Basic Course in Ornithology
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Lecture 39
Week 10
Interactive session

Hello everyone and thanks a lot for joining today. So, we have Dr. Robin with us and Dr. Umesh. So, I am looking at this word document here and I have a question on the assignment that was about measuring bird populations and communities which is on a point count the abundance of birds at different equally spaced radial distances is assumed to and there were four options.

The correct answer is to increase linearly. The question is if the abundance of birds at different equilibrium space radial distance means at each point, we select to sample birds like P1, P2, P3, it is a random points out of the grid then the assumption is that the abundance of birds is uniform that is the basis of the point count. The assumption that the of bird distributions being random or uniform is definitely an assumption of both the line transect and the point count forms of sampling.

But that is the distribution of birds in the habitat as a whole. At a point, if you look at different radial distances. Because the area of those circles increases linearly because the assumption is one of random or uniform distribution of birds in the habitat, because the area of those circles moving away from the point increases linearly. Therefore, the abundance of birds should also increase linearly as you move away from the point.

So, the it is a tricky concept, it is a little difficult to grasp in the beginning but if you go back to the recording and you look at the green and yellow bar graphs. The green showing you how the actual abundance of birds is increasing or remaining uniform increasing in the case of a point count linearly and remaining the same in case of a line transact with increasing distance from the point. Then, basically you are seeing that the actual abundance of birds at different distances from the points does increase linearly just because the area of the circle increases linearly

There is a second question which is, is there a conditional prerequisite for the relationship between individual bird numbers and bird species which is as individual bird numbers increase number of species increase to be true. We come across the reason for this question is that we come across large numbers of Rock Pigeons or Common Crows in an urban setting but it would not follow the set relationship.

Same for the flock of Flamingos or water birds, although individual numbers are high species numbers are not. That is a great question. The reason is it depends on the kind of community that you are studying. So, if you have an urban community where you have certain very, very common species. You have crows for example and then you have a large number of rare species.

And you compare that to a rainforest community where you tend not to have one or two dominant species but the number of individuals or the abundances of these species are more even than an urban setting. Then, it is true that if you have only one flock and all of them is made up of crows then if you add more individuals to your sample, you are actually not adding species. But that is often not the case when we encounter you know simply the sampling process is such that if you sample more individuals you are likely to add more species up to a certain point.

That point is when you have sampled all the species in the community. So, my first sample of an individual, the first individual I see will belong to one particular species. If the if the community is not very even, if you have a dominant species that is very, very common then the second individual sample will also be from the same species. So, you are not adding a new species, but if the community is more even in that the population sizes of various species is more even and you do not have these dominances.

Then it is very likely that the second individualized sample might belong to a different species and so on and so forth. You keep adding the third and the fourth and the fifth individual and the number of species will rise initially quite fast and then start peaking and then plateau and it will plateau when you have sampled all the species in the community. So generally, when we are sampling species it depends on the level of evenness

and dominance of different species in the; community how fast or how slowly you add new species with new individuals. There is a third question in the macroecology lecture which is does the larger range size of birds in temperate zones have to do with there being more long-distance migrants in these regions or is it only the breeding range of the migrants that is being considered. It is actually only the breeding range of these migrants is being considered. It is not because they are migrants that they have large range sizes.

If you only look at the breeding ranges of these migrants as well those ranges are much larger in temperate areas than in tropical areas. The reason for this is thought to be that birds in temperate areas or generally species in temperate areas are more generalist, they are able to deal with cold temperatures they are able to deal with relatively warm temperatures as well relatively warm temperatures compared to the troprical.

And so, because they are able to deal with a wide variety of climatic conditions, they are also able to occupy large ranges because anywhere in that large range is will have climatic conditions that they are able to adapt to and occupy. So, it is only the breeding season ranges that we are talking about here when we are talking about temperate birds and not the overall range including breeding and winter.

So, I have a question here which is it just says I have three queries regarding this if island one was larger and farther then what is observed also what is larger versus smaller relatively and how many species diversity are we talking about maybe relative. So, this is island bio -geography, yes. If island 1. So, the number of species on an island is a trade-off between the size of the island and the isolation or the distance of the island from the mainland.

So, if you had a large island close to the mainland, it would have a certain number of species. A same sized island further away from the mainland will have a lower number of species and when we are talking about species diversity and how many species it all depends on a variety of factors you know whether the islands are tropical or temperate. You know what is the distribution of those islands in space.

What is the relationship proximity wise mainland and so on. So, there is no one answer for this in terms of either the second question is what is larger but it is a smaller, it is just relative to each other right. So, a larger island is an island that is just larger than the other islands there is no particular size that cut off that determines whether an island is large or small. And again species diversity in island by geography is also

there is no one answer about what is a diverse island or what is the less diverse island it all depends on a variety of other factors. So, you know how many species are we talking about depends on you know the Japanese archipelago might have a very different number of species in their islands than the Galapagos. For example, the Galapagos is very, very far away from the mainland, it is in the middle of the pacific.

