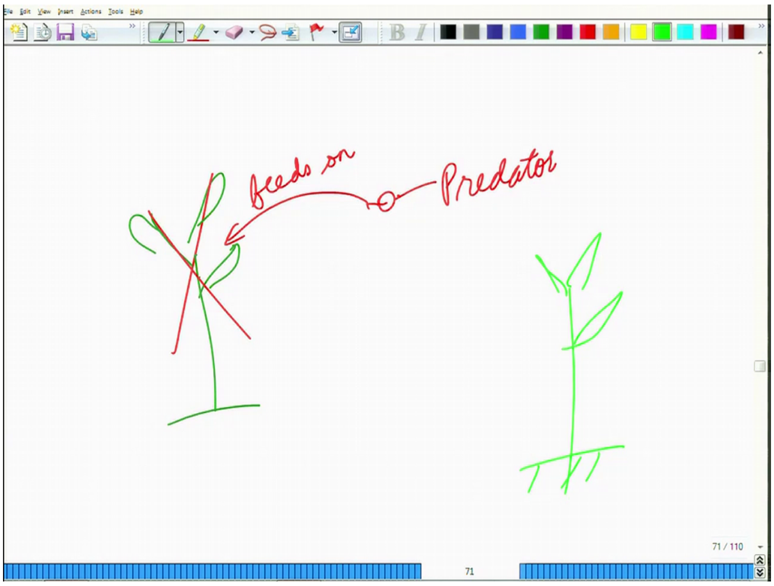

Now, in the case of biological control what you are trying to do is that if you have a particular plant and this plant is may be acting as a weed for your area, you can bring in some predator and this predator is one that feeds on this plant. Now you want to bring in a predator that feeds only on this plant because this is the plant that you want to kill. If this predator feeds on a number of other plants; so, in that case you will have a situation where all different plants are dying off and that is not what we want.

So, we want to have those predators which are extremely specific for their preys or for their plants. In an example of this is given by the pine rust.

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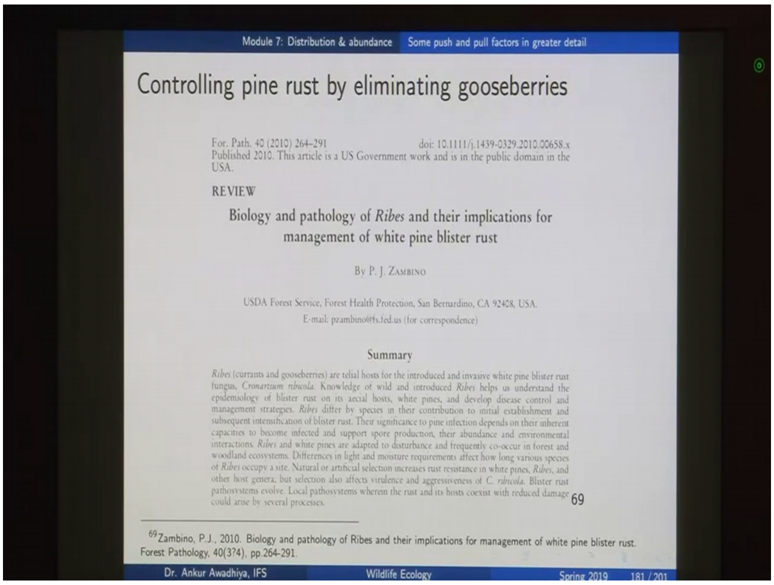

Now, pine rust is a fungus and this rust effects two species; so it effects the gooseberries or ribes. So, Ribes is another word for gooseberries. So, this pine affects the gooseberries and it affects this rust affects the gooseberries and it affects the pine. Now it has evolved in such a manner that it will spend some part of its life in the pine trees and it will spend some part of its life in the gooseberry trees and typically in the forest, you will find both of these trees together. So, you have a pine tree and as well as a gooseberry tree. So, because of co evolution it has so evolved that it requires both of these species now.

So, you have a predator that is now specific to two different preys. Now if you want to control this predator, you can eliminate the gooseberries because we want to maintain a plantation of pine and we do not want to our pines to be impacted by this particular rust. So, you can eliminate the gooseberries in which case the rust will not be able to complete its life cycle.

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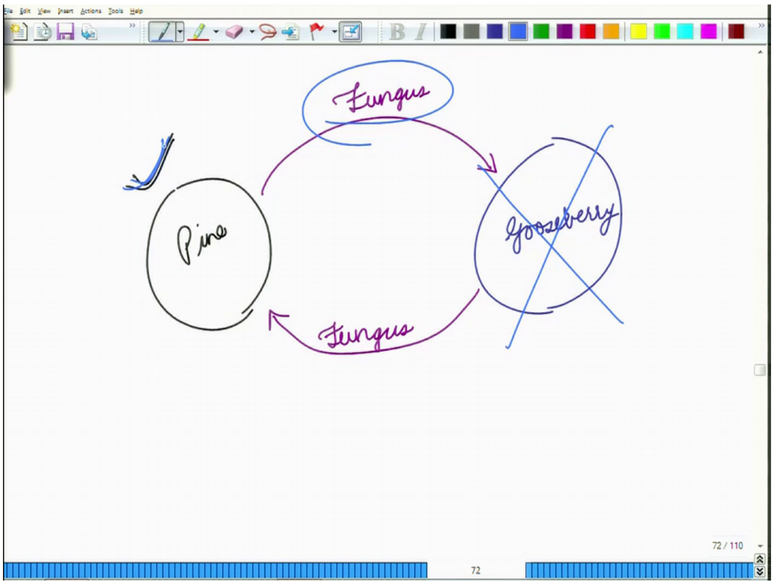

So, essentially what we are saying is that you have these two species. So, you have the pine and you have the gooseberry and there is a particular fungus that moves from pine to gooseberry and from gooseberry to pine. So, here you have the fungus and this predator is so specific that it has to move from a pine to a gooseberry and it has to move from a gooseberry to a pine to complete certain stages of its life cycle. Now, if you want to maintain a pine plantation and if you remove all the gooseberries from this area. So, this fungus will not be able to complete its life cycle in which case your pine trees will be saved from the fungus.

So, this is a way in which we can make use of our theories of push and pull factors for our own use for generating a pine plantation or you can make use of these specific predators to kill off certain plants that you consider as weeds. So, now, these are two instances that you can make use of by looking at the push and the pull factors.

