Wildlife Conservation
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Lecture - 26
Population genetics

[FL] In this lecture we will have a look at population genetics.

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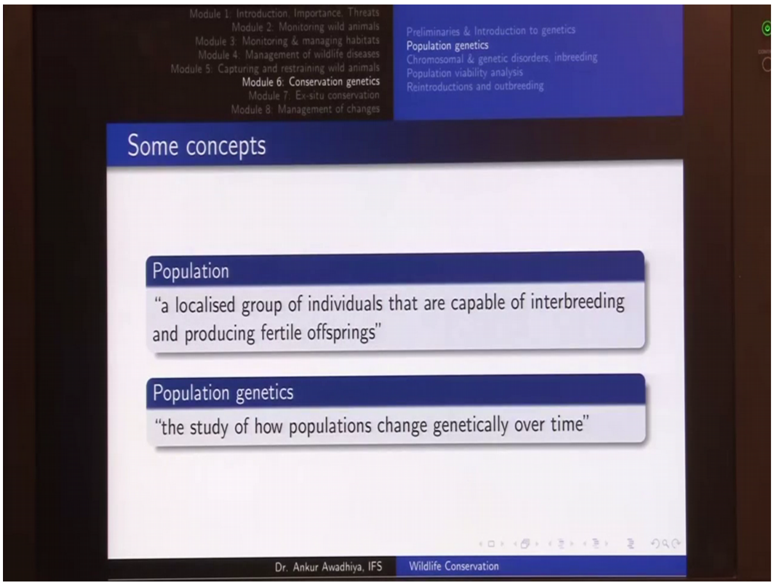

Now what is a population? A population is a localised group of individuals that are capable of interbreeding and producing fertile off springs.

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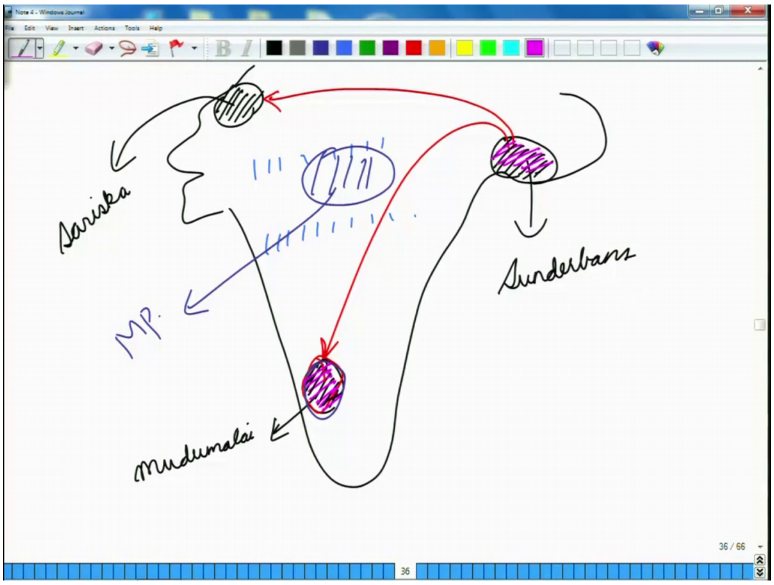

So, for instance if we consider the subcontinent of India. Now we have a tiger population that is found here in the Sundarbans. And we have a tiger population that is found here and Rajasthan say the tigers that are there in Sariska.

And then we also have a population of tigers that is found here in the south say the tigers of Mudumalai. Now what happens is that all of these different populations of tigers they are comprised of individuals of the same species Panthera tigris, but what we observe here is that the tigers of Sundarbans will be breeding amongst themselves. The tigers of Sariska will be breeding amongst themselves and the tigers of Mudumalai will be breeding amongst themselves. There is a very little chance that tigers from Sundarbans go to Mudumalai or tigers from Sundarbans go to Sariska.

So, in this case we say that these different populations of tigers, these different localised groups of individuals of the tiger species that are capable of interbreeding and in producing fertile offspring.

So, these different localised groups are interbreeding and they are producing fertile offsprings. And they can even interbreed amongst each other, but they are not doing so, probably because of geographical distances or probably because of some hindrance that is there. So, it is not just the distances, but also see in this area we have some mountains. So it becomes difficult for these tigers to go out into the other population. So, we call these as population.

So, population is a localised group of individuals of the same species. So, remember here we are not considering individuals of different species, but individuals of the same species that are capable of interbreeding and producing fertile offsprings. Now population genetics is the study of how populations change genetically overtime.

So, what do you mean by this. So, let us consider, let us put one more population here let us put the Madhya Pradesh population here. Now what happens is that even though all of these individuals are of the same species Panthera tigris, but over time we see some differences between these tigers. So, for instance the tigers in Sundarbans they have adapted to a life in water or with that is surrounded by water.

So, the areas of Sundarbans are extremely marshy areas. And these tigers may have to swim a lot. So, we have observed overtime that their bone density has reduced they have become much leaner and they also become much less light weight.

So, that they are easily able to swim longer distances, but if we considered the tigers of Madhya Pradesh where they are not exposed to situation say they have to swim a lot. So, they have grown very big in size. And then tigers of Sariska; so, they are it is a very hot and dry area. So, they will be having being very different adaptations as compared to tigers in Mudumalai. They will even be having very different food preferences.

So, population genetics ask this question when considering all of these different populations how were these populations changing overtime? And not just overtime how were these changing at the genetic level. So, essentially if we take the genome of the tigers that they found in Sundarbans and if we take the genome of the tigers that are found in Mudumalai are we expected to find any changes are there any difference between both of these. And if so, what is brought about these changes or these differences overtime. So, all of these questions are asked in the field of population genetics.

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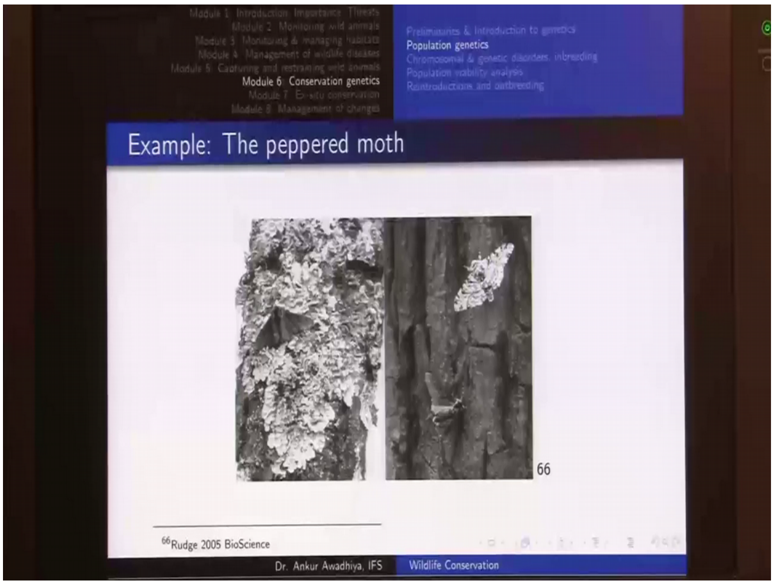

Now a good example can be this. This is the example of peppered moth. Now before moving on let us see if you can make out the peppered moths in both of these images.

So, in this image we can very clearly see that this is a peppered moth. And in this image this is a peppered moth. But then if you look closely will find that this is also peppered moth. This is a triangular shape that is coming out here in this is the body of the animal.

And in this one we have a peppered moth that is here in this triangle. So, this is the body of the animal and this is the peppered moth. Now why is it that we are seeing only one individual in both of these images. And why is this story important as an example case for population genetics. Now peppered moth is a moth. So, a moth is an insect that looks very much like a butterfly, but it has a very stout abdomen and quite a lot of hairs on its body.

So, this is an insect that was extensively studied in the Great Britain. Now what happened was. In the earlier times these are the surfaces of the trees and on these and these surfaces looked very much greyish or whitish colour. Now in this species we have two different colours, one is a dark colour and one is a light colour.

So, this dark colour is known as a Melanistic origin because it has more darker colours. So, now, in the earlier periods before the industrial revolution most of the trees look like this. And in such a scenario any of these light coloured peppered moths were quite camouflaged in the in their surroundings, but any of these dark coloured peppered moths were seen very easily. Now what happened was there are a number of predators like a number of birds that feed on this peppered moths. Now in this scenario they were able to the clearly see this black one, but they were not able to see the white one.

So, what happened was all these black ones were preferentially predated upon. And so, if you look that the population of peppered moth in the Great Britain, we would find that a number of individuals for in the light colour and they were of hardly an a individual that had a darker colour.