So, it is quite isolated and so, you have a lower number of species for the same island size than you might have in Japan for example where a Japanese island which is very very close to eastern Asia (the eastern Asian mainland) those islands are likely to have more species than the Galapagos. I think the other questions on this document are for Robin but let me just check the chat box in case I have any questions for myself.

I have one last question me and then I had it over to Robin because the other questions are for him this is a question about capture recapture formula to calculate population the formula is probably applicable only if all variables are non-null. Mr. Anand could you please elaborate on what you mean by non-null, I am not sure I understand that. So, you have one variable which is unknown that is n which is the actual population size.

You have the number of captures in the first occasion, you have the number of captures in the second occasion m and n and then you have the number of recaptures in the second occasion which is r. When you say m n and r are non-null, what do you mean by that could you please elaborate. If any variable is zero right okay then the population will show as infinity. So, so obviously, if the number of captures and the number of recaptures is sorry the number of captue in the first occasion and the number of captures on the second occasion is zero.

Then we cannot even estimate population size. If the number of recaptures is zero, then it could be either of two things. One is that you have gone back on the second occasion and sampled at such a point in time that none of the initial birds that were captured in the first occasion are present in the population anymore (they have either died or they have moved away). And so, the number of recaptures you get in the second occasion will be zero that is what is called an open population where you are allowing the population to change over time.

In the case of the formula m n divided by r, what we are assuming is a closed population which means that the population is not allowed to vary over time the number of individuals remains the same there are no individuals coming in from outside there are no individuals being born, there are no individuals dying or individuals leaving that area. So, the second period of second capture occasion has to be close enough to the first capture occasion such that the assumption that the population is closed is not violated.

And if that assumption is not violated then you will get recaptures in your second sample location as well. The other possibility is that the of not getting recaptures, let us say you are assuming a close population and the population has not changed over time and you have marked a certain number of individuals in the first occasion and you are still not getting recaptures in the second occasion.

Then that could be an issue of sampling effort. Maybe the amount of effort that you have put in in terms of you know the number of miss nets that have been put in the number of hours that those mistakes have been operated is low. And so, that that could also be an issue of the amount of sampling effort that is been put in. So, the key thing to remember in this issue of close population size estimation is that the sampling location should be close enough to each other.

To ensure that the assumption of demographic closure, which means that the population is not changing, is not violated. One other question from Anirudh is why what are the reasons for birds in the temperate regions to be generous compared to those in the tropics. So, if you look at

seasonality or just temperature variability in temperate areas, the temperate areas are far more seasonal, far more variable over the annual period in temperature.

So, the summers can go up you know 35 36 degrees celsius and the winters can go down to you know minus 30 minus 40 degrees celsius. So, talking about an 80 degree celsius range in annual temperature variability in temperate areas or you know 75 to 80 degrees celsius difference between winter and summer. Whereas, if you come to the tropical areas then there is not that much variability you know if you go to say Indonesia and you look at the winter temperatures winter you know large parts of the tropics do not have a clear winter or the summer.

But if you look at the equator for example the variability in temperature is very, very low. You know from the coldest period of the year to the warmest period of the year temperature variability might be you know 6, 7, 8 degrees celsius. So, birds that are in temperate areas and resident there will have to have evolved to be able to deal with these wide fluctuations in temperature over the years over the course of the year.

Whereas birds in tropical areas simply do not face that massive variation in temperature. So, they tend to be specialists because they do not need to evolve that generalized temperature tolerances and that is the reason for which it is an evolutionary reason why temperate birds are special generalists. Because they have evolved to be able to deal with that seasonality whereas tropical birds are specialists because they simply do not have to deal with the kind of seasonality that is their temperate areas.

I think that is all those are all the questions I have for myself. Robin do you want to take over. Yeah okay can everybody hear me? Yes. All right, excellent! yeah thank you. So, I will just start with the most recent question which is on the chat box. There was one on the context of the term dispersal. I think that is a really good question, because Umesh was just talking about migration and then there is dispersal.

So, the question is you know I mean basically both are movement but there is a characteristic this difference between these two. Migration is a seasonal movement where the entire population

moves from one area to another because the environment changes. But dispersal is a demographic thing. So, it is not the entire population but some individuals move out and this happens there is something called natal dispersal.

So, as the young kind of grow up, let us say they move somewhere and they find their own territories. So, so that is that is the difference between dispersal and migration and you are right the dispersal has nothing to do with migration in perse. I hope that clears the questions that KR was asking. Yeah. What time periods are we talking about. So, that because it is a demographic thing dispersal that happens at different stages of an animal's life.