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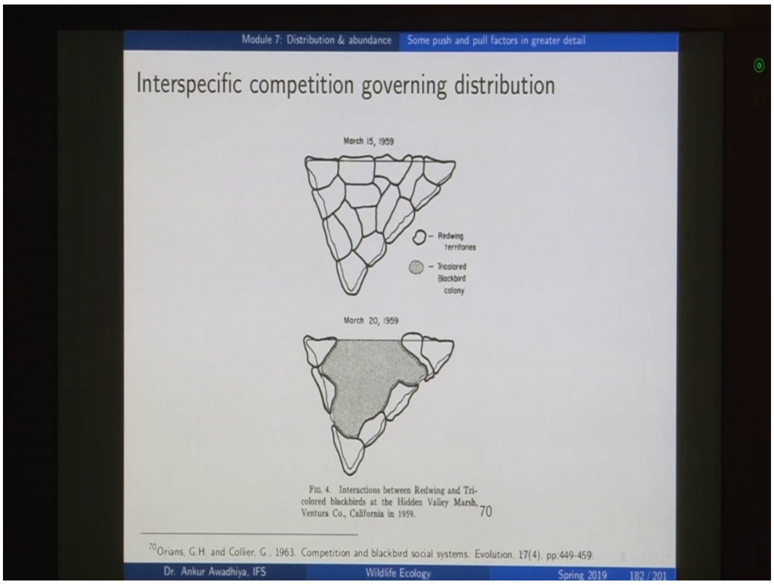

Now, we will also look at one other push factor and which is your inter specific competition. Now inter is between. So, you here you have competition between two species. So, this is an inharmonious interaction as we have seen before. Now this is an example in which you have two different species of birds. Now here you have this portion of this white colonies are the dread wing territories.

So, you have these birds that are known as red wing and you have this other word that is known as a tri colored blackbird. Now if you have a red winged blackbird, but and here you have this field observation that on 15th of March 1959 in this area there were so many colonies of these red wing blackbirds that had come up. Now, after a short while you started seeing the tri colored back blackbird that started appearing on the 20th of March. So, 5 days after these colonies were established, you started seeing the tricolor blackbirds in these areas and your tricolor blackbirds are more aggressive and they are larger in numbers.

So, they are able to push your red wing blackbirds to the periphery. So, in this case the central area which was earlier the area of the red wings is now all taken up by the tricolor blackbirds. Now, in this case what we are seeing is inter specific competition that is regulating the distribution of a species. So, your red wings are now distributed because of the impact of the tri colors. So, this is also another push factor that we see in certain instances. Now if we look at these areas then you will not find any more nesting that is being done by the red wings in this area because they have been completely pushed away.

So, in a short while you will see that you only have these tri colors that are there in this area. So, this is another push factor that we are seeing. Now we had talked about allelopathy.

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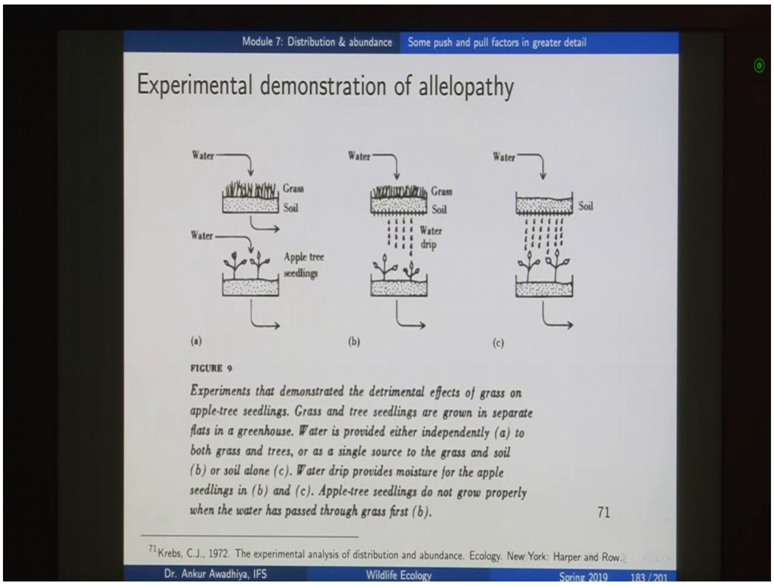

Now, we look at allelopathy in a bit more detail. Now allelopathy is the phenomenon, where you have a plant that is giving out certain chemicals which is inhibiting the growth of other plants. Now, allelo is someone else and pathy is producing or some sort of a disease. Now, how do you prove that there is this factor of allelopathy that is working for certain species. So, this is a classic experiment that you can do.

So, in this experiment people wanted to show that grass has allelopathic impacts on apple saplings or apple seedlings. So, how do you prove that? So, in this case you do 3 different kinds of experiments. Now in the first experiment, you keep both of these separate. So, you have these 2 pots. In the first pot you have grass; in the second pot you have the apple seedlings and you give water to the first pot, you give water to the second pot and in this case you look at the growth of the apple seedlings.

So, essentially this is a control experiment in which you are keeping your apple seedlings separate from the grass and you are giving it water. Now another experiment is where you put water into this pot which has the grass seed which has the grass that is growing and then, you keep this pot in a way that you are able to gather the water that comes out of this pot. So, essentially this pot is a permeable pot; so when you are putting your water onto this grass bed, the water is going through this grass it is reaching to the roots and then if there is any chemical that is given out by this grass. It gets dissolved in the water and then, it comes out along with this water and then this water is then given to the apple seedlings; so this is the second experiment.

Now, if you see the growth of these seedlings as compared to these seedlings, you will find that these seedlings are very stunted they are not able to grow properly that is they are having some kind of a negative impact which is being given because you have the grass here. But then somebody would ask that it is possible that you have a negative impact, but then probably this negative impact is not because of the grass but because of the soil. Now to counter that you take this third experiment in which you take a permeated pot and here you have only soil you do not have any grass; you put water here and then you take out this water that is coming out.

So, this water has passed through the layers of soil and once it has come out you are putting that water into the apple seedlings. And now you compare the growth of these seedlings with that of your control seedlings and you find that there is no change in the growth. So, essentially what you are doing is you are doing three experiments.

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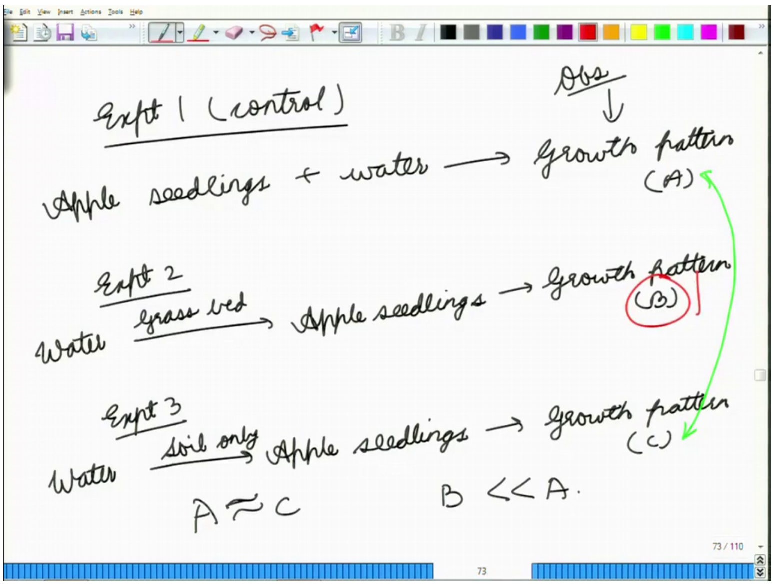

So, your experiment 1, which is the control; here you have apple seedlings plus water which is your normal water and then you are looking at the growth pattern. Let us call it an A kind of a growth pattern. The second experiment is where you put you are putting water, this water is moving through a grass bed and then it this water is being given to the apple seedlings and then you look at the growth pattern and let us call it a B kind of a growth pattern.