Now, when the industrial revolution came in and they were a number of industries that were spewing out smoke. And this smoke settled on the surfaces of the trees us well and which killed of all of these lighter colour like (Refer Time: 06:49) found on the trees. So, now, in this image we have these (Refer Time: 006:54) in this image we can clearly see the bark of the tree. Now when this lighter colour was gone and the suit deposition made the surfaces dark in colour. Now what happened was these lighter colour individuals that were earlier camouflaged.

Now they appear very distinctly out there on the surface of the tree whereas the darker coloured individuals that were earlier showing off now they become camouflaged. So, if you look at the distribution of peppered moths.

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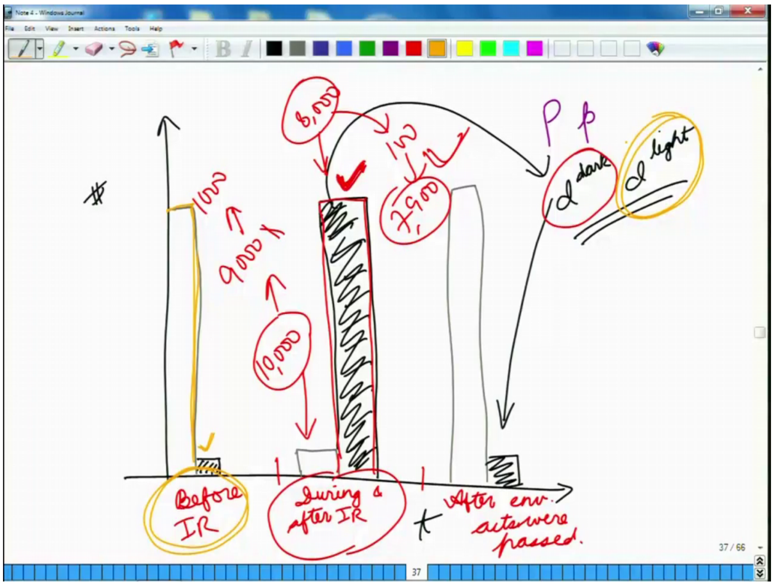

So, let us say the numbers the numbers and let us say time. So, in the period before industrial revolution so, let us divide into three stages. So, this is before industrial revolution. This is a safe during and after industrial revolution and this is after environmental acts were passed.

Now in the period before the industrial revolution we observed that we had lighter coloured tree surfaces. And on these lighter coloured surfaces we had a number of individuals that were light in colour. And we had very few number of individuals that were dark in colour.

So, this is how the population appeared before the industrial revolution because all these trees were light in colour and the lighter ones were more camouflaged. Now during and after the industrial revolution we got a situation in which the lighter coloured individuals population of the number went down and the darker ones increased. Because with all of these dark coloured tree surfaces, the lighter ones were preferentially predated upon and the darker ones the left out.

So, we saw that after a while a number of individuals were darker in colour and there were very few number of individuals that were lighter. Now, what happened was after the great smog of London. So, there was a very heavy outcry because of these industries and because of the smoke that was given out not only by these industries, but also in the homes. So, a number of environmental acts were past the clean air act and so on. So, after that these (Refer Time: 09:21) again became devoid of the suit and there then moved back into the lighter colour.

So, once that happen again we had the same situation as before the black moths were very clearly visible and the white ones were not visible. And so, after a while we saw that the lighter population again became more dominant. And the darker population were preferentially eaten out. So, this is at the level of the phenotype. But then as you saw in the previous class in the case of the colour of the flower we had considered to alleles one was a purple and one was the white coloured. Similarly in this case we had two alleles one was say a dark coloured.

So, let us call it dark and the second one was a light in colour. Now, we do not know which one is the dominant one. So, will call it d 1and d 2 or say d dark and d light. Now these are two alleles that are found in the population. If you have an individual that has the dark allele then it becomes darker in coloured if you have individuals that are homozygotes the light alleles we are lighter individuals, but when we observed these phenotypes then we can also see that there was a change in the genotypes of or the other frequencies of these alleles that was found there in the population.

So, because of the impact of the environment as trees became darker. So, the frequency of the darker alleles increased and then later on it decreased. Now question such as these or studies suggest these are done in the field of population genetics. Now these are some differences, but then how would these differences different from a similar to the evolution that we talked about. So, a population genetics is very closely related to evolution.

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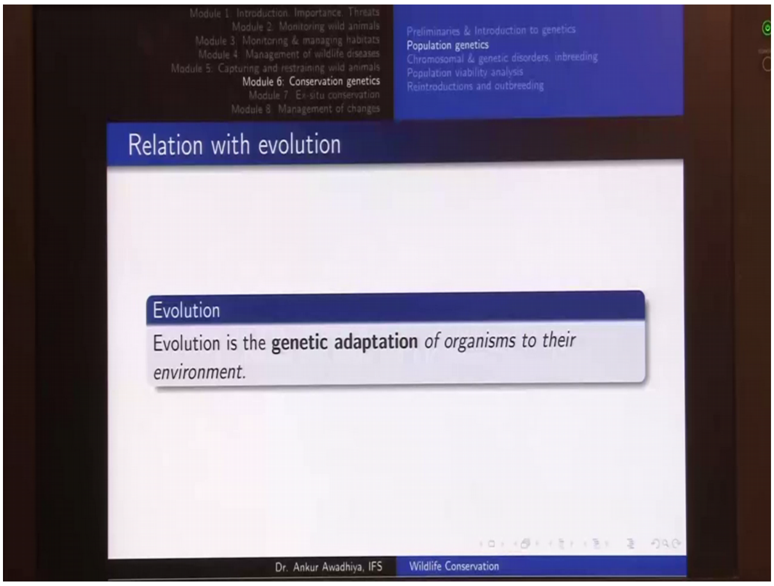

Evolution is the genetic adaptation of organisms to the environment. Now in the case of are peppered moth we are also seeing a genetic adaptation of the organisms to the environment. But then this genetic adaptation is only at the level of the different alleles and the frequencies of these alleles that are formed in the population, but then once this genetic adaptations become so permanent that they may evaluate to a new species then we can relate that to the evolution of the new species.

So, when we talk about evolution. So, here also the population is evolving to a threat or this population is evolving to a new change in the environment that has come up. Now, evolution when we look at its definition it says genetic adaptation to the environment. So, what is adaptation?

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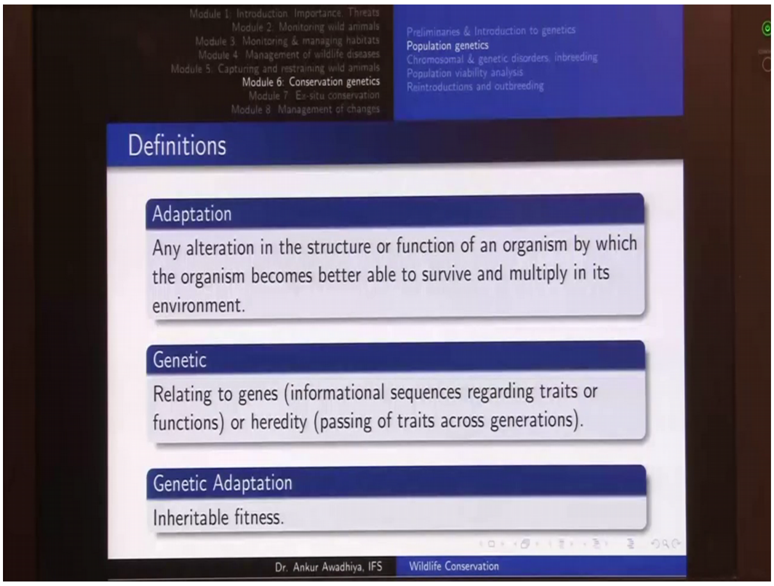

So, adaptation refers to any alteration in the structure or function of an organism by which the organism becomes better able to survive and multiply in its environment. So, in the case of a peppered moth there was an alteration in the structure of the organism or in the colour of the organism because of which the organism became better able to survive and multiply in its environment. So, it was an adaptation was it genetic genetic means related to genes or informational sequences regarding traits or functions or heredity.

So, was this adaptation a genetic adaptation the answer is yes, because it was because of a change in the frequencies of these different alleles of this particular gene that was coding for the body colour which was found in the population.

So, it was a genetic adaptation it was an inheritable fitness. Why was this an inheritable fitness because in the case of coming back to the drawing board. So, in the case of these individuals that were darker in colour their progeny were also darker in colour because they were having these alleles in preference. So, it became a fitness that was inheritable. So, it moves through heredity. So, why do we call it a fitness and what is the definition of a fitness?

