Wildlife Ecology
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Lecture – 03
Ecology and Evolution

[FL] We are the products of Evolution. Life began on this earth roughly four billion years back. And whatever life forms we observed now, whether it is trees, whether it is birds, animals even us, we are all the products of evolution. Now, in this lecture, we are going to have a look whether ecology has any relation with evolution.

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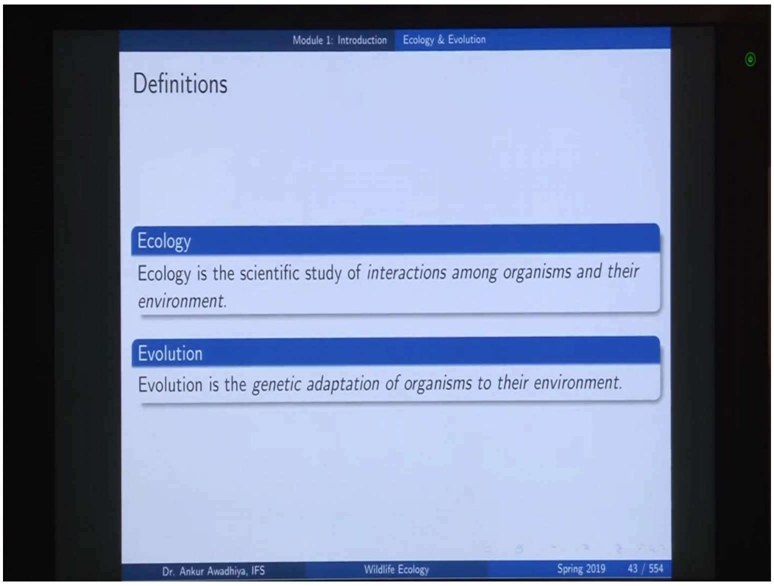

So, let us begin with some key terms. As we saw before ecology is the scientific study of interaction among organisms and their environments. And here we need to emphasize on the word interactions. So, we are studying the interactions among the organisms and their environment, where is evolution the process through which we have all been made, it is the genetic adaptation of organisms to their environment.

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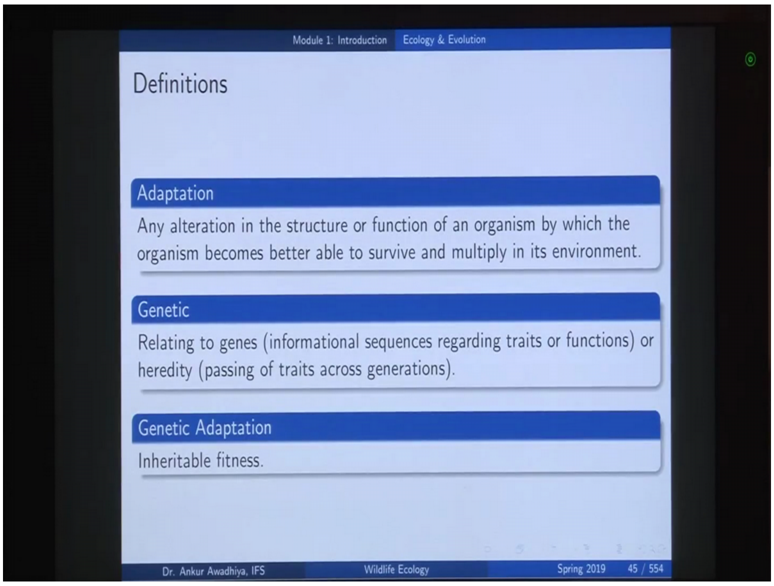

Now, in this case we need to look into these two terms genetic adaptation, what is genetic, what is adaptation, and how are these related to evolution. Now, adaptation is any alteration in the structure or function of an organism by which the organism becomes better able to survive and multiply in its environment. So, adaptation is any alteration. Alteration is changes any change in the structure of an organism or the function of an organism.

So, for instance if in place of hands, if I develop wings, so that would be a change in the structure or for instance a change in the function would be in place of using my hands for writing, if maybe I start using it for something else. So, probably for instance I develop some other sense organs on this hand, so that I can smell these objects by touching them, so that would be a change in the function of an organ.

Now, any such changes in any organism or any organ of the organism by which the organism becomes better able to survive, and multiply in its environment. So, any changes will not be adaptation. A change or an alteration is an adaptation only, when it permits the organism to better survive in that environment, better survive and to better multiply in that environment.

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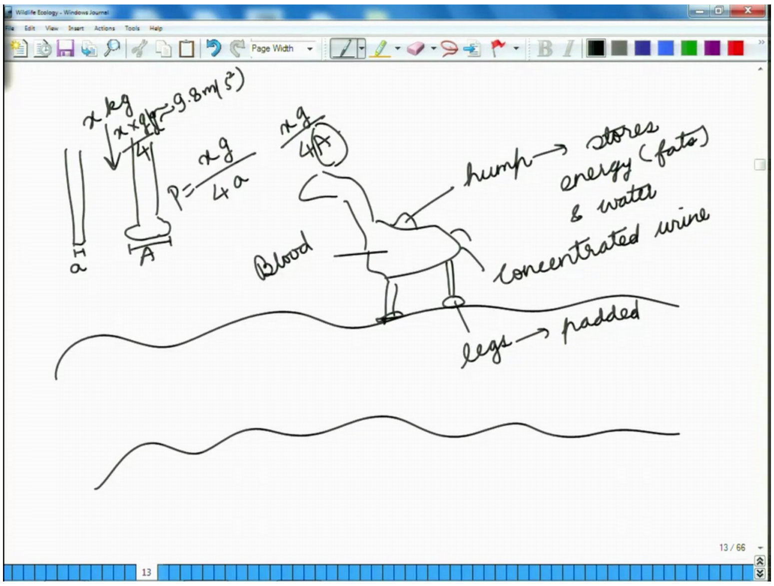

So, for instance classical examples of adaptations are now the camel lives in a desert environment. Now, in that desert environment you have mounds and mounds of sand, and there you have a camel. Now, what are the kinds of adaptations that you will find in this animal? One is that it has a hump, now why does it have a hump. The hump stores energy in the form of fats and water oh no why is that required. Because, when you are living in a desert environment, you do not have a very ready access to water and food.

So, if you have ever seen a camel drinking, it would drink buckets in buckets of water and store all of that into its body. And the urine that this animal releases out is a very concentrated unit, because it is trying to save all of that water inside its body. If it loses out that water, it would not have access to that water again.

Similarly, if you look at the blood of the animal, it has the characteristic that even if it has lost quite a lot of water, it will still be able to pump this blood into the body and be able to bring nutrients to the cells, and take out the waste materials. Similarly, if you look at the legs, so the legs are padded. Now, why are they padded? Because, if you consider a leg that is say like this, and a leg that is padded and has a larger surface area.

So, now if this area is A and this area is capital A, we are talking about these areas. And if the weight of the animal is say x kg, so the amount of downwards force that that is being put on the legs is x into g, where g is the acceleration due to gravity approximately 9.8 meter per second square.

Now, this much amount of force that is acting downwards is divided in by the four legs. So, and the pressure that would be exerted by this force that is x into g by 4 on each interface between the leg and the sand would be given by x by g by x into g by 4 a in the first case and x into g by 4 A in the second case.

Now, in this particular example if A is large, so in that case the pressure would be less. So, if you have less amount of pressure, how it helps is that if you have this sand, and if you have a pointed leg, it will go inside the sand whereas, if you have a padded leg, then because the amount of pressure is less, so the animal will be able to walk on this sand. So, this is also another adaptation that is there in the animal.

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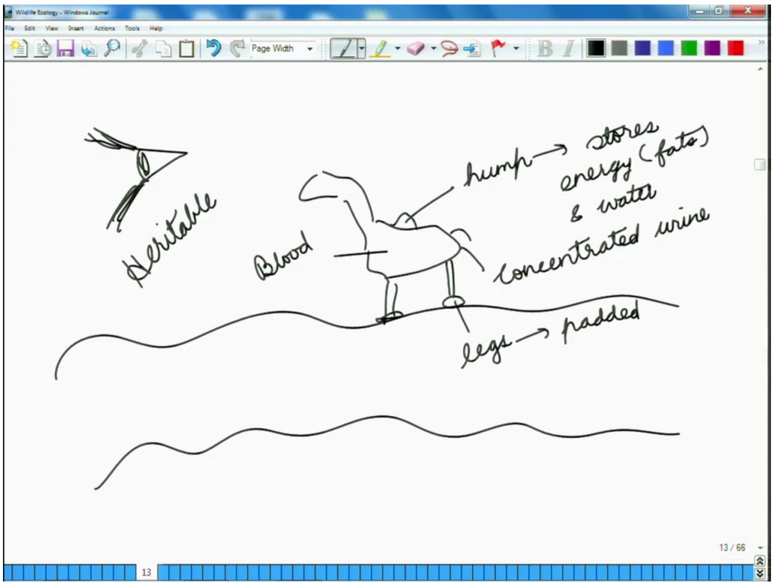

Then if you look at the eyes of the animal, you would observe that the eyes have very large eyelashes. Now, these eyelashes prevent sand from getting into the eyes of the animal. If you look at its tongue or even its mouth, it will be very well suited to eat the kinds of vegetation that are present in the desert environment. So, these are all different kinds of adaptations that this animal has and all these adaptations are permitting this animal to better survive in this environment.