In the third experiment, you have water that is moving through a bed of soil and this soil does not have any grass. So, it is soil only. Then it is given to the apple seedlings and then, you look at the growth pattern and let us call it a C kind of a growth pattern. Now, when you look at these three observations; so, here you have the observations. You find that a is roughly equal to C, but B is very much less than A.

So, the growth when you are giving water through the grass bed, the growth is very little when you compare it with your control. But the growth when you put it only through the soil is roughly equal to the control. So, both of these are equal and this one is very low. So, in that case you can say that yes there is some inhibitory effect that is coming when the what is passing through the grass bed and this inhibitory effect is not coming because of the soil. So, it must be coming from the grass only.

So, this is one way in which you can demonstrate your inhibitory effects. Now in the case of allelopathy, you have inhibitory effects that are coming from one species and they are influencing the other species. So, they are coming from the grass and they are influencing another species that is apple. But then can you also have inhibitory impacts that in which case you have one species that is putting an inhibitory impact on to members of its own species is that also possible. Now before we move on to that let us think about the reason why any particular species would want to inhibit the growth of its own species members.

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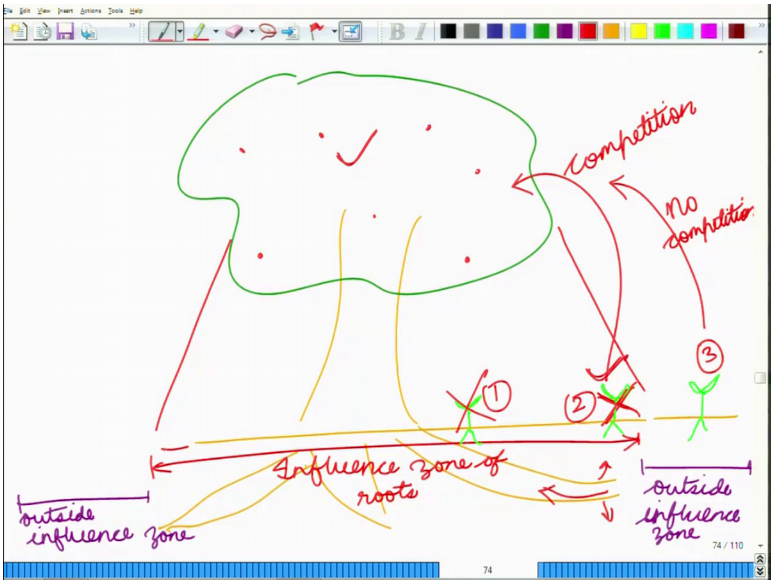

So, let us say that you have this tree in an area and this tree has long roots. So, probably it is covering a very large area and then, this tree is giving out certain fruits which have the seeds and then through dispersal, these seeds can come into an area from here to here. Or probably they can go off even further. So, let us say that this is the region where you have the roots. So, you have you can have seeds that come here or you can have seeds that come even after this.

So, in this case this red region is showing you the influence zone of roots and the purple one is outside the influence zone and this is also the outside in the influence zone. Now, let us say that you have a plant that is say coming up outside the shade, but inside the influence zone. So, let us say that a seed fell into this region and now it is trying to grow in this region. So, this see if you have a seed that is coming right under the plant and that is the first situation, the second situation and then you have a third situation, where you have this seedling that is coming up outside the influence zone of the roots.

Now in the first case, the plant is going to die; why? Because it is not getting enough amount of shade or enough amount of sunlight because it is there in the shade of the parent tree; but then in the case of the second plant, it is outside the shade region, but then if it grows, then it will also take up the nutrients that are currently being taken up by these roots. So, in this case if this plant is allowed to grow. So, this plant will be will be putting a negative influence or a competition to the mother plant. So, if there is a competition both of these plants will not be able to get sufficient amount of nutrients or sufficient amount of water.

If on the other hand, you have this third situation where you have these seedlings that are coming up at a larger distance and there is no there is very little possibility that it would so it would give a competition to the mother plant. So, here we are considering these three cases. In the first case, your seedling is already at a great disadvantage. So, your seedling dies, but then in the second and the third case your seedling is not at a disadvantage.

But in the second case your seedling can give a negative influence to the parent. In the third case it is so far away that it will not be able to give. So, here you have no competition because it is very far away. Now if you look at nature it makes a lot of sense for the mother tree to kill even this seedling because if it grows it will put up a negative influence or competition to the parent.

Now, how can you kill off the seedling when it is so far away that it is not under your shade. So, you have a situation in which your mother plant will also release some chemicals from its roots which will inhibit the growth of any of its own daughters in the surroundings. Now if this daughter plant grows up you will not only have the competition in this area, but then there will also be a lot of inbreeding because your mother plant and the daughter plant are related to each other. So, through evolution there has been a selection of these traits in which the mother plant is able to kill the daughter plant as well. Now we look at some examples.

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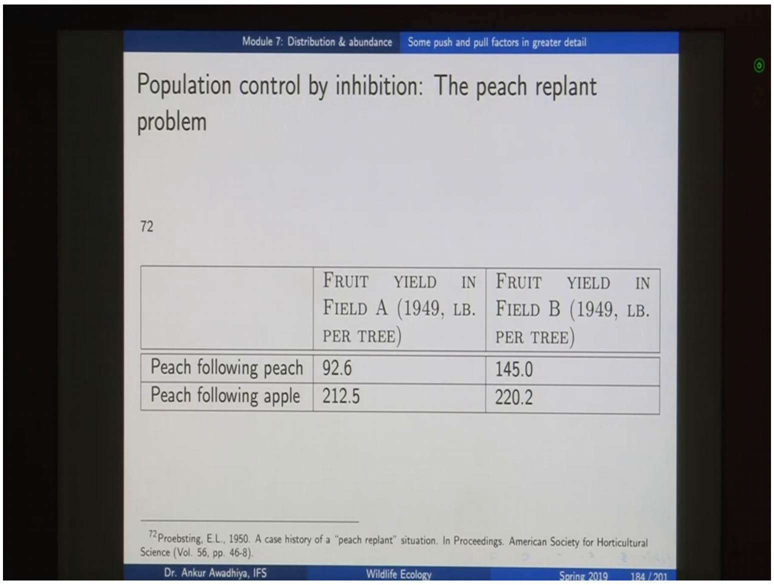

So, this is population control by inhibition which is the peach replant problem. Now, in this case people looked at the fruit yields in peaches. So, peach was grown in these areas and there were two kinds of these growths. In the first case you had a peach plant.