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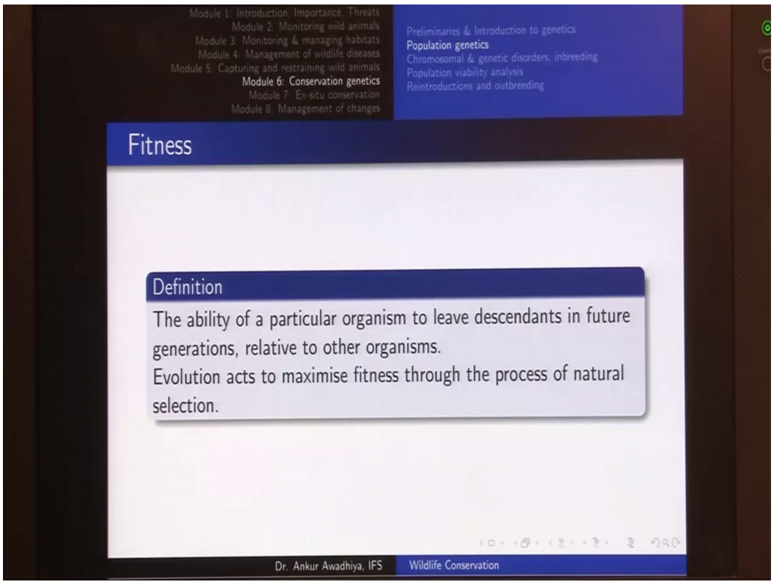

Fitness is the ability of a particular organism to leave descendants in future generations relative to other organisms. So, basically when we talked about these darker coloured peppered moth in this period during and after the industrial revolution where the barks of the trees were getting darker.

So, this darker colour was able to give it an ability of living more number of descendants in the future generations, because not only was the adult moth saved from the predators, but also its progeny also saved from the predators because they were also darker in colour. Relative to the other organisms, and this other organisms for those in the lighter colour. So, in this period these darker individuals had an advantage.

Before the industrial revolution and after the environmental acts were passed the lighter coloured individuals had a more advantage. So, this fitness evolution acts to maximize fitness through the process of natural selection. If this fitness continued for a longer period of time then it would have been selected through the process of natural selection in the process of evolution.

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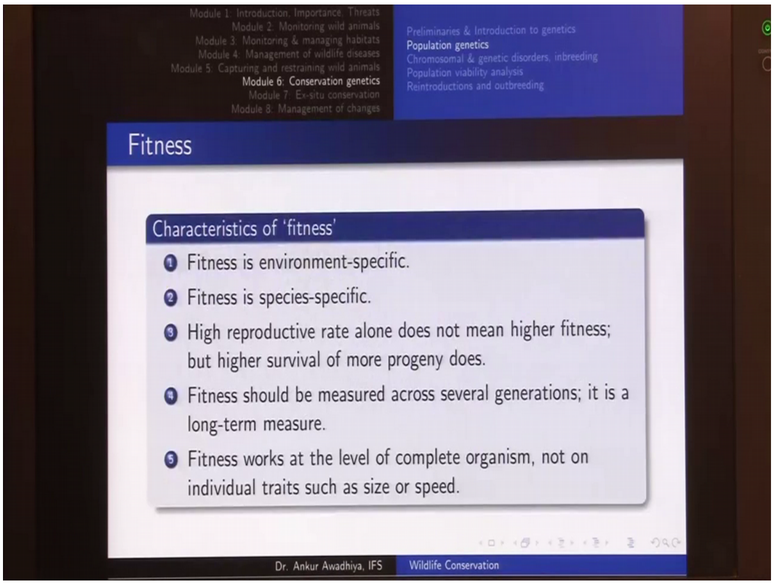

So, what are the characteristics of fitness? Fitness is environment specific. So, in the environment where we had lighter coloured tree barks, there was the lighter coloured that was given fitness in the environment where we had darker coloured tree barks there was a darker coloured that was given the fitness.

So, it is environment specific also it is species specific. So, this dark and light colour would have helped the peppered moth, but may be it do not have helped much the predators. So, this fitness is species specific. Then high reproductive rate alone does not mean higher fitness, but higher survival of more progeny does.

So, it could also be possible that in the middle period, in this period when we were. So, in this central period where were having during and after the industrial revolution where we were having darker coloured tree barks it is also possible that these individuals that were lighter in colour were having more number of progenies.

So, for every female moth's say this one was giving say 10000 eggs and this one was giving se 8000 eggs. But just higher number of eggs or higher reproductive rate will not mean a higher fitness because it is also related to the higher survival of more progeny.

So, in the case of these 10000 individuals, suppose 9000 of them were eaten away and only 1000 were left, but in this case suppose only 100 were eaten away and so, 7000 and 900 were left. So, in this case we would say that this has a higher fitness. Next fitness should be measured across several generations it is a long term measure. Now, in this case a peppered moth has a very short generational times so, it is a few months. So, we are talking about a long period as compared to the generational time we are talking about say a few decades of times at a go.

So, fitness has to be measured across several generations it cannot be we measured in one generation or two generation. And fitness works at the level of the complete organism not on individual traits such as size or speed.

So, when we talk about fitness we are talking about whether the organism was able to survive and produce a number of offsprings and those offsprings were able to survive for the next generation. So, it is not related to just one or few traits of the organism, but it deals with the complete survival of the individual. So, it works at the level of the complete organism not at the individual traits.

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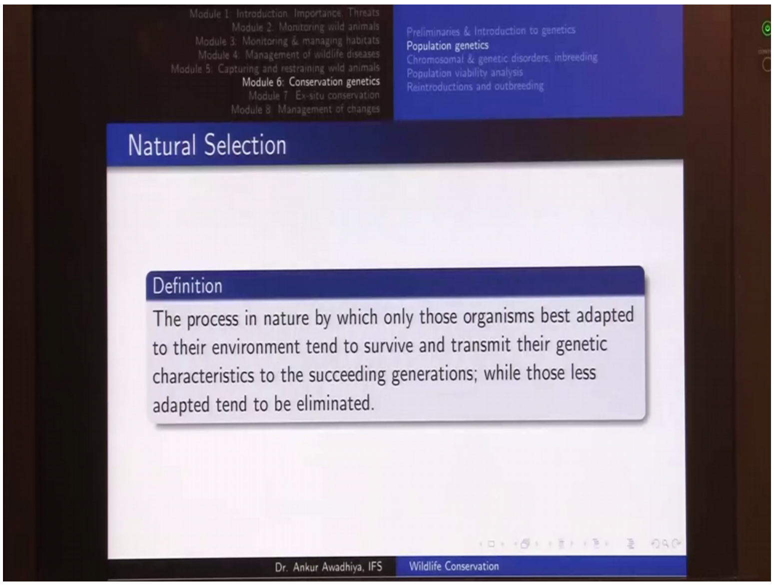

Now when we say that fitness is selected by natural selection then natural selection is defined as the process in nature by which only those organism that are best adapted to their environment tend to survive and transport the genetic characteristics to the succeeding generations; while those less adapted tend to be eliminated.

So, in this case of peppered moths, we can say that the body colour was giving the organisms a way of surviving and transmitting their genes to the next generation or to the succeeding generation. And those individuals that were not having the right colour of body as compared to the colour of the trees and their environment they were eliminated out.

So, this is a process in which the nature is selecting some individuals that are better adapted to the given environmental conditions. So, if it is a dark coloured environment the dark individuals are better adopted. So, the nature selects for them. So, those get a great a chance to survive and reproduce and where children also get a better chance to survive and reproduce that is natural selection.

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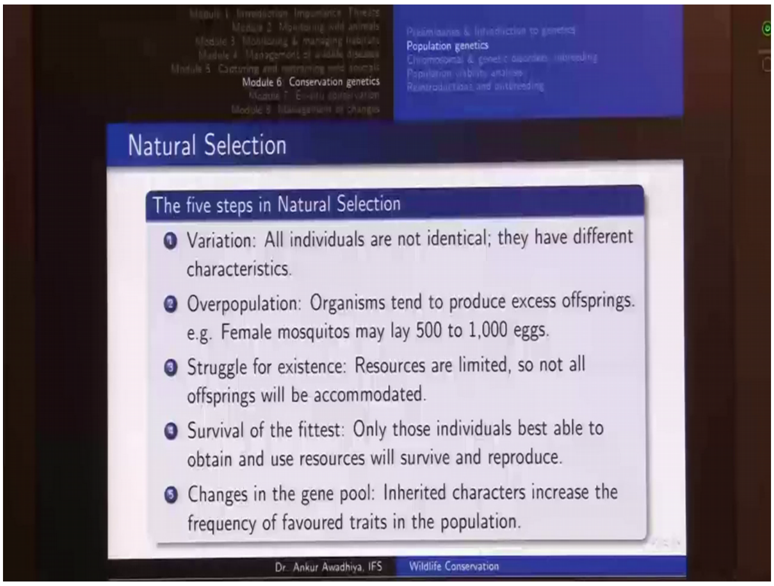

And it occurs in five stages or five steps one is variation. So, all individuals are not identical and they have different characteristics so, coming back to the drawing board. So, even in this period before the industrial revolution it was not that because these light coloured individuals are better adapted.