Now, genetic means relating to genes or heredity. So, basically all of these adaptations, they should be of such a manner that they get passed on from one organism to its offspring, to their offspring, and so on, so which means that all of these adaptations have to be heritable adaptations. So, if you have a camel that for instance has feet that are even better adapted, then most of its companions. And if this trait is not able to be passed down to its offspring, it would not be called a genetic adaptation. So, what we want in the case of evolution is genetic adaptations or inheritable fitness that permit the anvil to better survive and better reproduce.

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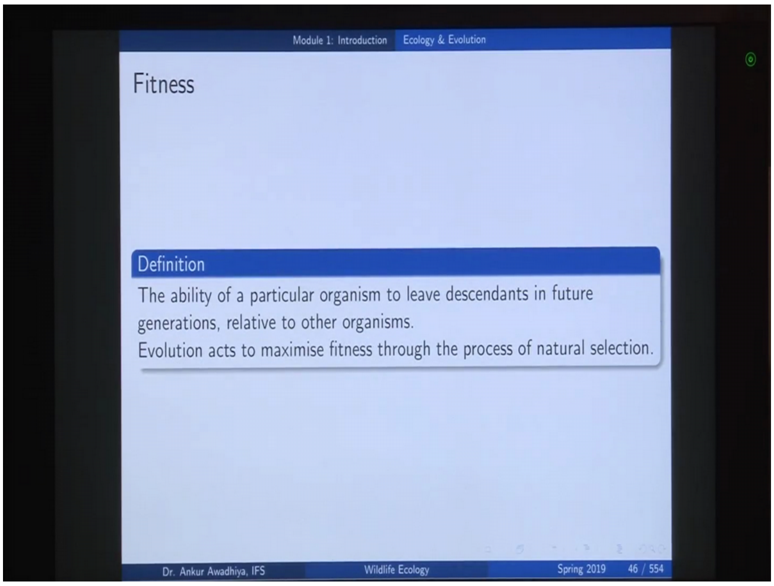

Now, we have introduced this term fitness. And fitness refers to the ability of a particular organism to leave descendants in future generations, relative to other organisms. And evolution tends to maximize fitness through the process of natural selection. So, basically fitness is the ability of an animal or an organism to leave descendants in the future generations relative to other organisms, which means that it should be able to leave more number of descendants as compared to any other organism of the same species that is there in the environment.

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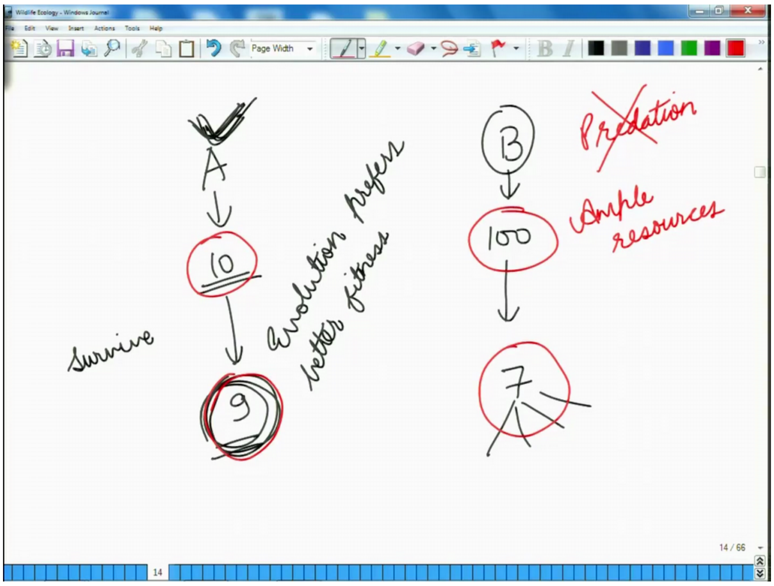

So, for instance you have two individuals, you have this individual A, and this individual B. And suppose you have individual A that has produced 10 offsprings, individual B has produced 100 offsprings. And all of these are able to survive to their maturity. So, here you have 10, and here you have 100. So, in this case we would say that organism B has a better amount of fitness as compared to organism A, because it left 100 offsprings, whereas A was only able to leave 10 offsprings.

But, suppose out of these 10 offsprings 9 were able to survive, and out of these 100 offsprings only 7 were able to survive why because organism A was able to devote all its time and attention to all of its 10 offsprings, so that 9 survived. Whereas, B just produced more number of offsprings, and it did not give it any parental care and so only 7 survived to the next generation.

So, in that case we would say that A is having more amount of fitness as compared to B, because it left more number of offsprings to the next generation. Now, why is that important, it is important because evolution tends to maximize the fitness through the process of natural selection. What we mean by this is that evolution will always prefer evolution prefers better fitness why, because if organism A has those characteristics which are inheritable, and because of which it was able to leave more number of offsprings. So, all of these 9 offsprings will also be getting those characters from A and so all of these 9 or most of these 9 organisms will be able to leave even more number of offsprings in the next generation as compared to B.

So, in the case of B out of 100 only 7 survived out of these are the in very few number would survive. So, after a while we would observed that in this system, we will be having more number of organism with A kind of characteristics as compared to B kind of characteristic. So, evolution tends to maximize the fitness that is present.

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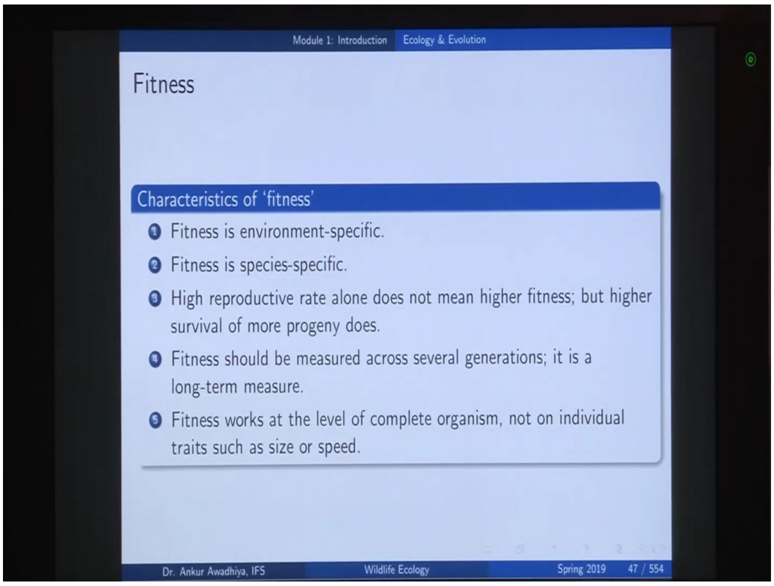

Now, what are the characteristics of this fitness. So, fitness is environment-specific, so we do not have an absolute value of fitness, it is environment-specific. So, for instance in the case of our organisms A and B in one environment it is possible, so let us consider an environment in which there is more amount of predation.

Now, in this environment if you are able to protect your offsprings, you will be able to have more number of offsprings in the next generation whereas, if you are not able to protect your offsprings, most of the offsprings would die off. But, then in an environment in which you do not have any predation and you have ample resources as compared to the population; so, in that case you do not require very much amount of parental care that needs to be given to the offsprings.

So, in that case this organism B that was able to have more number of offsprings would be said to be more fit as compared to organism A that only gave 10 individuals, because in the absence of predation, in the absence of diseases, when you have ample amount of resources available, most of the offsprings are able to survive. So, in such situations just producing more number of offsprings would give you a bit of amount of fitness. So, in this example we saw that fitness environment is specific, it depends on how harsh the environment is.

Secondly, fitness is species-specific. So, we do not compare fitness is between two different species. High reproductive rate alone does not mean higher fitness, but higher survival of more progeny does. So, as we saw before it if you have more number of offspring, it does not mean that you have more amount of fitness. What is important is how many of those offsprings are able to survive to the next generation.

Then fitness should be measured across several generations, it is a long-term measure. So, we cannot determine fitness in just one or two generations, it has to be determined over a long period of time. And it works at the level of complete organism not on individual traits such as size or speed.

So, essentially if you have two organisms, in one organism is faster than the second organism will be more fit, because we will have to look at all the characteristics that are present in that organism. So, it is possible that the organism that has speed also has more amount of blood pressure, and so it dies off quickly as compared to the second organism. So, in that case we will say that speed is alone insufficient to give fitness to the organism. So, all the characteristics of the organism need to be looked in totality.