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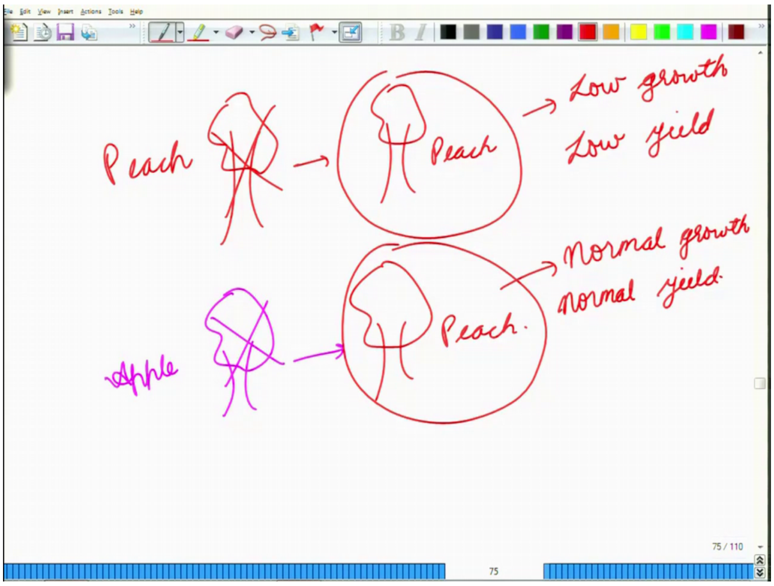

So, there was a growth of these peach plants in this area. Now these plants were uprooted and then, this area was again grown with peach. In the second case you had these apple trees that were growing in this area and these apple trees were uprooted and this area was planted with peach. Now if you have a scenario in which the mother plant is giving out some chemicals that can remain in the soil and that will inhibit the growth of the seedlings.

So, in this case if we have such a scenario, we should observe that this peach should have low growth or probably a low yield as well; whereas, this peach because it is not preceded by one of its own species. It should have a normal growth and a normal yield. So, now, let us look at the results. If you have peach following apples; so you have apple that was removed and then it the idea was planted with peach. On an average, on this first field you have 212 pounds of fruit per tree. In this second field you had 220 pounds of fruits per tree. So, there was a very large amount of yield.

But if you had this peach plant that was following a previous peach cultivation, here you see only 92 pounds per tree and here you see only 145 pounds per tree. So, essentially we can say that if you have this peach that is following the apple you have excess of 200 pounds per tree; whereas, if you have a peach that is following a peach plantation. So, you have less than 150 pounds per tree. So, this is showing a negative influence in which one species is putting a negative influence on members of its own species. So, here we are seeing allelopathy that is acting on the members of the same species.

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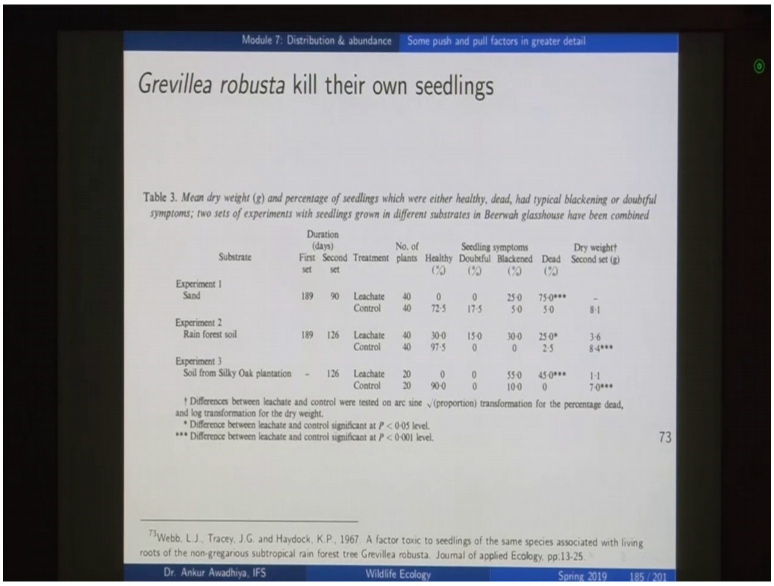

So, this is also another push factor and this has been seen in even more detail in the case of Grevillea robusta which is your silver oak. Now in this case there were 3 sets of experiments that were done. Now in the first experiment, you have the your Grevillea robusta seedlings that are grown on sand. In the second case they are grown on rainforest soil and in the third case, they are grown from another oak plantation and in each of these experiments, you have the plants the your seedlings that are treated with two things; one is a leachate and this leachate is coming from a very similar experiment to what we had seen.

So, in place of grass here you were having your Grevillea robusta trees and from those trees we were taking out the extracts from the roots.

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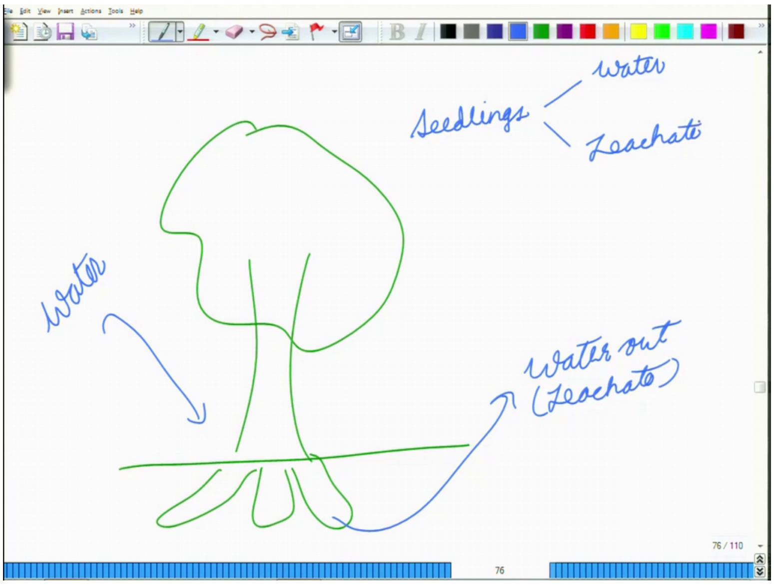

Or we were trying to get all the anything that was given out by the roots into the plant medium. So, in this case you have these roots. So, you add water into it. So, you add water to this, water percolates, it comes, it trickles down, it reaches to the roots and then you are taking this water out and you are calling it a leachate because anything that leaks out or leeches out of the roots is now there in this water. Now in every set of your plants or your seedlings; so, you have your seedlings of the same species and you can either treat it with water or you can treat it with this leachate.