It is not an annual event like migration which happens through the organism's life. It is a seasonal movement. But dispersal happens only in some particular especially natal dispersal happens only in some stages of organisms life. So, I hope that is clear yeah there are some other questions that are there. There is a question from Vadhana on the form, but I think that is the same question I think that is the same question that Gaya had yeah and that is about the physical barrier about park straight and Sri Lanka and things like that.

So, I think one thing that. So, I find that there are two kinds of questions that people have been having about biogeography. One is about you know just getting really confused about this emigration immigration and the number of species extinction and colonization. And I think that you know I can keep explaining it but the real way to figure that out is do that simulation that I had sent. It is very simple you can do it on a phone you basically play around with the size of an island do the simulation and see what happens.

So, that is one, the other is so, I mean I am not saying I will not engage but you know like do that exercise come back and then we can engage further you know so, that is like a little bit more nuanced engagement that happens. Another is about relic species and so on. Again about this I posted a I think there is a response on the discussion thread with a link to an article. I mean you do not have to understand all the words in the article that is the main thing that you have to understand is how that there is something you know how do you identify a relic and increasingly people are doing that with phylogenetic data.

And that there is a visualization, there is a figure there just follow the figure you will understand what that means uh yeah basically that so, there are no other relatives everything else has gone extinct. What it means about the age of the habitat and things like that I mean that is more complicated. So, it can be that habitat that relic is in is also old but that is not necessary as that article actually points out very nicely. So, do take a look at that article and that would kind of clarify the relic idea.

So, let me see other. So, the Sri Lanka yeah the question so, there was another thread of questions that was about barriers. So, I think that barriers, the thing about barriers is that it is relative and I know how annoying this can be you know for people who are used to defining things in very absolute terms but that is in some ways the challenge with ecology and that is why many of us like doing ecological research because it is not it is not that straightforward everything depends you know it depends on something.

So, in this case the barrier depends on the organism, it depends on certain locations. So, you cannot say that you know 10 kilometers is always a barrier between the mountains, that may depend on where that 10 kilometer barrier is. For example, in tropical coastal mountains you know they tend to accumulate a lot of cloud. So, you have this cloud forest and then barrier can be just a drop in that elevation from where that cloud presence is found. So, now so that is that is actually a very relative thing because that drop in elevation may seem very small, the distance between the mountains may seem very small.

And this is exactly what happens you know in those examples Shengottai a gap and so on that is that is very very interesting. And Goa gap you know it is not even a real gap actually. So, this is just an it is a climatic barrier again there is a paper that is shared on the discussion group which is more bird related. What is happening is that the climatic regime north of that that imaginary line seems to be different than to the south it is different.

At least that is what we suggested early on. But since then there are other researchers for example there is a recent paper I think it is this year that talks about the height of the trees and they actually

use remotely sensed tree height data from all of areas north of the Goa gap and then the south of the Goa gap and they say that the trees are actually shorter north of the Goa gap and then they go on to propose that it is a consequence of this difference in tree high that you know organisms like the Draco which is this gliding lizard is not found north of the Goa gap but it is found to the south.

So, what I am trying to say is that what is a barrier for one may not be a barrier for the other, it depends on the organism it differ it depends on the extent of specialization that that organism has to whatever is being you know barriered or whatever you know how you want to say it but the point is that it is not very easy to say. But the principle the idea is the same it is about what how far you can you can or you will disperse.

And so, the Sri Lanka you know uh is very similar. So, Sri Lanka is always attached to India, it is just that the water levels the sea level kept going up and down. What I will do is I think there is a very nice animation, I mean it is not it is not just an animation it is an interactive tool where you can slide the time bar and it shows you what the sea levels were in the past. And I think that is really great because you will see that Sri Lanka and India have had constant you know separation and connections.

And obviously what happens when you have connection is that organisms move across and then when they are separated, they are isolated. So, they tend to differentiate. And how soon those events happen and how dramatically it impacts some species that then results in you know speciation and things like that. It completely depends on on the facts are in question. I think that are there any other questions that are there.

I do not know Devika or Jobin if I have missed anything? Robin, I think there might be some questions in the chat box yeah. I do not know where to go from. So, that is an exam question whatever you all are teaching from there only questions are going to come. I think so, but I do not think and I do not think uh yeah I do not think any of us are going to ask you questions directly from the lectures.

If you are thinking of you know sitting with the transcript and mugging up terms, I do not think that is going to work I mean you have to really think and that is how most of us our idea of teaching is in that way. So, yeah Palghat line is also south of Goa. Yeah, I think I just answered that and yeah you noted. Yeah Deepak uh has a very interesting question about the continental drift and Pangaea.