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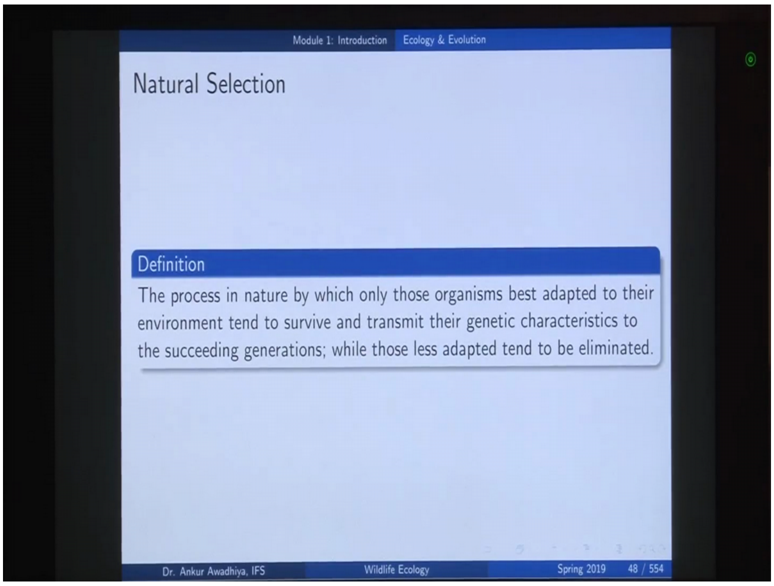

Next we said that natural selection is the mechanism through which more fit organisms are selected. So, how do we define national selection. It is the process in nature by which only those organisms that are best adapted to their environment tend to survive and transmit their genetic characteristics to the succeeding generations, while those less adapted tend to be eliminated. So, natural selection is the process through which nature is selecting those organisms that are better fitted to the environment.

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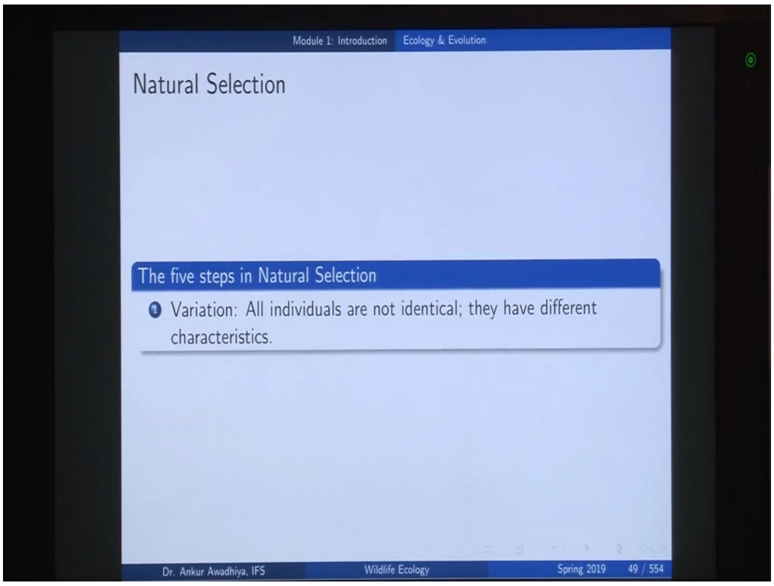

And there are five stages in natural selection. The first stage is called variation. All individuals are not identical, they have different characteristics. So, for instance if we look at a class of students; we would find that we have students of different heights or we have students of different weights or different skin color or different color of the hair or different eye color. So, these are all variations that are found in a population. Now, natural selection when it is when it wants to select those organisms that are the best fit, so in essence it also means that you need to have some variations. If all the organisms are one and the same, then you cannot select between these two organisms.

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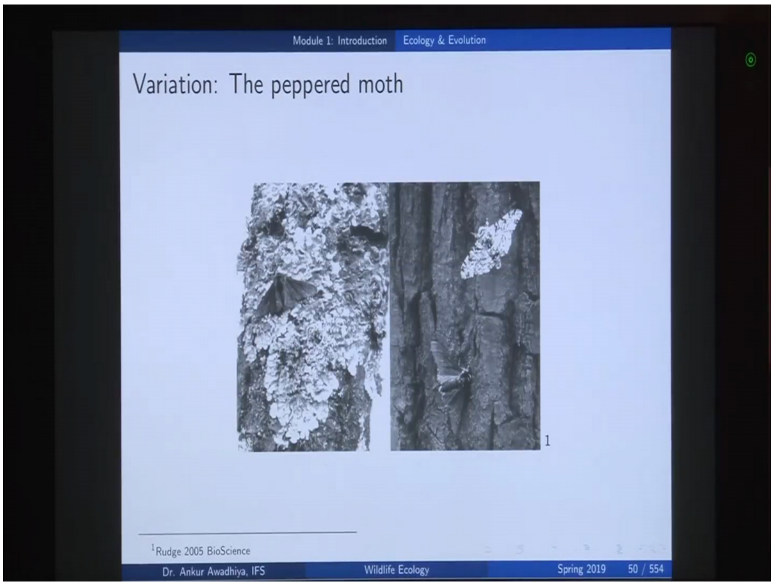

So, we have variations that are present in organisms, and a classical example is that of peppered moth. So, this is a moth, and it is present in two varieties. One is this dark colored moth, and the second is this light colored version. So, these belong to the same species, but they have different colors.

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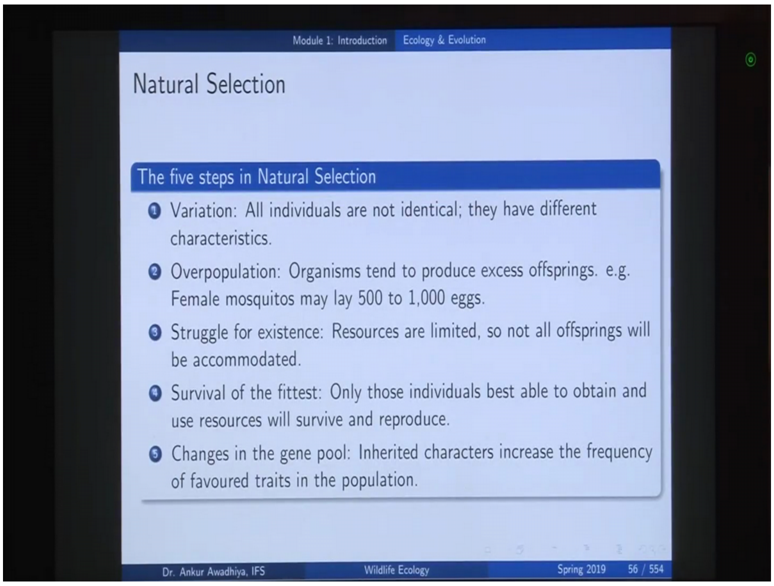

The second step of natural selection is over population. Now, over population means that organisms tend to produce excess number of offsprings. So, for example female mosquitoes may lay 500 or to 1000 eggs.

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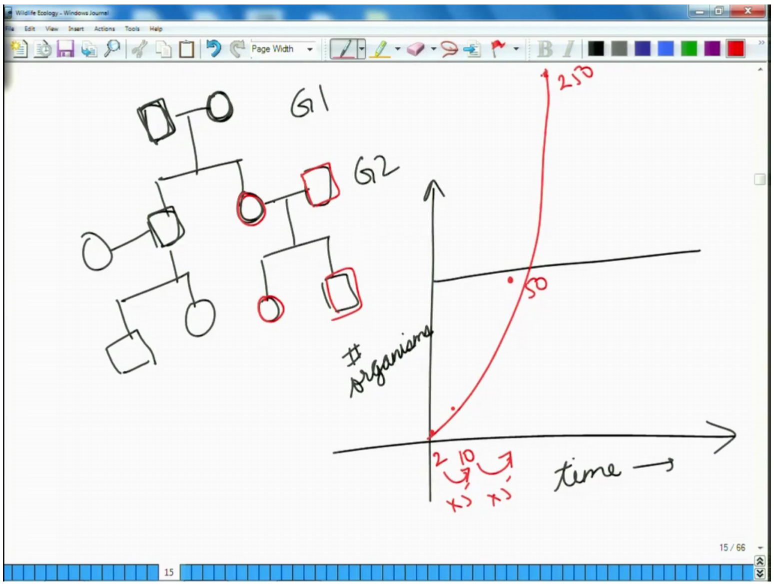

Now, if you had a situation in which every two organisms after meeting, they only produced two offsprings which upon meeting again produced only two offsprings. So, in such a situation will observe that the population is not growing the population is static, because for every two of organisms in this generation say G 1, you only have two offsprings in the second generation G 2. For these two organisms in the second generation, you only have these two offsprings.

So, in this case you will have a situation in which with time, the number of organisms will remain constant with time, they will not be any change. However, it is observed that if you provide ample amount of resources to any organism, it tends to overpopulate. So, overpopulation means that from one organism in the first or say from two organisms in the first generation. The second generation may be having say 10 organisms.

The next in place of having the first one had two organisms, this second had 10 (Refer Time: 16:35) organisms, so it was a multiplication factor of 5. If you do this multiplication factor of 5 again, then in place of ten you will be having 50 organisms, next you will be having 250 organisms. And so you will have a curve that is arising exponentially.