So, we only you will have this light coloured individuals. But we also have some dark coloured individual even though they are not best adapted. Now, why is this variation important in nature because the environment might change. So, in this case if these peppered moth did not have this dark coloured variation even when you even in this those period where dark coloured was a handicapped in the whole of this population would not have been able to survive in the periods of the industrial revolution when the environment changed.

Now, similarly in our case all of us are having different heights. Now in this present scenario the height does not play much of a roll, it does it does not decide whether we have a greater chance of survival or not, but even then the variation is there. Now to give another example suppose we have an individual, who does not have hands who develops wings by way of some mutation. Now in our at present environmental quantix this individual will not be able to write this individual will not be able to type this individual will not be able to drive a car.

So, in that case this particular variation of having wings in place of hands may be selected against by the nature because this individual will have a lesser chance of survival and reproducing what to give more no more offsprings for the next generation. As compared to the normal individuals that are having two hands. But then supposed all of this area was flooded and all those people who were having two hands they drowned of, but this individual who had wings was able to fly away.

So, now in the next generation and suppose we have a group of such individual that are having wings in place of hands. Now those individuals because they have been able to survive this flood in the next generation will be having in the population more number of individuals that will be having wings in place of hands.

So, natural selection is acting at all times. And it is active on the variations that are there in the population. Now the second thing is over population of organisms tend to produce excess number of offsprings. So, a female mosquitoes may lay 500 to 1000 eggs. Now, if all of this 1000 eggs were able to survive to the next generation then we would be have a huge scarcity of resources because the resources are limited.

So, out of these 500 to 1000 eggs say only two individuals will be able to survive to the next generation and produce offsprings. Why is that? Because there is a struggle for existence at all times the resources are limited and so, not all the offsprings will be accommodated in the nature or in the environment. Now in the case of are peppered moth this struggle for existence was also related to the struggle of diverting or saving oneself from the predators. Now this struggle for existence leads to the survival of the fittest. Only those individuals that have best able to obtain and gives resources will survive and reproduce.

So, in this case the survival of the fittest was related to the colour of the moth. And then the survival of the fittest also leads to changes in the gene pool. So, inherited characters increase the frequency of the favour traits in the population.

So, coming back to the drawing board what it means. In this period when we have more number of light coloured individuals this d light genotype is being favoured. And so, more and more of the individuals in the population will be having this genotype because they are getting it from their parents and. So, the frequency of the lighter coloured individual so will go up. So, this is leading to a change in the gene pool of the population in which the frequency of different genes or different alleles is changing.

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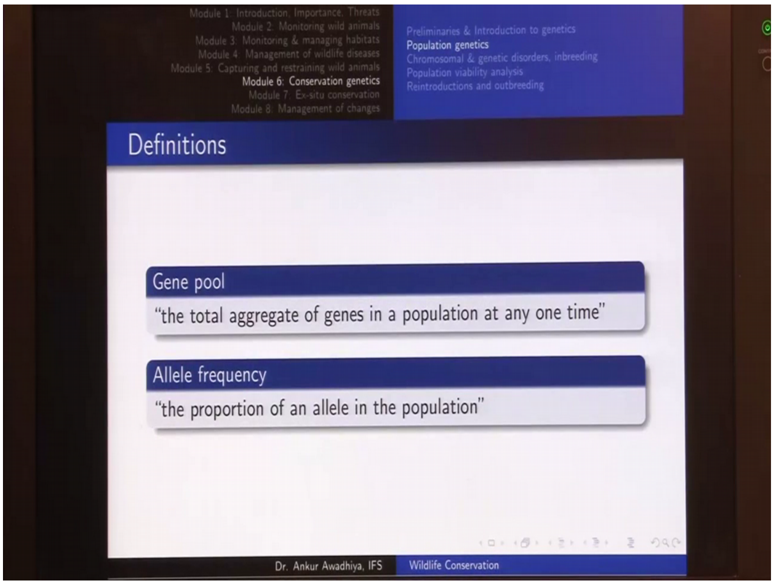

So, coming to the gene pool gene pool stands for the total aggregate of genes in a population at any one time. So, in any population consider all the genes all the variations that are presented there. Consider them all together and you get the gene pool and in the gene pool we can talk about the allele frequency or the proportion of an allele in the population.

So, for instance coming back to the drawing board in this case it is possible that our d light was present in 80 percent of the gene pool and our d dark was present in only 20 percent of the gene pool. So, will look at it in more detail in this example.

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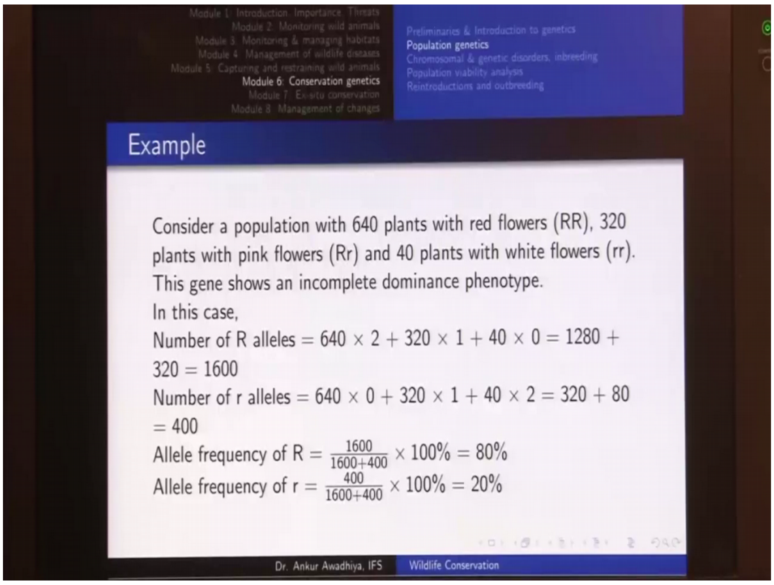

So, consider a population with 640 plants with red flowers with. So, in the case of these red flowers we have capital R capital R. We are talking about a case of incomplete dominance 320 plants with pink flowers that is capital R and small r and 40 plants with white flowers that is small r small r.

So, when we talk about the in this complete gene pool. The total number of capital R alleles in this population will be given by 640 into 2 because all of the 640 individuals have 2 of the capital r allele.

So, 640 into 2 plus 320 into 1, because these are one single capital R plus these 40 individual do not have any capital R. So, 40 into 0 which comes to 1600 and the number of small r alleles will be given by 640 into 0 because these do not have any small r plus 320 into 1 plus 40 into 2 because these are having 2 small r alleles.

So, this comes to be 400. So, total number of alleles in this population comes to 1600 plus 400 which is 2000. And the allele frequency of capital R will be given by 1600 divided by 2000 into 100 percent which comes to 80 percent. And the allele frequency of small r will come to 400 divided by 2000 into 100 percent which 20 percent.

So, this is how we calculate the allele frequency now in the case of population genetics. When the environment is changing these allele frequencies may change with time and this is something that is important for us to consider. Now there in a normal situation where there is no change in the environment we should we should assume that or we would hypothesize that these allele frequencies will not change and this is something that is given by the Hardy Weinberg principle.

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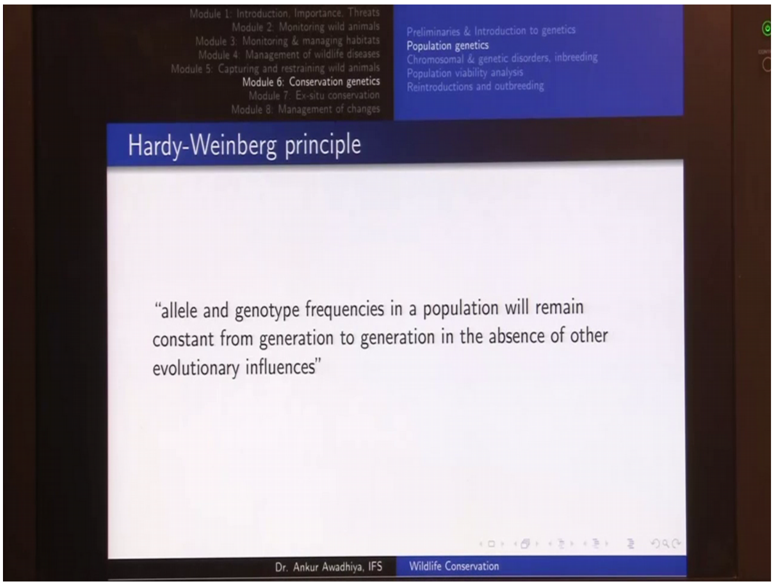

Now, Hardy Weinberg principle says that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences.