Now let us look at the results; in the first case of experiments where you had these seedlings that are growing on sand; if you put your control that is your normal water. So, in this case you have 40 seeds in the 40 seedlings in the control, 40 seedlings in the leachate and then in the case of the control you see 72.5 percent of seeds of seedlings remain healthy and in the case of the leachate all of them died out.

So, you have 0 percent healthy seedlings. So, they either die out or they become very shriveled or they blacken out and so, a number of things are seen in these. If you have your soil from the silky oak plantation, here also you find that you have 90 percent healthy seedlings in the case of control and 0 percent healthy seedlings in the case of leachate. In the case of rainforest soil, you have 97 percent healthy seedlings and you only have 30 percent healthy seedlings in the case of leachate.

So, what are these experiments showing us? The first thing is that in all 3 of these experiments, the health status goes down dramatically if you are putting the leachate. So, the first thing that it is showing us is that the is that Grevillea robusta is giving out some chemicals into the water which is inhibiting the growth of its own seedlings. So, it is putting up an allelopathy impact on its own seedlings. So, that is the one thing.

The second thing is that the impacts vary with the kind of soil. So, if you are putting your rainforest soil. So, here the mortality is or the mortality is much lesser or the health status is much better. Now why would that be so? Now here, again we are looking at different push factors and different pull factors.

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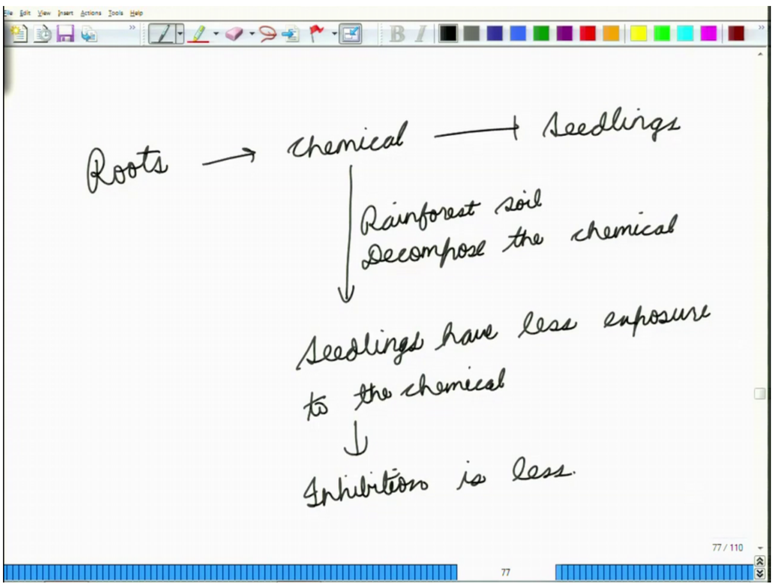

In this case your roots are giving out this chemical which is inhibiting the seedlings, but then in different kinds of soils you can have different kinds of bacteria. So, in the case of your rain forest soil, you have bacteria that decompose this chemical. So, in this case you have the when you are adding the water into this soil and there are so many bacteria. So, they are able to decompose the chemical at a very fast rate and once that happens your seedlings have less exposure to the chemical which means that the amount of inhibition is less.

So, in this case what we are seeing is that not only do we have allelopathic impacts in which one species negatively influences another species, but you also have allelopathic impacts in which one species influences negatively the members of its own species. But then these impacts can also be modulated by outside organisms. So, these impacts can be modulated by say bacteria.

If you have enough amount of these bacteria in the soil, they will eat up these chemicals they will degrade these chemicals and so, the negative influences will be listened to quite a lot of degree. So, when we are talking about any push factor or any pull factor, it is also important to note what are the other things that are present in the surroundings; so that is a learning that we can get out of this.

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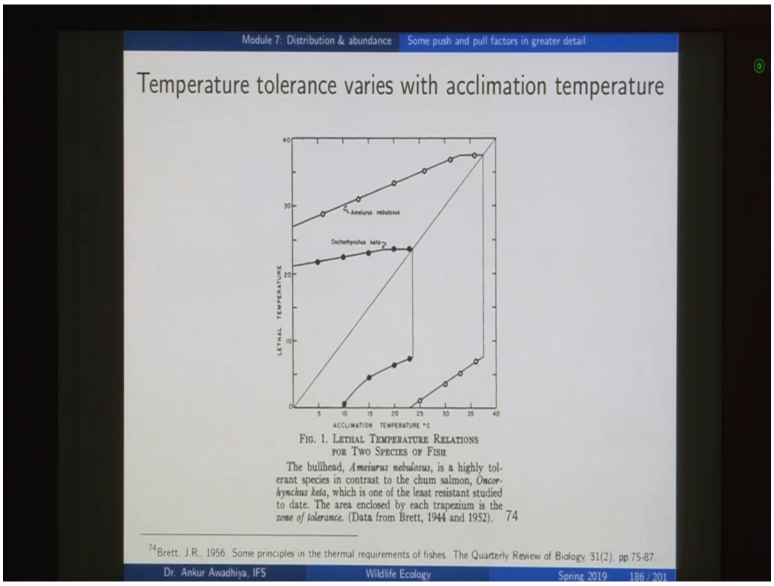

Now, similarly like in the case of your Grevillea robusta the bacteria were playing role in modulating the impacts of the negative factors. Similarly, in the case of temperature we have the acclamations that plays a modulating factor. Now what is acclimation? Now, suppose you have a species of fish and this species of fish is same.

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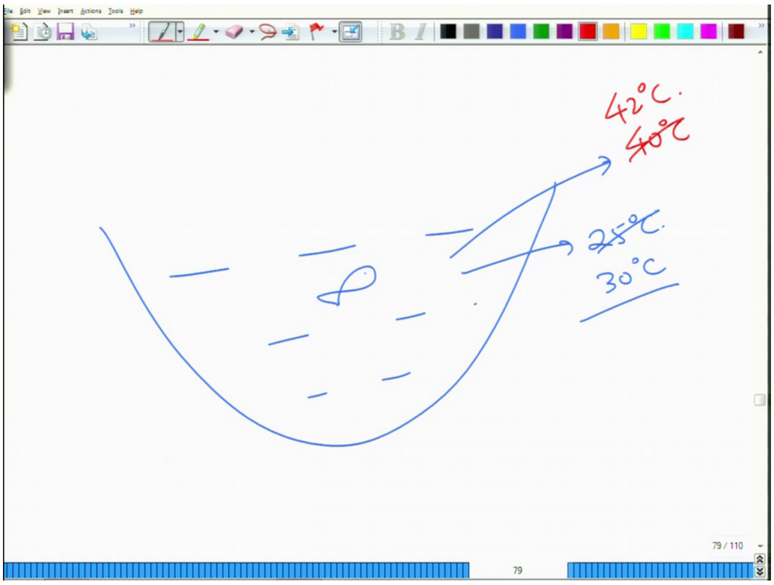

So, here you have a water body and you have a species of fish and normally this the in the water body is at a temperature of 25 degree celsius. Now if you increase the temperature of this water body and say you are seeing what is the temperature at which your fish is going to die and you increase it to say 40 degrees and your fish is die and all your fishes are dead at this particular temperature.