Now, in nature what we observe is that organisms tend to produce excess offspring, so most of the organisms into for an exponential curve. But, the problem with that exponential curve is that you do not have ample resources to accommodate all of these organisms. So, there will be a struggle for existence. The resources are limited, so not all offsprings will be accommodated. And when that is a situation, then you will have some individuals that will have to be eliminated.

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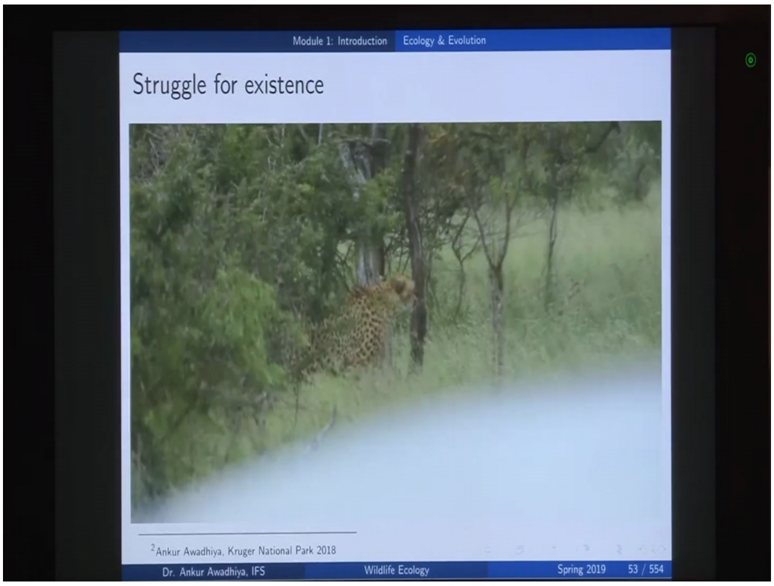

Now, we went to Kruger national park in 2018, and they will observe cheetahs that were hunting. So, now let us have a look at how this hunting happens to understand better, what is the struggle for existence, so that is the voice of our tour operator. And we are observing cheetahs that are hunting impalas. Now, impalas are deer that are found in South Africa. And as we can observe here this cheetah is moving in a stealth pattern, so it is moving very slowly, it is moving very cautiously towards the impalas which are the prey of this animal. And now it has started running and the prey or the impalas are also running, and there we see another cheetah.

So, in fact these cheetahs were hunting in groups, so we had four cheetahs in this particular group. The impalas are also there in a group, the cheetahs tried to run after the impalas. But, even after running and even after spitting quite a large amount of energy doing this strength operation and running, they were not able to catch any impala, so that tells us the struggle for existence. We have four cheetahs here, but they will not get food every day. So, out of this struggle for existence if there is out of these four cheetahs, if there is a cheetah that is not able to tolerate hunger or falls prey to our disease, because it is not getting enough amount of food. So, it will be eliminated from the nature.

So, only those that are the best fitted will survive to the next generation, which brings us to the fourth step of national selection, which is survival of the fittest. Only those individuals best are able to obtain and use resources will survive and reproduce. So, for instance even in the case of these four cheetahs after hunting a prey, if you figured out that one of these four brothers was able to do to get the largest amount of meat and there was another one that was not able to get enough amount of meat. So, in that case you will have the first cheetah that would be able to survive better (Refer Time: 20:04) second cheetah which does not get enough amount of food. So, survival of the fittest means that only those individuals that are best even to obtain, and use resources we will survive and reproduce.

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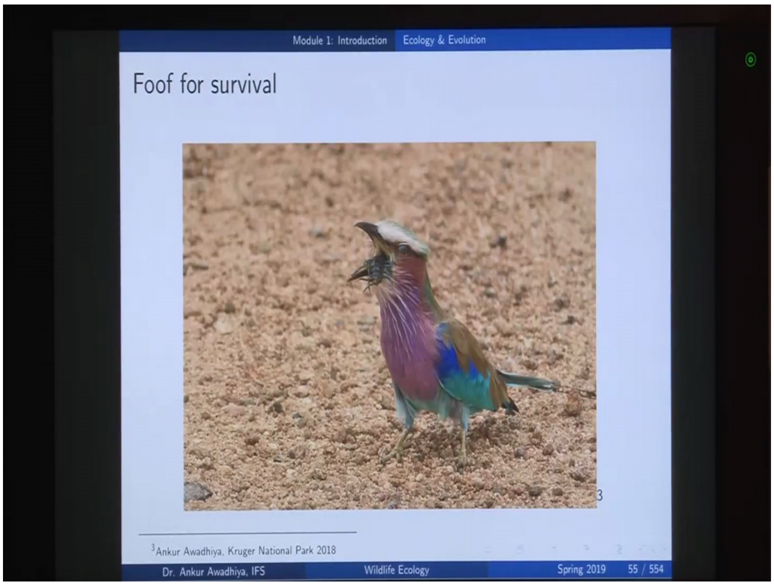

So, getting resources is crucial for the survival of an organism. And only when this organism survives, breeds and produces more number of offsprings will we say that this organism is fit, and will be selected in the process of natural selection. Now, the fifth step in natural selection is changes in the gene pool. So, inherited characters increase the frequency of favorite traits in the population, now what is changes in the gene pool. So, we come back to this example of the peppered moth. Now, we saw before that this peppered moth is present in two color variations. One is the dark color, and one is the light color.

Now, this example comes from England. And before the industrial revolution, the trees the area was very pollution free. So, trees had a lot of lichens on their surface, and these whitish color are the lichens. So, lichens provided the bark of the trees lighter shade. And on this lighter colored bark we can observe this insect, but we cannot observe this insect as easily. So, we also have a lighter colored insect, a lighter colored peppered moth that is there on this bark, but we are not able to see it very easily.

Now, many industrial revolution came. So, there was quite a lot of air pollution in that area, and pollution killed of the lichens. So, if this lichen gets removed from the bark, so the barks get exposed. And probably you will also find some amount of soot on these barks. Now, when that happens, this lighter colored version which was earlier very much camouflaged on the lichens is now clearly visible, where is this dark colored version, now it becomes camouflaged. So, in this image as well we have two peppered moths, and we are very easily able to see this peppered moth, but not this peppered moth.

Now, how is that important that is important, because in these situations when you have an unpolluted atmosphere, when you have quite a lot of lichens on the trees, these dark colored individuals are preferentially predated. So, if there is a bird that feeds on peppered moths, and if it will its this tree it would be able to observe this peppered moth, but not this one, so it will eat up this one, and this one will be saved. Whereas, in the case of a polluted environment, we would observe that this one is very clearly visible, but this one gets camouflaged, so this will be preferentially peter.

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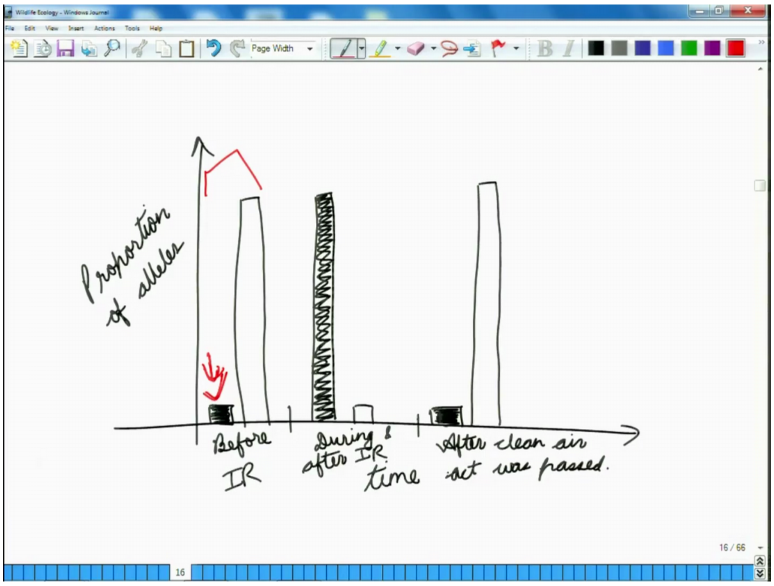

So, when it was observed that across generations with time, what was the proportion of this dark colored allele, and what was the proportion of the light colored allele in the population. This is how it went link number or let us say proportion of alleles. So, let us divide this period into stages. So, the first stages before industrial revolution. The second one is during and after industrial revolution. And the third one is after clean air act was passed.

Now, in the first period before industrial revolution, we had a situation like this one. Now, in this situation it so happened that most of the dark colored peppered moths were eaten up, and so their numbers were very less. Most of the peppered moths that you would observe would be light in color. So, before industrial revolution, you have this dark color variety which is very less, and you have the light colored variety that is very high. Now, during and after the industrial revolution, the light ones were preferentially eaten up, and the black ones more spared; so, after a few generations, it so happened that the number of dark colored moths in the pollution increased, and the light colors reduced.

Now, once we had quite a lot of air pollution and we had situations of public outcry especially after the great (Refer Time: 24:52) smog, we had the passage of a clean air acts through which the amount of pollution in the air was regulated. Once that happened and when once the air cleaned up again, the situation again reverted back to this situation. So, we had less amount of pollutant, so lichens again came up on the trees, and again we had situations in which the dark colored must be preferentially eaten.