So, basically what this is saying is that if evolution is not happening if there is no change that is going on there is no adaptation, no natural selection that is going on. We would assume that the allele and the genotypic frequencies in the population will remain constant from generation to generation. Or in other words we can also say that if allele and genotypic frequencies in a population are changing from generation to generation then there are some evolutionary inferences that are happening.

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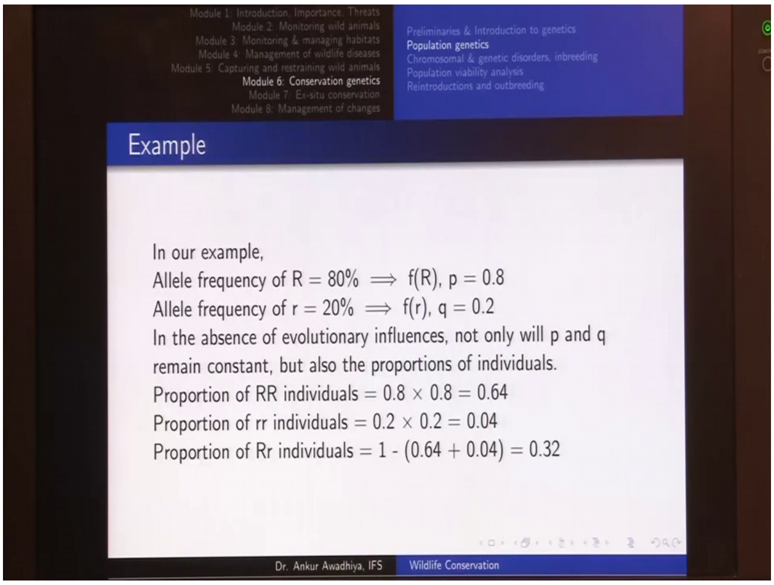

So, coming back to our example I have it calculated that the allele frequency of capital R is 80 percent and the allele frequency of small r is 20 percent.

So, we can also write this has the frequency of capital R which we can we can represent by small p is 80 percent or 0.8 and the allele frequency of small r that is f of r which we can represent in shorthand by small q is 20 percent is 0.2. Now in the absence of evolutionary influences p and q will remain constant at every generation.

So, even in the next generation we will have p is 0.8 even in the generation after that we will be having p is 0.8 and q will remain the same as 0.2, but not only will these remain constant, but also the proportions of the individuals.

So, the proportion of capital R capital R individuals will be given by p into p which is 0.8 into 0.8 is 0.64 the frequency of small r small r individuals will be given by q into q which is 0.2 into 0.2 is just 0.04. And the proportion of capital R small r individuals will be given by 1 minus the sum of both of these which is which comes to be 0.32.

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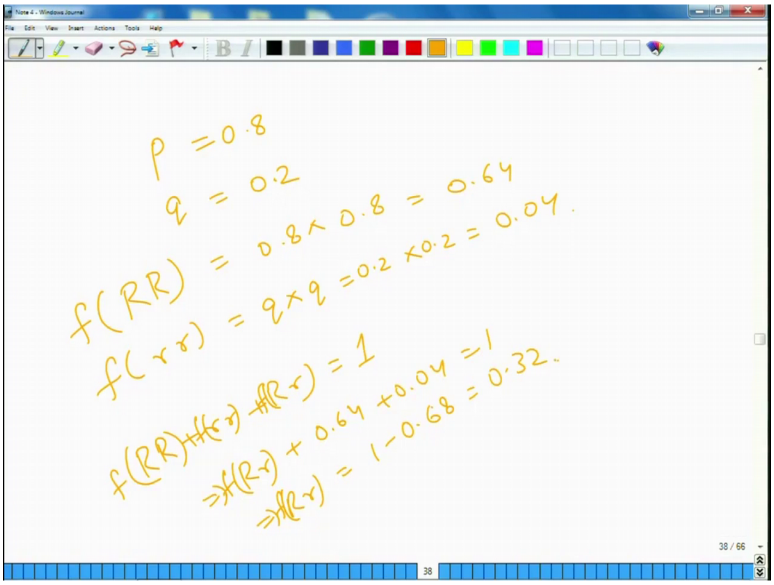

So, essentially what we are saying here is that if you have p is 0.8 q is 0.2. So, in this case capital R capital R individuals the proportion of those is 0.8 into 0.8 is 0.64. And the proportion of small r small r is given by q into q 0.2 into 0.2 0.04. Now because this population consists of capital R capital R small r small r plus capital R small r and this whole should equal to 1.

So, we can say that capital R small r plus 0.64 plus 0.04 is equal to 1 or the number of capital R small r or the proportions. So, the proportion of capital R small r will be given by 1 minus 0.68 or 0.32. Now we can also represent this in the form of a Punnett square.

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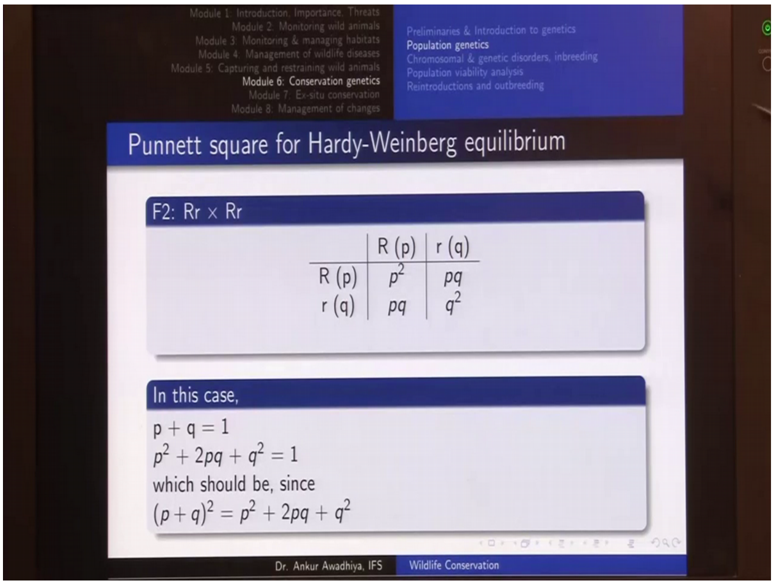

Now, in the Punnett square we have like as before we were representing these two alleles capital R and small r. And we are representing their proportions by their frequencies by these letters p and q.

So, capital R capital R will be given by p square, small r small r will be given by q square capital R small r can come either from this p q or it can come from this p q p and q.

So, in this case we will have p square q square and 2 pq is equal to 1. Now this is also something that should be obvious because we have p plus q 0.8 plus 0.2 is equal to 1. And in this case we are saying that p square plus q square plus twice pq is equal to 1 which should be there because this is the expansion of p plus q whole square.

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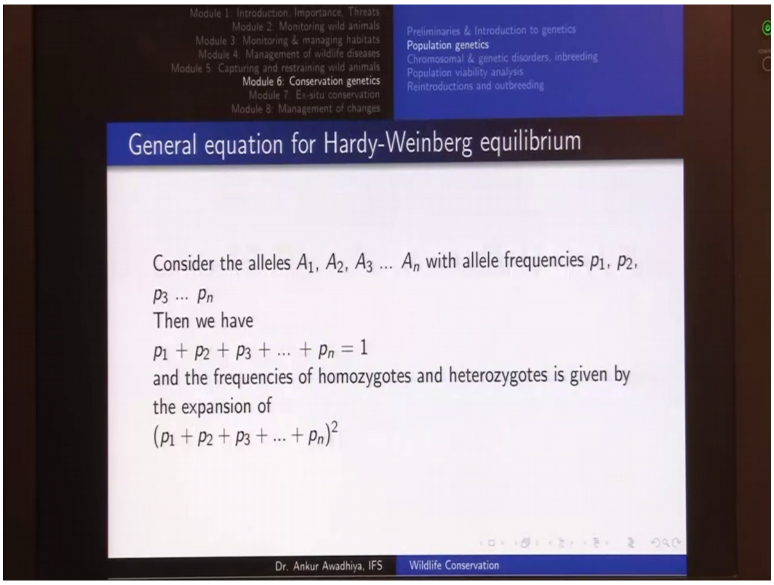

Now we can also write this as a generalized equation. So, in place of considering only two alleles so, in our example we were considering capital R and small r, but let us say that we have n number of alleles. So, A 1, A 2, A 3 up till a n with their allele frequencies that a given by p 1 p 2 up till p n.