Now, acclimation says that suppose you increase the temperature of this water slowly. So, in place of changing it from 25 degrees to 40 degrees, you suppose take it to 30 degrees Celsius and then you let your fishes remain at 30 degree Celsius for a very long period of time. So, that they are getting acclimatized to the ambient conditions that is of a higher temperature.

Now if you try to increase the temperature of the water again and you are seeing at what temperature do these fishes die; in place of 40 degrees, it is possible that they die off at 42 degrees which tells you that when you are talking about any push and pull factors when you are talking about a tolerable range; so, the tolerable range for any species is not fixed.

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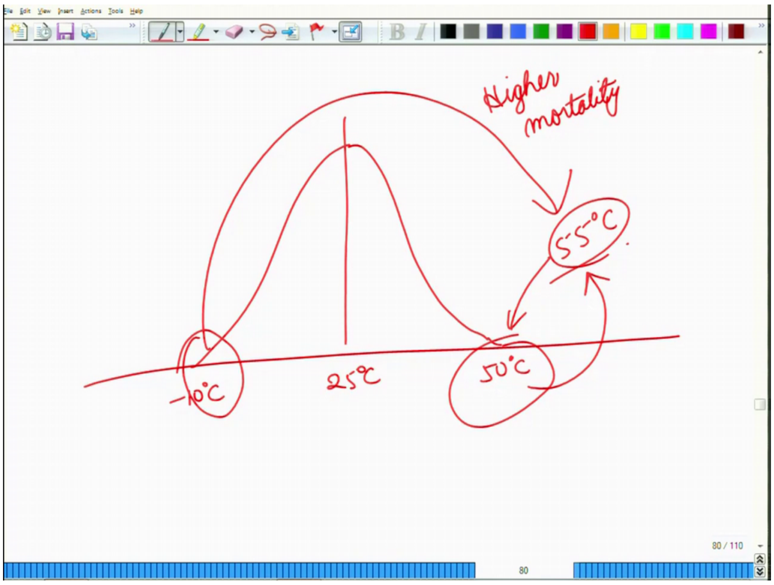

So, for instance if we say that in the case of human beings, we are very much comfortable at say 25 degree Celsius and we can live for at as hot as 50 degrees Celsius or say as low as minus 10 degrees celsius. Now in this case if you look at the mortality of human beings, if it goes to a higher temperature. So, let us say that the ambient temperature is not 50 degrees, but 55 degrees Celsius.

So, a person who is more adapted to living at minus 10 degrees celsius, if you put this person into this temperature of 55 degree celsius, there will be a higher level of mortality as compared to if you are taking a person who is already living at 50 degrees and you are placing this person at 55 degrees or a group of such people at 45 degrees; why? Because the people who are living at minus 10 degrees are acclimatized to lower temperatures. So, they cannot tolerate very high temperatures; so when we are talking about these curves when we are talking about the mortality curves that is a function of the acclimation temperature.

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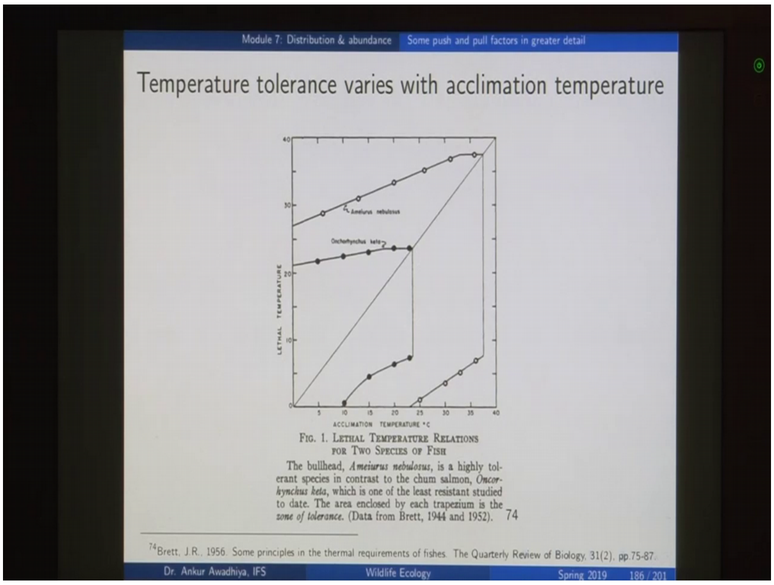

And this is what we are seeing here. So, on the y axis, we are seeing the lethal temperature. On the x axis, we are looking at the acclimation temperature. Now suppose the acclimation temperature was 10 degrees. Now, if you have a you have the individuals that are kept at 10 degrees and you lower the temperature even further.

So, you lower the temperature to 0 degrees, do any of these individuals survive? Answer is no. So, at 0 degrees when water becomes ice all of these individuals die off. But then, if you have individuals that that are acclimatized to 15 degrees and in this case, you are putting them into water that is colder. So, even before reaching 0 degrees, they will start dying off. So, they will die off at say 5 degrees. If you have a higher acclimation temperatures at 20 degrees, maybe they will die at 7 degrees. So, by plotting these different acclimation temperatures and different lethal temperatures; for each acclimation temperature, we can get this curve.

Now similarly if you have a fish that is acclimatized at 5 degree Celsius and you are putting it in warmer waters.

So, it probably dies at say 22 degrees. If it if your fish has been living at a at a higher temperature. So, let us say your fish has been living at 20 degrees. So, this fish will be able to tolerate a higher temperature. So, in place of 22 degrees, it will be able to do to tolerate say 23 degrees. So, by this way we can plot this curve. Now these sorts of curves which are telling us the lethal temperatures for different acclimation temperatures, they will be different for different species. So, for instance if you look at this species, this can tolerate a much wider range of temperatures as compared to the species.