So, in that case we again got to a situation in which the number of dark colored moths reduced in proportion, and the number of light colored moths increased in proportion. So, what we are observing here is changes in the gene pool. So, this is a very good example of how natural selection operates in principle. So, in this example we can see that there is variation in the organism, so different individuals, different colors. Now, peppered moths like most other organisms also produce a number of springs. So, there is overpopulation there is struggle for resources.

Now, if this was the only tree that was available, and if these two peppered moths were the only two peppered moths that were available, so this peppered moths would have resided here, and this peppered moth would have moved to this location in which case both of these peppered moths would have been spared from predation, and both would have been able to live equally well.

However, because there is a struggle for resources, because we: because there is a dearth of resources as compared to the number of organisms that are produced. So, there was a struggle for existence, not every peppered moth could get into a place where it would find out. So, there was a struggle for existence.

Now, in this struggle for existence, there was survival of the fittest. So, in the presence of predation in the sort of an environment, this one survived better. So, this would be said survival of this organism was preferred by natural selection. In this environment, this one was preferred. So, there was a survival of the fittest. And this also resulted in two changes in the gene pool. Now, here it is important to note that whenever there are these changes in the gene pool, in most of the situations we do not have a situation in which you have 100 percent organisms that are of one variety, and no organism that is there of the second variety.

So, coming back to the drawing board here we observe that even in the first situation, we had a very few number of individuals that were dark in color, but they still remained there in the system. Variation is very crucial for the system to survive, because if it so happened that this number went to 0, so they would not have been any more variation that was remaining in the system.

And once the system changed, once it moved to a polluted scenario, if we in this situation if you only had the light colored moths so; in this situation all of those light colored moths would have been eaten up and so no peppered moths would have existed today. Whereas, nature always prefers to have these variations, and so even in these situations we observe that we will have some number of individuals that still persist in the system even though they are not the best suited.

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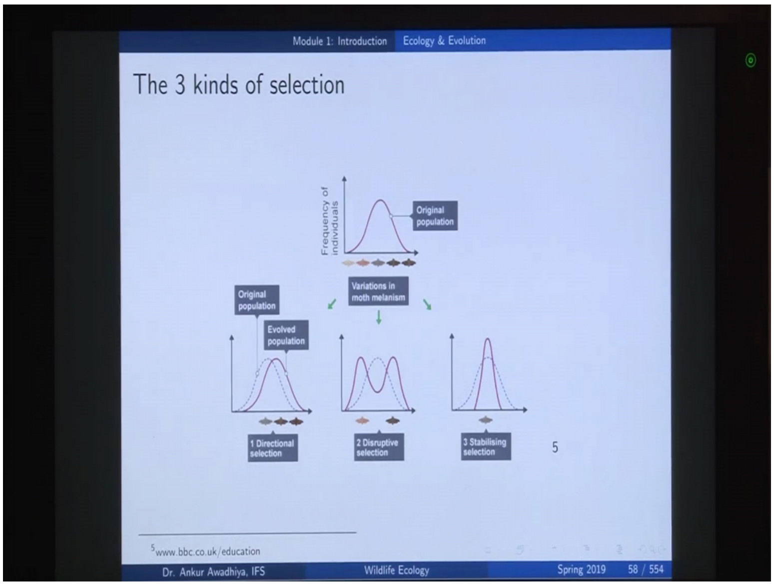

Now, how does this selection occur, we have three different kinds of selections which are called as directional selections, stabilizing selection, and disruptive selection. Now, in this example what we are observing is that here we have the frequency of individuals, and here we have different colors that are present in the population. So, here we have an organism that is very light in color, here we have an organism that is very dark in color, and these are variations in between. Now, suppose the original population was something like this, so it the most preferred or the most fit organism was there in the center.

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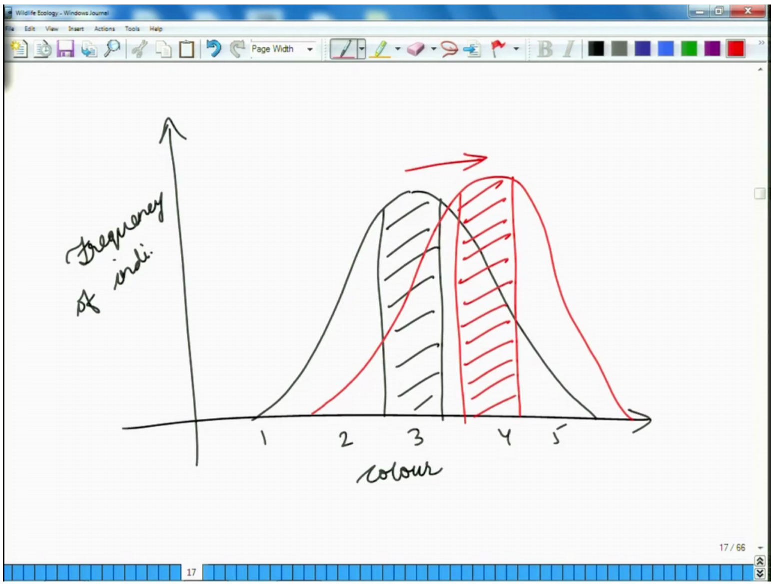

Now, in the case of a directional selection, this curve would shift either to the right or to the left, so what we are saying here is that here we have the frequencies of individuals, and here we have the color, let us call these shades as 1, 2, 3, 4 and 5. And the earlier population was something like this. So, in this case, we had most of the organisms that had this color of three, so this is the most preferred one.

Now, if the situation changes, and if this curve shifts to the right, so it becomes something like this. So, in this case, we will have that this the organisms of shade for are more selected, so this is a directional shift. So, essentially the peak of the curve shifts from this to this or it can move to the other side as well. So, this is a directional selection.

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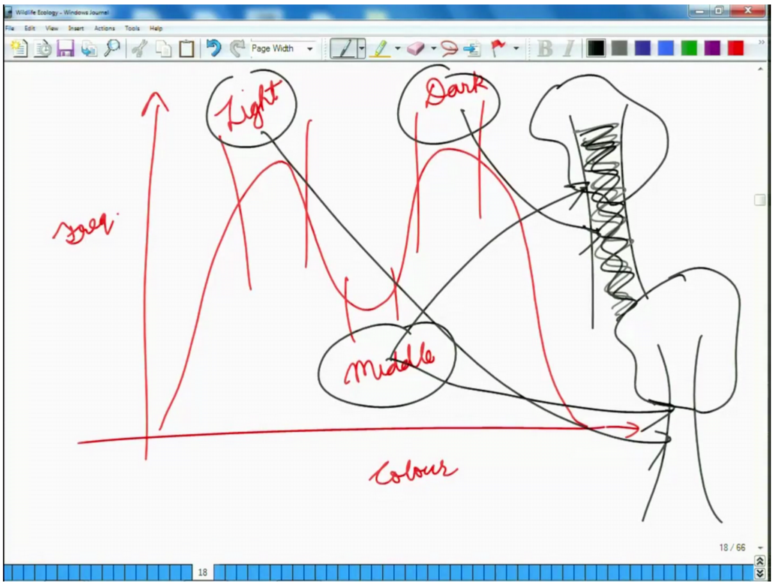

The second selection is called a disruptive selection. Now, in the case of a disruptive selection, we have a situation in which these organisms are selected the middle ones are not selected, and then the larger ones are selected. So, in this situation we have that the light ones are preferred, and the dark ones are preferred, but the middle ones are not preferred, now when do we have a situation like this.

So, suppose you have a forest in which you have some trees that are dark in color, and then you also have some trees that are light in color. Now, in such a forest if the light colored individual goes and sits on the light colored bark, and the dark colored individual goes and sits on the light colored bark, both of these are spayed from predation. But, the middle color whether it goes to the dark tree or whether it goes to the light tree, it is not that much camouflaged, so it becomes apparent and it gets predated upon. So, such a selection in which nature prefers the two extremes, but not things in the middle goes by the name of or disruptive selection.

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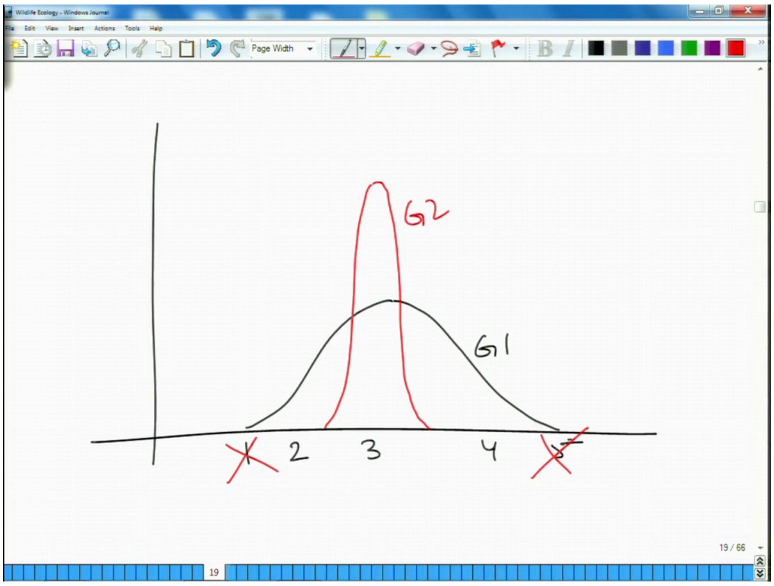

And third is a stabilizing selection. So, in the case of a stabilizing selection, we have a situation in which earlier the curve was like this earlier curve was like this, in the later generation this curve becomes even more narrow down. So, for instance earlier we had these shades 1, 2, 3, 4 and 5 in generation-1. But, in the second generation, the shades 1 and 5 get completely removed and now this whole curve has become even more towards the center; so, in this case we have lost two traits, and we have even shifted the system towards a center point. So, this would be called a stabilizing solution.