So, we had represented this by only p and q in the previous example, but let us (Refer Time: 29:24) p 1 p 2 up till p n because all of these alleles so, will be having some frequencies. So, we can say that the sum of all of this frequencies will be equal to 1 because that is how we are defining all of these frequencies.

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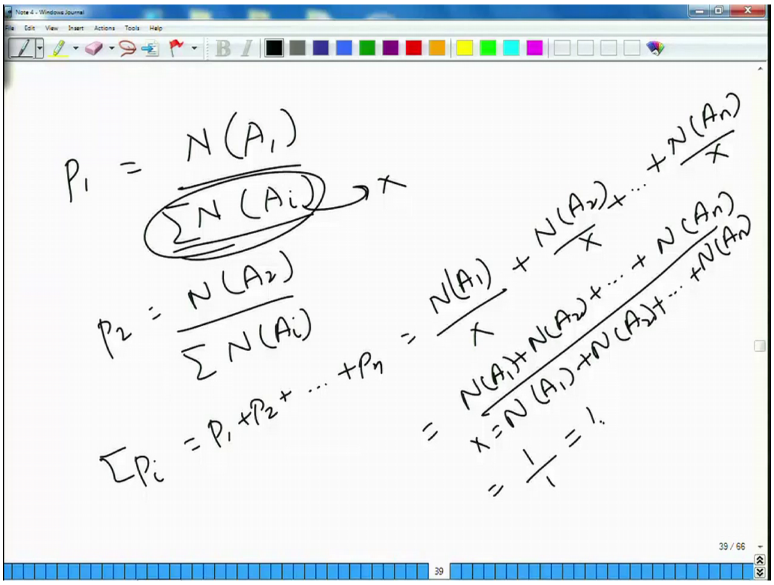

So, in this case we are having that p 1 is the number of alleles of A 1 divided by the total number of alleles. So, sum of all of these. Similarly we have p 2 is given by number of alleles of A 2 divided by sum of all the alleles of A i.

So, when we write sum of p i we have p 1 plus p 2 plus. So, on plus p n which is given by number of A 1 divided by this value. So, let us represent this as x. So, number of A 1 by x plus number of A 2 by x plus 1 plus number of a n divided by x. Which will be equal to number of A 1 plus number of A 2 plus. So, on plus number of A n whole divided by x. Now x in this case is this sum. So, this x can be written as number of A 1 plus number of A 2 plus. So, on plus number of A n. So, this is equal to 1 by 1 as equal to 1.

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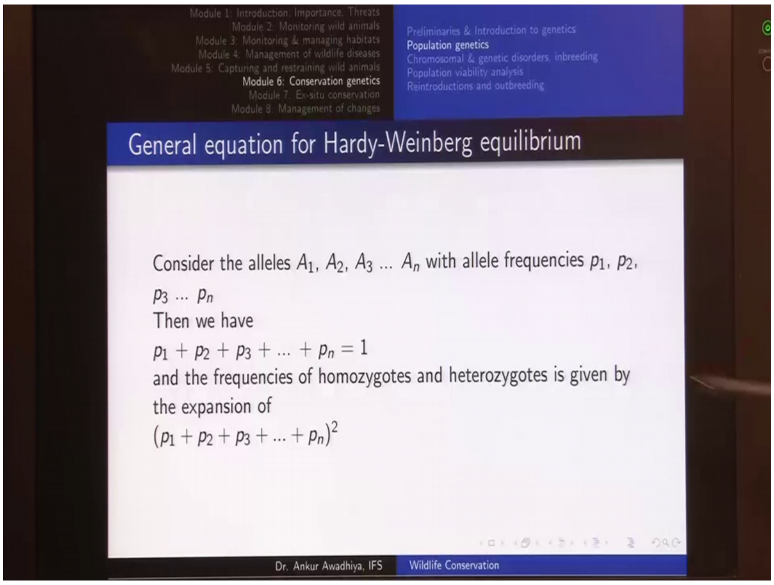

So, we have some of pi’s p 1 plus p 2 plus p 3 up till p n is equal to 1 and the frequencies of the homozygotes and the heterozygotes is given by the expansion of this whole term square. When we expand this and when we divide this from the complete sum then we will be getting the frequencies of different homozygotes and heterozygotes. Now this happens in the case of any absence of any evolutionary influences. So, when does evolution occur?

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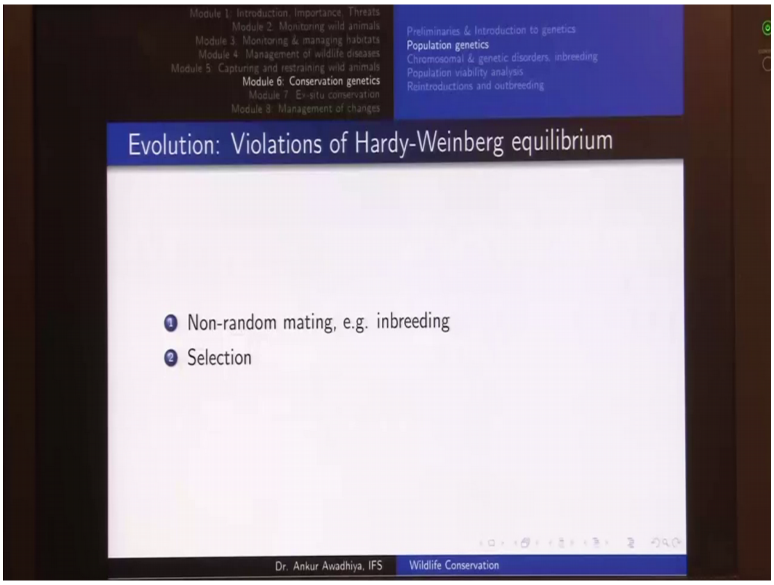

So, evolution occurs when there is a violation of the Hardy Weinberg equilibrium. So, some situations in which revolution occurred is a non random mating suggest inbreeding. So, an are example we were considering. So, when we wrote about r Punnett squares. So, whenever we are writing r punnetts squares, we are saying that all of these values are in are in average of what is happening.

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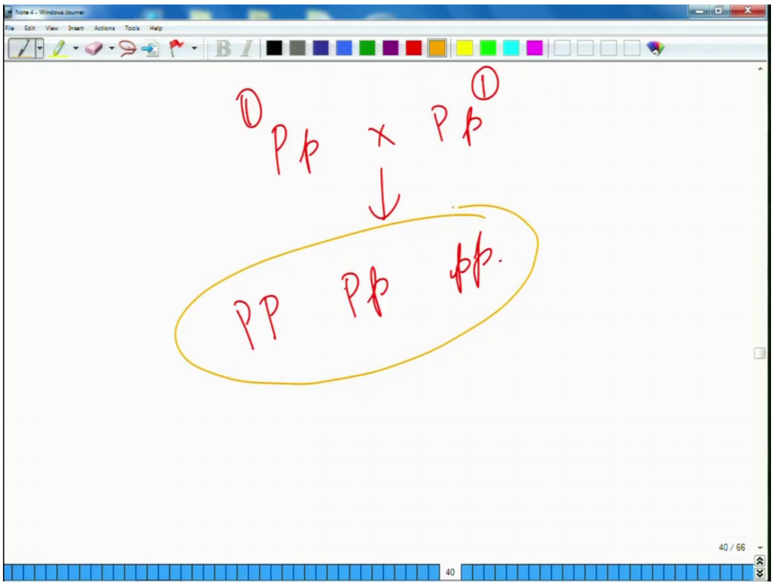

In the whole of the population so, if you have only one individual that is say coming back to r capital P small p cross with capital P and small p. So, if you have only one individual as male and only one individual as female. And there is only one offspring then that offspring can be capital P capital P capital P small p or small p small p, but we can never be sure which of these will it be.

So, it a stochastic phenomenon it is a random phenomenon what of which of these genotypes with the offspring get. Now, when we talk about the ratios 3 is to 1 or 9 is to 3 is to 3 is to 1 or so, on we are considering that a number of such meetings are happening in a large population of parents that are having these genotypes only then will be able to make any derivations about the next generation.

Now similarly when we talk about the Hardy Weinberg equilibrium, when we use this formula the expansion that is given by this term this will only be applicable when we are having a large size population. If there is a small population or when there is a non random mating. So, for instance if there is a population in which all tall females prefer only tall males and shorter females prefer only shorter males.

So, we will not be getting an average dot situation that we were considering not theoretical example. So, in that case these tall individuals will start getting more preference. Because not only are their homozygotes tall, but also their heterozygotes tall and they are being selected or they are being chosen in the form of a non random mating.

So, any non random mating or any inbreeding will be a violation of the Hardy Weinberg equilibrium. Another example is selection. So, an are example we were saying that all of these individuals have an equal probability of surviving to the next generation and producing their offsprings, but this may not always with the case.