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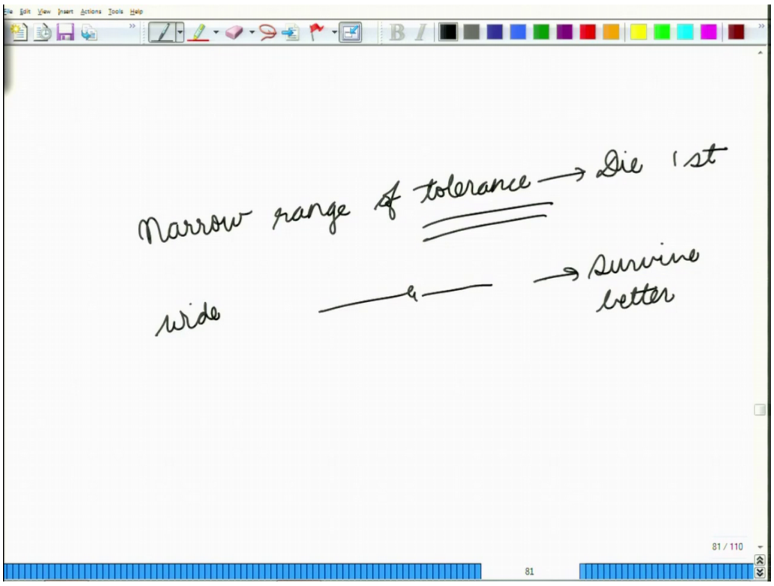

So, when we were saying that every species has a range of tolerances and a species with a narrow range of tolerance, this will die first and a species with a wide range of tolerance, this will be able to survive better. Now this thing is true, but this is also modulated by the fact that your tolerances depend on what ambient conditions you have been living in. So, in the case of this push factor; so, when we are saying that for that and that any particular species can only live till this much of heat of heat conditions or this much of cold conditions. So, even this factor will depend on or is modulated by the ambient surroundings in which this particular individual has been living.

So, whenever we are we are we are talking about these push and pull factors they are modulated by a number of things and one of those is the acclimation temperature.

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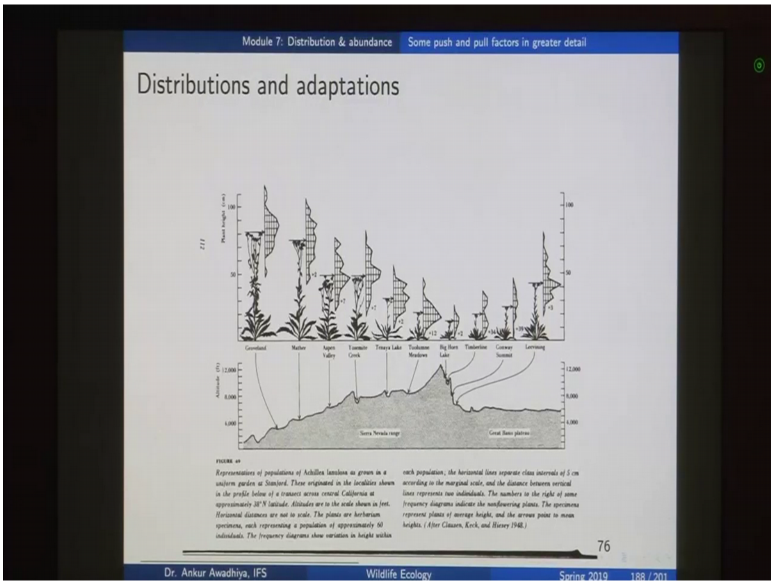

Now similarly it has been seen that if you look at any particular species and suppose this is ah. So, this is the Sierra Nevada range and we are looking at plants of just one species and if you are taking out plants from here. So, you are taking out seeds from here and you are growing it in a lab condition. Similarly, you are taking up seeds from say here and you are growing them in the lab conditions. So, all of these are the same species, but if you take out the plants which have been living at these in these areas, where there is a lesser velocity of wind that flows.

So, these plants have been acclimatized to a condition, where you do not have a very high wind speed. So, probably these plants are taller plants.

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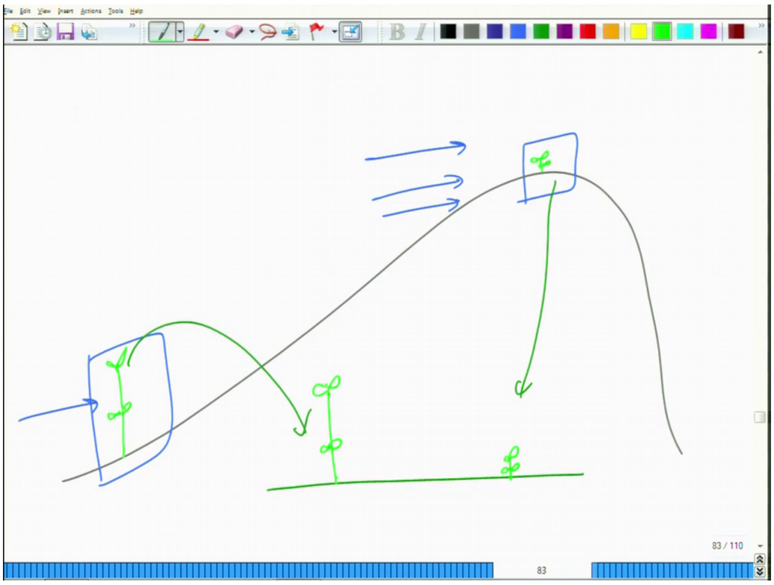

So, essentially what we are doing here is you have a hill and in this hill the plants that are growing here are probably taller plants and the plants that are growing on the stop are probably shorter plants. Why? Because the wind speed here is less and the wind speed here is very high; so if the plant is taller, so it will have to face much greater vent pressures and probably it will get broken. So, these particular individuals and mind you both of these are belonging to the same species.

So, these individuals have been acclimatized to different wind speed. Now if you take the seeds of this plant and if you grow them in the lab conditions; so you are taking seeds from here and you are taking seeds from here and it turns out that these plants will still remain short plants and these plants will still remain taller plants. Eventhough, now they are both subjected to the same sets of conditions. So, here what we are saying is that the push and pull factors that any particular individual has been subjected to or has been acclimatized to they retain some amount of continuity even when you are taking those individuals out of those areas.

So, whenever we are talking about push and pull factors you also need to keep these modulating factors in mind. So, if you are talking about allelopathy, you also have to think about is there any amount of bacterial degradation that is reducing the impacts of allelopathy. If you are talking about temperatures, you have to think about whether a particular individual has been acclimatized to a higher temperature. Because if you have individuals that have been acclimatized to higher temperatures, probably they can tolerate a bit more or individuals that are acclimatized to lower temperatures, probably they can tolerate a bit more on the lower side or individuals when you are talking about plants living in windy areas.

So, those individuals that are acclimatized to high wind conditions, probably they will be better able to tolerate a bit more amount of wind. And these modulating factors become very important when we are looking at the distribution and abundance of different organisms or different species because these are the ways in which any species can extend its range a bit more.