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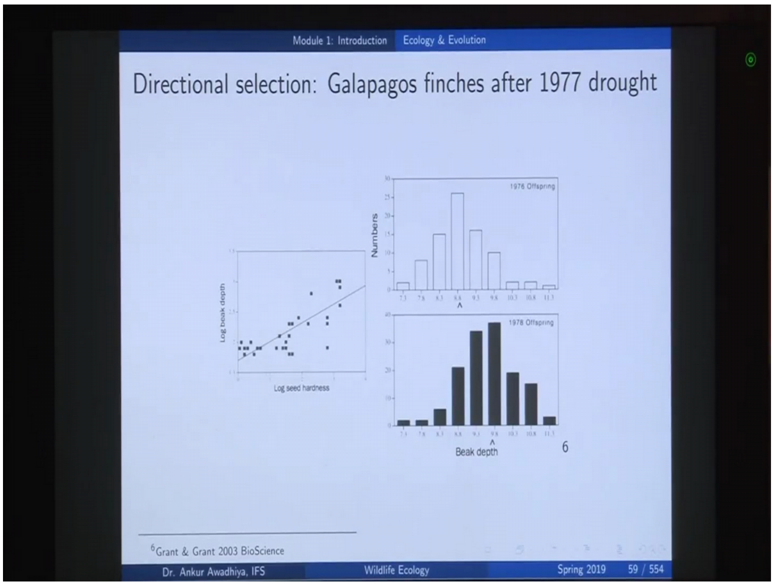

And we observe examples of all three of these in the nature. So, for instance this is a study of directional selection. So, there is a set of islands that go by the name of Kenapa goes islands, and here we have birds that have all finches. Now, these birds have beaks, and their beak size was studied. Now, there was a draught in 1977, and before the draught we had this sort of a curve. So, what we observe here is that this big depth of 8.8 is the most preferred one. Now, after the dot what happened was that during this period most of the nuts that were there became even more harder to break open. So, here we have this chart of seed hardness versus the big depth.

Now, if you have a seed that is harder to break open, so you require a larger sized beak to break open that seed. Now, in this draught what we observed was that before the draught, we had this pattern in which the beak size of 8.8 was more preferred. After the draught it shifted from 8.8 to 9.8. So, there was a directional shift towards larger sized beaks because of the draught. So, this is an example of directional selection.

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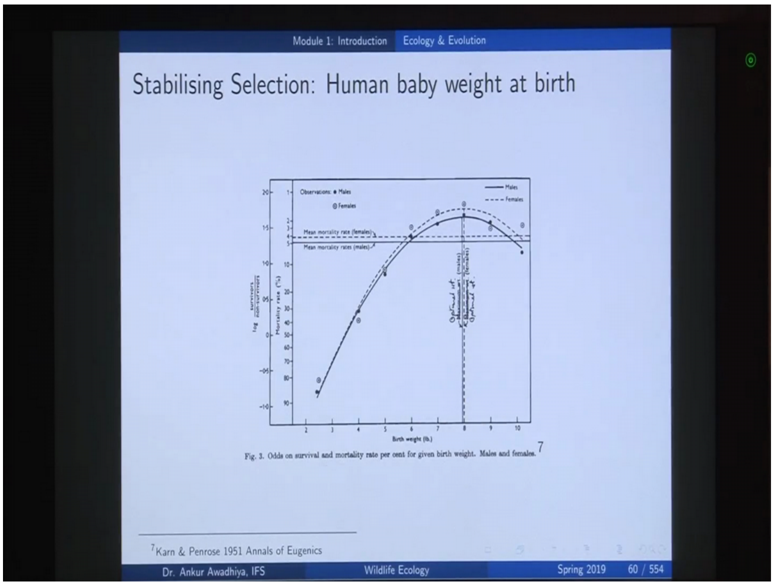

An example of stabilizing selection is the weight of human baby at birth. So, here well observe that if the weight is around 8 pounds, so we have minimum amount of mortality that is there in the in the system, and highest amount of survival rate. If it shifts to the right or to the left, so in those situations these babies die off more easily.

Now, this is obviously a very old paper and our advances in medicine have enabled other babies to survive today. But, then if you look at this graph, if you only concentrate on this graph will observe that babies of eight pound are selected, so this is the most optimum weight. This is an example of a stabilizing selection. So, if you shift to the right or to the left, you have a lesser probability of survival.

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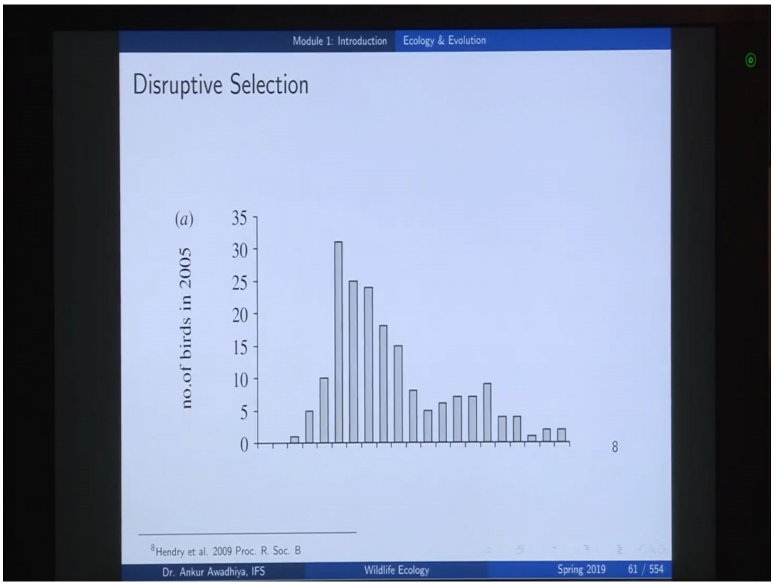

Now, this is an example of a disruptive selection. So, this is again an example from Galapagos Islands in which we had a bird population in which these beak sizes were more preferred, and then this beak size was more preferred, but the center ones were less preferred. Now, why can nobody have a situation like that, we can have a situation like this if to have an environment in which you have say these nuts that are hard to crack, and these nuts that are easy to crack, but you do not have any nuts that come in between.

So, if you have a that comes here, it would not be able to crack a larger sized or a more harder nut. But, if it tries to crack open these softer nuts, so it will face a lot of competition from their already existing birds, which have smaller big sizes are and are probably more adapt or a more amenable to crack open those softer nuts. So, in such a situation, we will have a disruptive selection, so we will observe two moves in the curve.

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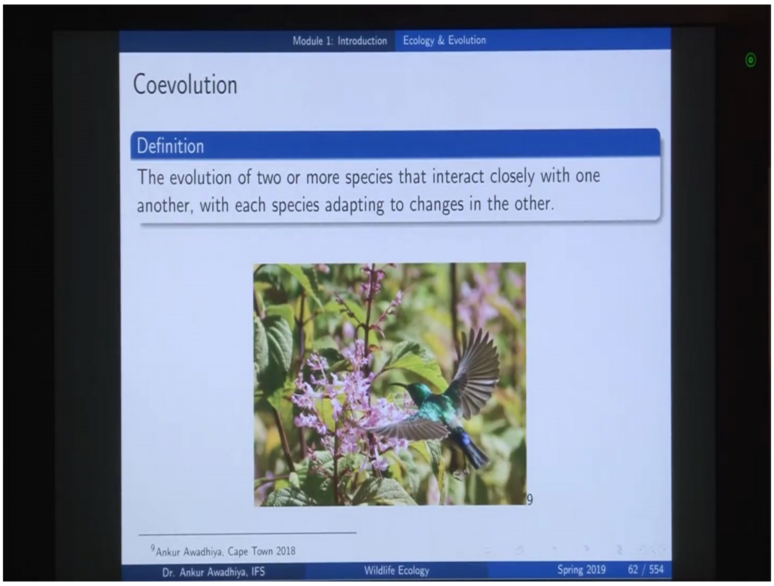

So, next we have a look at coevolution, which is a situation in which there are two species that are evolving at the same time. So, this is the evolution of two or more species that interact closely with one another with each species adapting to changes in the other. And a good example is be hummingbird that is feeding on these flowers.