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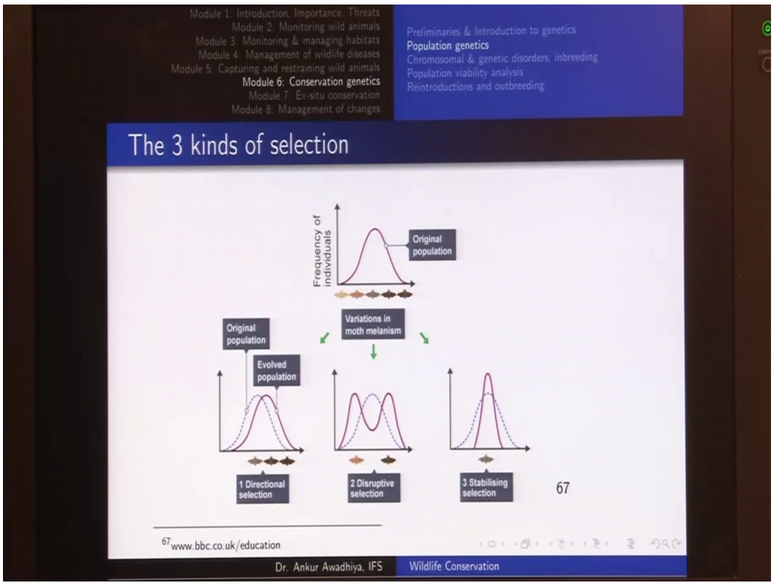

So, if there is any selection. So, in the case of are peppered moth. There was a selection against dark moths when we had a lighter barks and there was a selection against the light moths when we had darker barks.

So, if there is any such selection then we can have situations, in which suppose when we are having only darker colours that are being selected. So, in the next generation we will have more individuals that are there in the darker colours. Because they are better able to survive and these individuals are dying of. So, we will have a directional selection in which the whole population is moving towards darker shade individual. Or we could be having a disruptive selection. So, disruptive selection happens when in situations for instance when tall individuals prefer tall mates and shorter individuals prefer shorter mate.

So, in that case any mates which comes in between any individual that comes in between is being selected against. Or this could be in situations for example, in the case of bird in which if they have very smaller size beaks they are able to eat smaller insects food. If they have larger size beaks they are able to eat larger insects. And in the environment there are no insects that are in the middle size range. So, if it has a shorter beak it will be having preferential selection. If it has a larger beak it will be having a preferential selection, but not in between.

So, such kind of selections are called is disrupting disruptive selection. Because they are disrupting the population and putting it into two different extremes. On the other hand we also have some stabilizing selection in which only the middle parts are selected. So, these are to violations of the Hardy Weinberg equilibrium.

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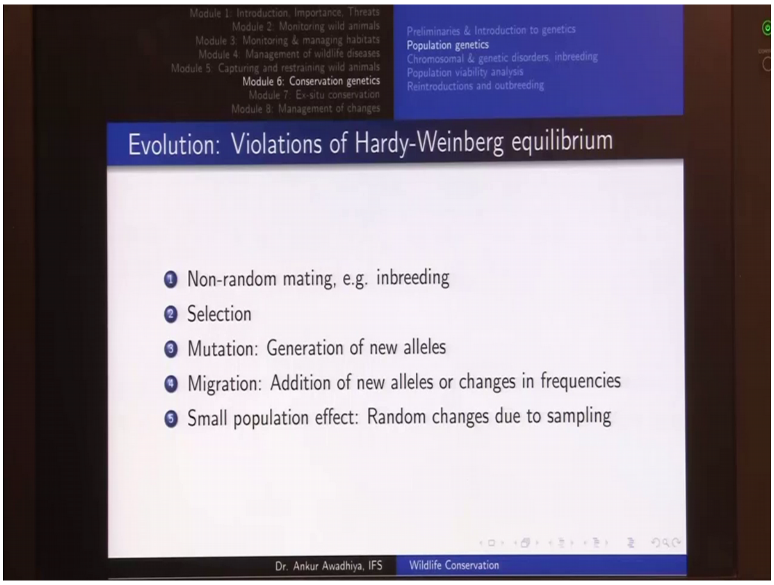

So, we look that non random mating and selection also another violation is mutation or the generation of new alleles.

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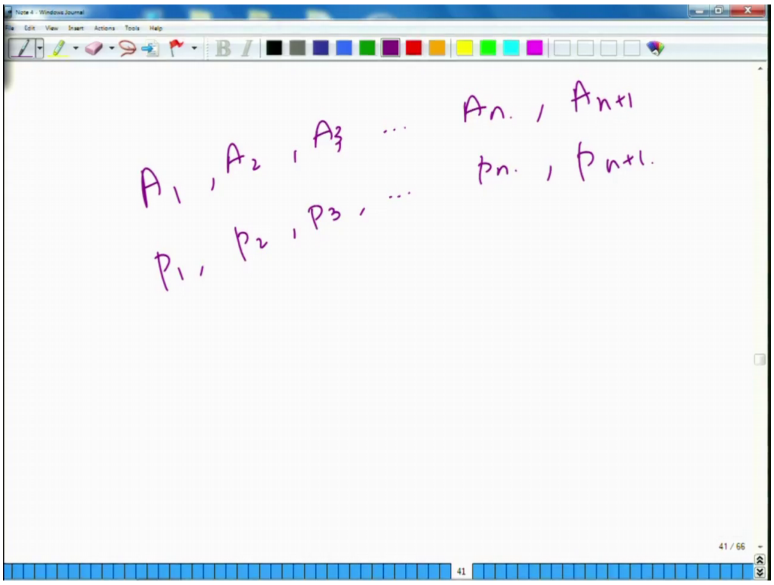

So, in the case of Hardy Weinberg equilibrium we started with n number of alleles. So, we had A 1A 2 A 3 and so, on up till A n.

So, all of these were having their own of probabilities or the frequencies. Now suppose there is a mutation in this population and we have a new allele A n plus 1 with this frequency of P n plus 1. So, in that case when we say that let genotypes and the alleles and their frequencies remain constant across generations that is not possible because we have the generation of a new allele that has happened. Next is migration; migration is addition of new alleles or changes in the frequencies.

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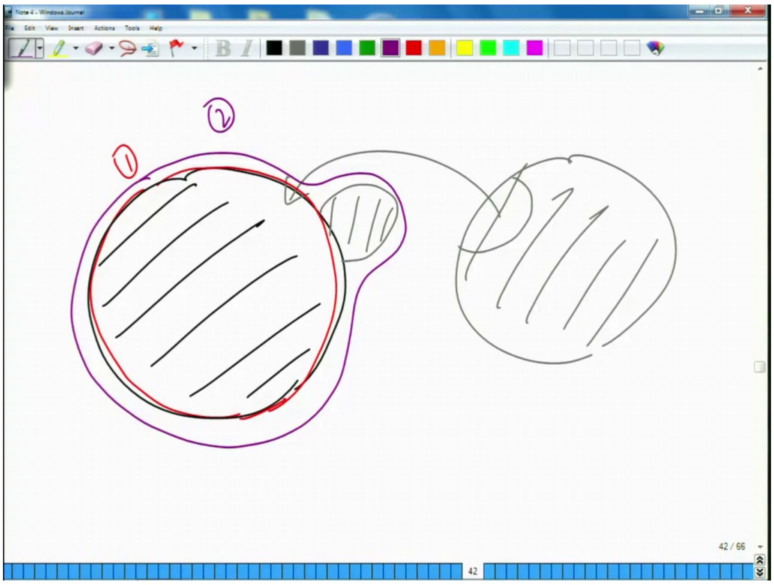

So, for instance suppose we had two populations. So, one was the population of these dark in colour moth so, most of the individuals for darker colour. And then we had a second population of the lighter colour moths. Now suppose there was a migration and there was a chunk of these individuals that came into this population. So, this migration has brought in some new alleles or it has changed the frequencies of the alleles. So, this is also a violation of the Hardy Weinberg equilibrium.

Because Hardy Weinberg equilibrium is saying that the genotypes and the allele frequencies will remain constant across all the generations, but here in the first generation we only had these many individuals, only this many genotypes and this much frequency, but in the second generation we are having a population that has these alleles as well.

So, the genotypes and their frequencies have changed. So, migration also leads to a violation of Hardy Weinberg equilibrium. And this might also lead to some amount of evolution in the population. Next is the small population effect or the random changes due to sampling. So, in case we have a very small population.