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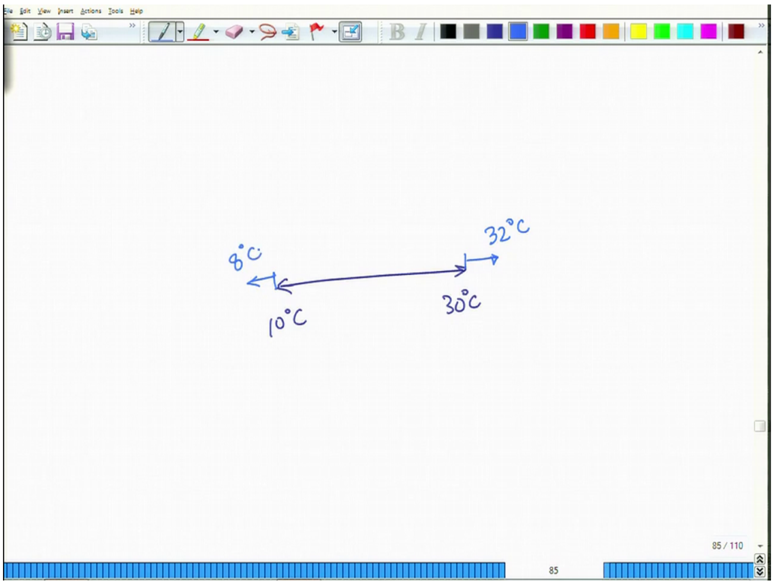

So, for instance, if you had all the fishes that were same able to tolerate this, this temperature range and this temperature ranges say you are 5 or say 10 degree Celsius to 30 degree Celsius. So, if this is the normal range the species are able to extend this range because a fish that was that has been living in at 30 degrees celsius. You can take some individuals even up to say 32 degree Celsius or those individuals that have been living at 10 degree Celsius, probably you can take them to 8 degree Celsius. So, this is one way in which the species are able to extend their ranges.

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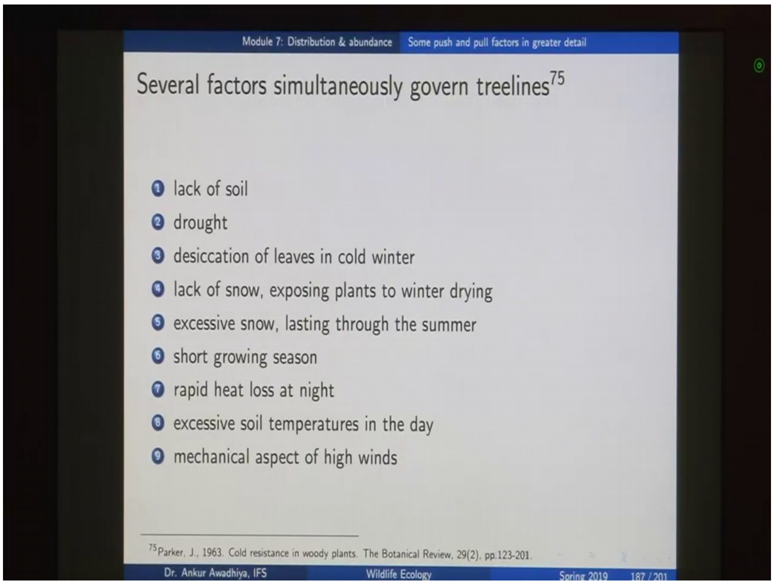

Now, similarly if we look at any particular characteristic; so, if you have in the case of mountains, you will see that you have tree lines basically what that means, is if you have this mountain you will have freeze here you have trees here.

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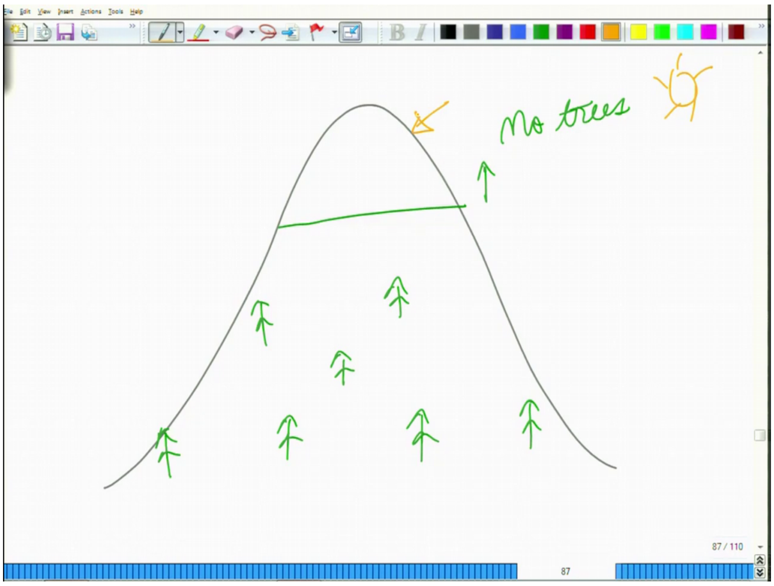

But then, there will be a particular line above which you will not find any trees; what let us say there is this line above which you have no trees. Now if you say that you do not have trees in this area, if you ask the question; why do not you have trees in this area?

There can be n number of factors; it can be because there is lack of soil it can be because there is a drought in this area.

It can be because you have desiccation of leaves in the cold winter because in the cold winter also there is a huge amount of wind that is blowing and probably the leaves are drying out or probably there is lack of snow in certain areas because of which your plants are more subject to winter drying because if there is snow on the plants. So, the impact of dry winds is not that great or there is excessive snow in certain areas which is lasting when through summer.

So, the plant is never able to get out of snow or there is a very short growing the season or there is a rapid heat loss at night or there is excessive soil temperatures in the day because there might be certain areas here. So, suppose this is the northern hemisphere and this is the southern slope. So, in this southern slope probably the temperatures go up in the night or in your day time. So, they grow up in the in the daytime and they are very less in the nighttime because of which the plants are getting killed off or because of the mechanical aspects of the of the high winds. So, you can have n number of reasons.

So, whenever we are talking about the distribution and abundance of n of any organism, we have to look at all the alternatives that are there and then we can dissect out each and every alternative by looking at different transplant experiments. So, for each of these factors, you can construct a transplant experiment with certain modifications. If you think that lack of soil is the reason, you can create a certain patch where you add soil and then you see if lack of soil is the reason. If there is if you are thinking that desiccation of leaves in the cold winter is the reason, probably you can provide some sort of moisture or maybe be some sort of emollients to these plants. So, that they are able to survive it better.

So, not only do we have to look at multiple reasons which could be which could be leading to the to the observed distribution and abundance of the organisms, but at the same time we will also have to look at different modulating factors for all of these different reasons and only when we have dissected each and every of these will we be able to tell us will we be able to tell what is the exact cause for the observed distribution and abundance of different organisms. So, this is all about the push and pull factors in more detail. So, you have to look at various alternatives and you also have to look at various modifying factors or modulating factors for each and every push and pull factor. So, that is all for today.

Thank you for your attention [FL].