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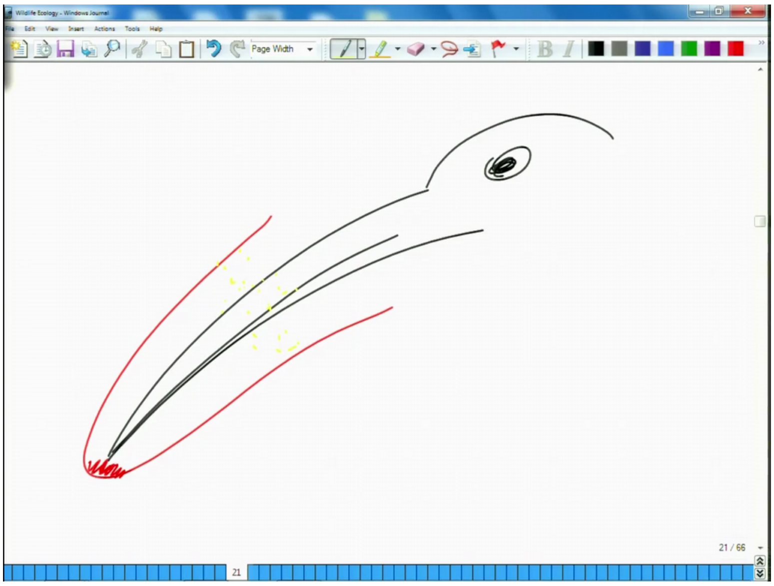

Now, in these flowers, they have an elongated shape much like a funnel, and there is nectar on the inside. And the flower produces nectar to attract these birds, so that if this is a flower, and here we have the nectar. This bird reaches, and tries to feed on the nectar, and in that process it gets the pollens from the flower onto its beak. And it when it goes to another flower of the same species, it is able to transport these pollens from one flower to another flower.

Now, if this bird randomly fed on different flowers, so it went to say this flower that belonged to species one, and then it went to another flood that belonged to species two. So, in that case the pollen grains of a species one would be transmitted to species two which would not make any sense, because these pollens will not be able to result in fruits in the case of the second flower.

So, nature wants to have a situation in which the birds and the flowers are specific. So, essentially if you have a bird species that is that has this beak, it should only go and feed on flower of is species one. And the birds that go and feed on flowers of species two should be different. So, species one birds should not be able to get to species two flowers, and species two birds should not be able to get to species one flowers.

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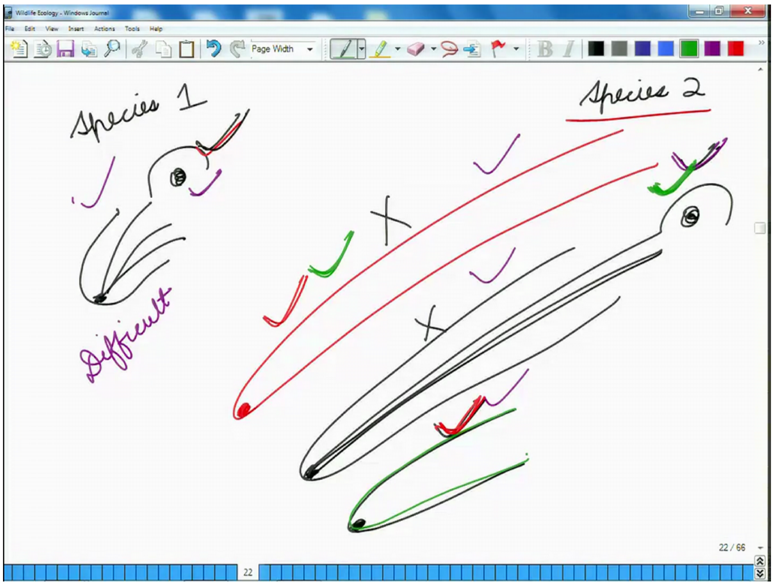

So, essentially we have this situation in which you have say this is your species-1, and this is your species-2. Now, in the case of species-1, you have a flower that has the shape, and in the case of species-2 you have a flower that is more elongated. Now, in this case a shorter beak would do in this case you will require a very long beak, long and slender beak to get to the nectar.

Now, consider two individuals of a species-2, so one is this individual. And then there is another individual that has an even more elongated flower. So, this is another individual of the same species species-2. Now, if we consider a bird such as this bird, and let us consider one more variety which is this one.

Now, in such a situation if we consider this bird, it will not be able to feed on this flower, it will not be able to feed on this flower, but it might probably feed on this flower. Whereas, this bird would be able to feed on, so let us consider this bird, it will be able to feed here, here, here, and here as well. But, in this case it will find it more difficult, because it is facing competition from this second bird which has a shorter beak.

Now, in such a scenario, we will observe that if this is species-2 has these different individuals. This individual with the longest tube or the longest funnel will be much more specific as compared to this individual that has a shorter funnel. So, if you want more specificity more specific a more specificity would mean that you have more probability of reproduction, because more probability of pollens from the same species reaching into the flower of the same species. So, you want to have more amount of specificity.

Now, more specificity is being provided by a longer funnel and not by a shorter funnel. So, after a while because natural selection is selecting those organisms that are best suited or that are the most fit, and in this case we are we can intuitively guess that a longer funnel will result in more amount of a specificity and so more amount of fitness. So, a longer funnel will be preferred, and when that happens. This bird will also have to evolve, because in the next generation if you have even longer funnels, so you also require an even longer beak to get to that nectar in that particular flower. So, this bird will also have to evolve at the same time. So, the evolution of one species is driving the evolution of the second species.

And now if this bird evolves, what will happen is that these individuals of the same species that were having a smaller size or a shorter funnel, they will be they will become even less fit, because now this bird will choose to get into a larger flower a longer flower as compared to a smaller flower. And this smaller flower will we will maybe start getting birds of some other species. So, in this situation, the longer beak of the bird will also result in more amount of evolution in the flowers. So, this is an example of co evolution.

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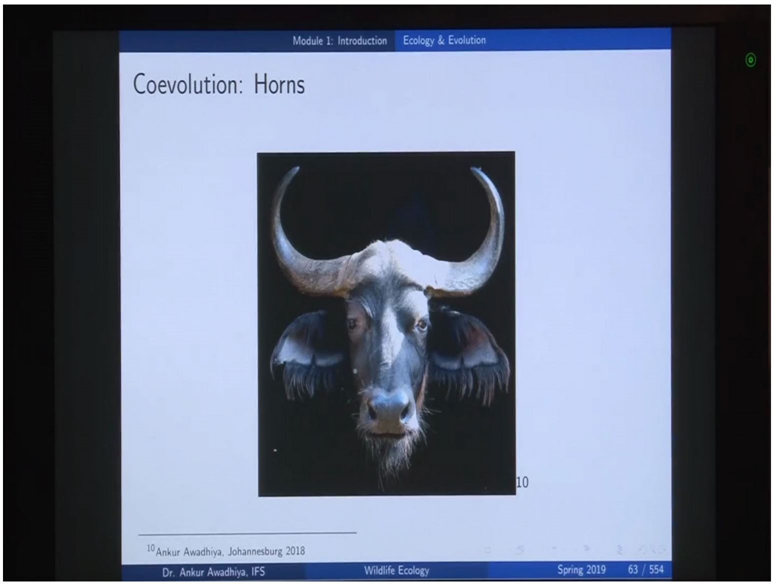

Another example of co-evolution is the evolution of horns. Now, in a number of herbivores, we observe these horns. So, this is an example of a cape buffalo. And the horns serve as a deterrent from the predators. So, if there is a lion, and if this line observes to cape buffalos, there is one cape buffalo with a long horn, and there is another cape buffalo which does not have a horn say it is a calf.

So, approaching a calf is much more easier as compared to approaching an adult with long horns because, if this elk tries to fight back with its horns, it might even be able to kill the lion. Now, if you have a situation in which you have horns, so in that situation the predator will also have to evolve some strategy to be able to counter a counter vent these horns. So, probably the predator will start approaching the adults from the behind. So, evolution of horns, which was a risk a response to the pressure of the predators would also result in evolution of some other behaviors that are there in the predator.

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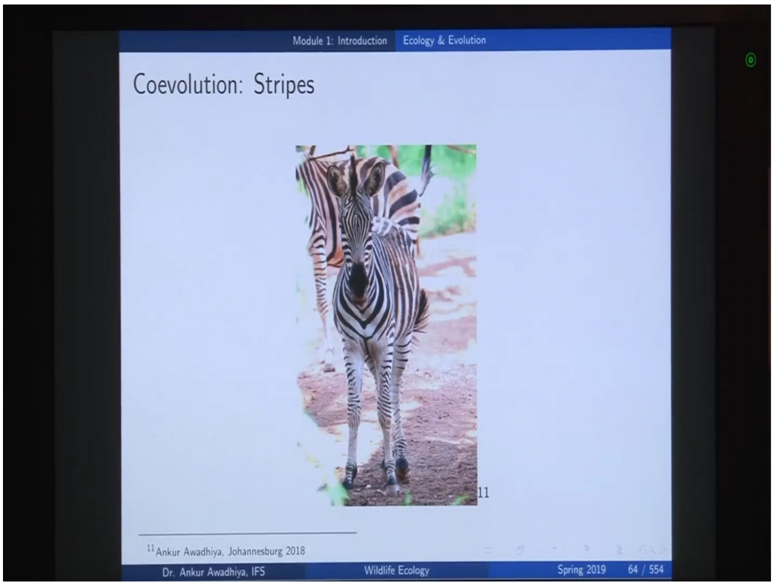

Another example is evolution of the stripes of zebras.