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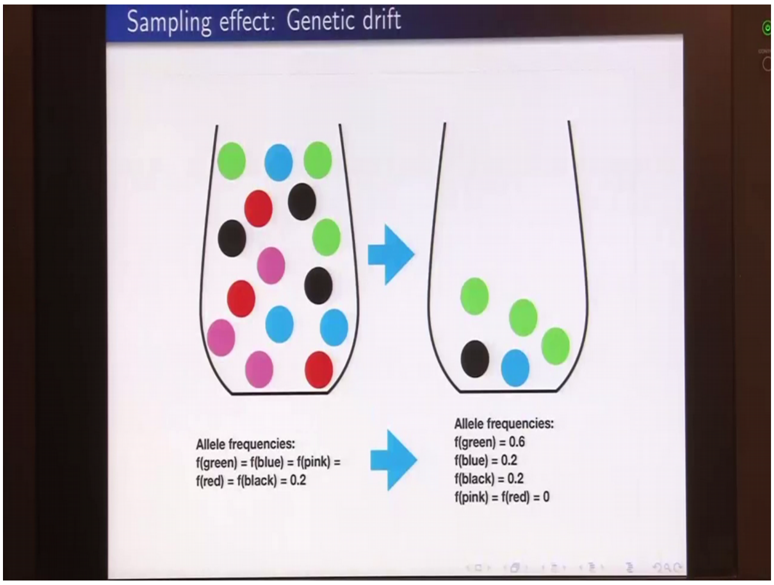

Or in case where we have a genetic drift there are very small number of individuals are able to survive to the next generation. Then we can have a drastic change in the genotypes and the allele frequencies that are there. So, for instance we can represent this case by this example of different coloured marbles that are kept in a jar. Now in the first generation we have three marbles of green colour, then three of blue colour. So, all of these marbles are three number of are all different colours.

So, the allele frequency is given by f green is equal to f blue is equal to f pink is equal to f red is equal to f black is equal to 0.2 because there are five different colours each of these have three individuals. And so, we are having the same frequencies for all of these, but if you just select a handful of marbles from here and drop it into the second jar.

So, we are having the allele frequencies that are now given by 1 2 3 3 divided by 5 is 0.6 for green and for both of these it is 0.2 and 0.2. And know there is no pink and there is no red in the population. So, this becomes 0. So, when we have situations in which only a small number of individuals are being selected for to get into the next generation just because of a sampling. We say that this is situation of genetic drift and name these situations the allele frequencies and also the genotype that are present in the population will change drastically.

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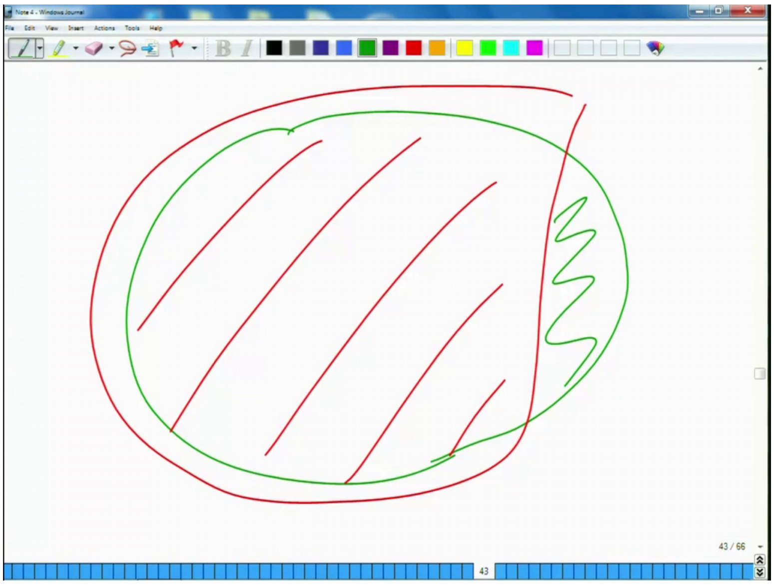

Now, an example where this could happen is suppose you had a big a large size forest. Now in this large size forest you had different animals that were having different genotypes, but then there was fire in this forest and all of these areas were burnt out.

So, only these individuals have been selected here. Now were these individual selected because of any rule or because of any formula. So, the answer is no, it just happened by chance that this left portion was burnt out and the right portion survived. So, this is what is happening here as well. So, essentially all these individuals died out and anything that was here survived in the next generation.

So, which is why we are getting. So, if you take out these portions will get three green one blue and one black three green one blue and one black. So, this is what is happening in this case. All the individuals below my hand died out all the individuals that the above my head survived. So, this is an example of genetic drift. So, other examples of genetic drift this could include say diseases which wipe out a large portion of the population or say a tsunami in an island.

So, most of the individuals get drowned only a few individuals remain into the next generation or see situations of a founder effect. So, for instance you had large size mainland.

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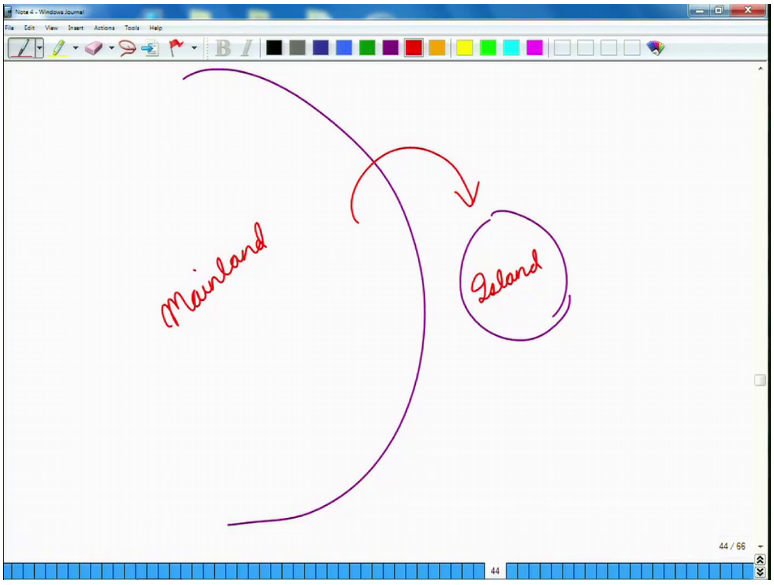

And then there is a small island and then there are only a few individuals that migrate from the mainland into this island. So, now, for instance the individuals that migrated into the island what say taller individuals because they were able to swim and migrate to this new island.

So, all the individuals that are born in the island will be having a higher frequency of the tall alleles in their population. So, there genotypes and their allele frequencies in there in the gene pool will be very different from what we see in the mainland.

And after a while these changes will be (Refer Time: 41:28) because all the individuals in the mainland because they are having their gene frequencies that are that will been constant with generation.

So, then remain in an average height, but all the individuals that moved into the island they started with as a taller height and then continue as a taller height. And after a while it even become that both of these population will turn out to be very different species, because they are now no longer able to breed amongst themselves.

So, situation such as these oh by the name of genetic drift and these are sampling effects just because there are some individuals that were able to survive or only some individuals therefore, able to move into the next generation.

So, in this lecture we saw that that every population is going to have different individuals and those different individuals are able to mate amongst themselves and their not mating with any other population that is nearby.

So, in these circumstances the genotype and the allele frequencies that are there in the population because they are constantly and randomly meeting with each other they remain constant across generations a phenomenon that will refer to as the Hardy Weinberg principle.

Now, if there is any deviation in the Hardy Weinberg principle. If these allele frequencies are changing to some direction either because of selection or because of non random meeting or because of any new allele that has come up due to a mutation or a migration or maybe some sort of a sampling effect.

So, will get with two populations that are not changing with time an example from the field of wildlife conservation could be tigers from Sundarbans and tigers from Sariska. Both of these populations have remained separate for quite some time the this are Sundarban population is breeding amongst Sundarban tigers and the Sariska population is breeding amongst the Sariska tigers. And they are being put across different selection (Refer Time: 43:27).

So, one population is in a very hot and dry climate the second population is in a very humid humid climate and has to swim a lot. So, because of these different selection pressures that are acting on both of these populations. We develop different traits and different different allele frequencies in both of these different populations. Now, when we talk about conservation of any species all of these variations need to be conserved conservation of these variations important because we do not know in future which of these which of these differences will be important for us. .

So, for instance if after take an extreme example suppose the whole of our country became flooded in that case Sundarban tigers will be able to survive, but all other tigers will be slowly wiped off. Or for instance because of climate change all of these area became extremely hot and dry. So, Sariska tigers will be in a better position to survive, but the other populations of tigers will be slowly exterminated.

So, when we talk about conservation of a species it is important to maintain all of these different variations. Because we do not know what the future will bring for us. So, maintaining of all of these different variations is important and it is also important that we do not mix all of these different populations together. Otherwise will come up with a population that is neither suited for Sundarban like areas or not suited for Sariska like areas. So, we discussed all these different topics in this lecture. So, that is all for today.

Thank you for your attention [FL].