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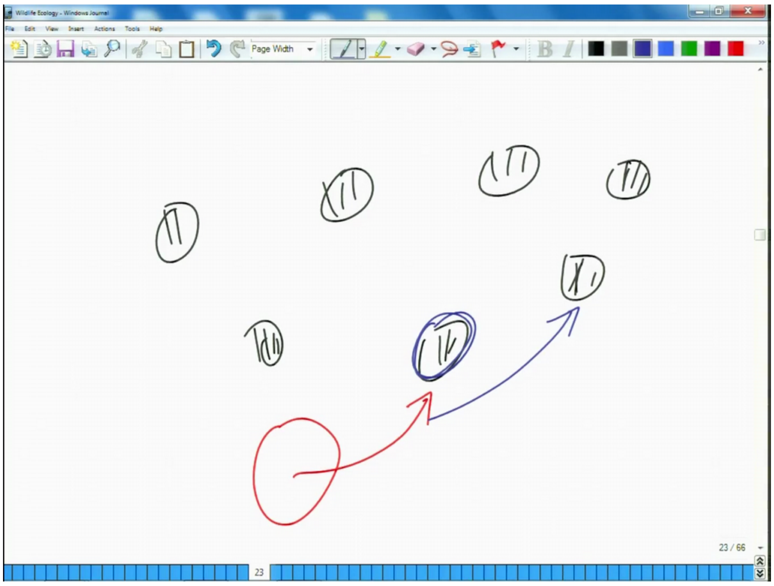

Now, why do zebras have stripes, now zebras have stripes so that if there is a group of animals, and all of these animals are having stripes. And then there is a lion, there is a predator that is chasing say this particular zebra. If this zebra moves into the group, then the lion gets confused which zebra was the one that I was chasing.

Now, if you have only one zebra which the line is chasing, so the line will be very easily able to capture this zebra, because after a while our zebra will also become tired. But, if it gets into this group and probably in place in the confusion the line in place of chain in this zebra, now shifts its attention to another zebra. So, in this case this zebra will be able to get its breath back, and will be able to survive. So, this is one mechanism that is zebras in evolved to are to be able to circumvent the predators.

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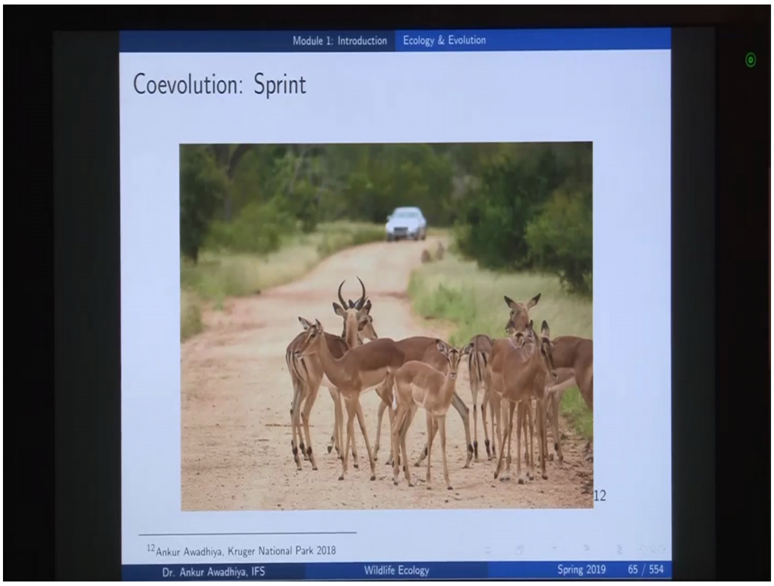

So, here again we see an example of coevolution, because we had predators, so we had this evolution of the stripes or for instance why do impalas run fast well impalas are run fast, because they have to counteract the cheetahs. So, here we have the impalas, here we have the cheetahs. And if these impalas are not able to run fast, then these cheetahs will be able to predate on these impalas. But, then why do cheetahs run fast cheetahs are run fast, because they have to predate upon the impalas which run fast.

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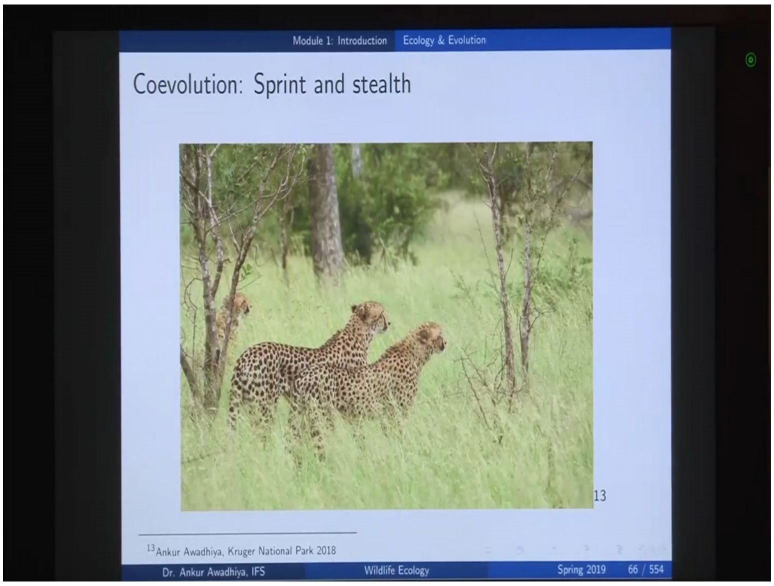

So, essentially these two species, because they are interacting so closely with each other, they are evolving at the same time. So, these are examples of coevolution. So, what we are observing here is that if you have two or more species that interact closely with each other, so in those situations the evolution of one species, leads to the evolution of the other species. And the evolution of any species becomes dependent on all the evolutions that are happening in all the other species, so they all become linked together.

Now, why are these organisms interacting with each other, and interacting so closely with each other, and that is because of ecology. In the case of ecology, we saw that we have situations of population ecology, a population ecology would say that in this group, what are the interactions between these different animals. If this animal is slow and others are fast, then this would be eaten up and its genes would be removed from the system. So, interactions within the population are important. Similarly, interactions between the species are important. So, here we are talking about community ecology, so we have cheetah, then we have the impalas what are their interactions.

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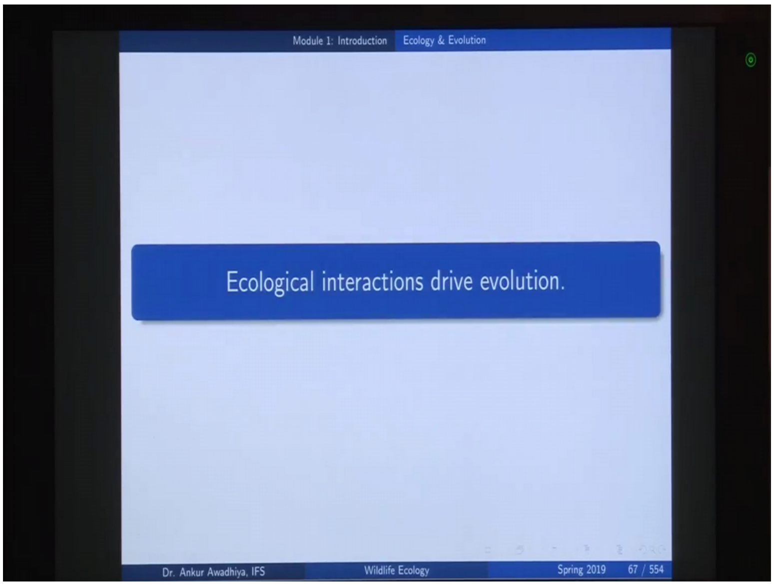

So, ecology becomes very important for evolution, because the ecological interactions drive the evolution of different species, and which is the one of the importance of learning the subject of ecology that we can understand evolution. How it happens, why it happens if we are able to understand, the interactions that are happening within a species between the species, and between the environment, and the species the environments are changing.

So, in this lecture we saw how ecological interactions are driving evolution, we began with evolution what is evolution how it happens, what is what are adaptations, what I our genetic adaptations, and what are the steps of evolution, how does natural selection act what are variations, why do we have overpopulation, why do we have a struggle for resources, how does survival of the fittest happen, and how does that lead to evolution.

And then we moved on to the process of coevolution, where different species are interacting with each other, and driving each other's evolution. Not only the species interact with themselves, but they also interact with the environment. So, any changes in the environment also drive evolution. So, all of these in total can be said that ecological interactions are driving evolution, which is a very important reason to understand wildlife ecology, so that is all for today.

Thank you for your attention, [FL].