Yes you are very correct and there is a there is a very nice website you should go to this. Yeah, I think that is the spelling it is the name it is the name of a scientist and he has I mean his basic goal has been to create these uh these maps (these illustrations) of you know how continental drift has happened. So, he has a very nice website where he thought he has simulations of various things.

But yeah, I mean you have to understand this whole thing has happened over several million years right like the Indian plate is just dramatic because you know it just moved quite a lot. But most of the others are very small changes and they keep they keep kind of having these uh breaks and I think there are there was a recent story about I think a building or something that was on one of these continental you know the those lines and then it was beginning to stretch apart or something like that and it was a big tourist attraction and finally it was thought to be not safe anymore for people to visit that.

I think if you also Google you will find very nice underwater like these videos of people that Russia and America that area where a lot of the human migration also happened that for that area also there is a lot of people who have been going diving and they kind of look at those plate plate boundaries that is what they are called uh. So, it is fascinating I mean that is a whole field in geology.

So, yeah I mean I do not have a specific answer to it, but there are people who study this as a full-time carrier. So, you should you should look that up. There is a question for me. One of those is on the document I am sorry that does not have names but the question is in the tropics temperature availability is minimal and food availability relatively equal during summer and winter is this the reason why we do not have birds migrating in the tropics and only in the colder latitudes.

Yes, that is certainly one of the hypotheses that has been advanced to explain bird migration which is that these species that are migrating long distance are actually tracking resource availability. So, resources are available resources like insects for example are available abundantly in summer in tropical latitudes. And when these resources become scarce during winter these birds are forced to move to warmer areas where resources are still available.

So, that is definitely one hypothesis that has a lot of support that temperate species do migrate because food availability is different throughout the year. You know in the tropics also there is a form of migration in tropical mountains that is the old equipment migration you know tropical mountains. Like the Himalayas for example the Andes, if you go there is a relationship between seasonality and elevation. So, low elevations are far less seasonal than higher elevations.

So, at higher elevations you have warm summers very cold winters whereas at lower elevations the winters are not as harsh. So, even in tropical mountains you do see elevational migration where birds that breed at high elevation (large number of species that breed at high elevations) actually move down to lower elevations in the winter and then return to breed at high elevations in summer.

So, it is a much shorter scale movement of birds, it is not the large dramatic latitudinal migrant's migration that you see you know from for example North America to South America but it is just in within the mountain range from high elevation to low elevations. I think Manjari has a question about great Manjari question is there a correlation between the size of an island and the rate of extinction.

I understand both of these are influencing factors in the number of species also does the size of an island take into account surface area for example smaller island with the mountain might have a larger surface area. Yeah, Manjari you are absolutely right the island I will just deal with the second question their first is that the island biogeography theory itself does not make any assumptions about topography and area right.

So, you are absolutely right that a small island that is more complex topographically if it has a mountain on it will actually have more area. And you know the classical theorem of island

biogeography does not really deal with things like this but you know if you have two islands that are equal in area when you look at them from above you know that let us say they are both this size and one of them has a mountain and the other one is completely flat.

Then actually the effective area on the first island will be higher the uh the number of individuals that you can support will be higher than in this in the case of the second island. The correlation between the size of an island and the rate of extinction arises from the fact that larger islands are able to support a larger number of individuals. So, if you have larger populations. So, if you have as a large island with which can support a large number of individuals then that population size of that species is also large and a larger population is less vulnerable to demographic stochasticity.

So, small populations can go extinct because of demographics stochasticity and so when you have a small island with small populations those populations are vulnerable to extinction from demographics stochasticity. If you have large islands with large populations simply because of the population is large, it is less vulnerable to extinction that is the reason why there is a correlation between size of an island and extinction probability on an island.

The reason is that larger islands support more individuals, therefore population sizes are higher and those populations are less vulnerable to extinction because they are not as exposed to demographic stochasticity as smaller populations on small islands. Devica, there is a question on the exam do you want to take that? Yeah sure. So, the questions in the exam are going to be mainly multiple choice I mean only multiple choice.

So, yeah if there are no more questions should we end the session? A recording of this session will be shared with you in a couple of I mean hopefully very soon. Yeah, so, somebody said there are follow-up questions. I mean if you have follow-up questions you can ask them now or you can ask it through the forum also that is not a problem. Robin, there is a question of the Godavari and it being the Paleo river. Yeah, I mean so, this the idea of actually I can refer you to other literature also.

So, Paleo rivers are I mean I am not sure even if that is a technical term but essentially there are these rivers that have been there for a very long time. Because they have some geographical feature and at the Godavari area you know there has been this apparently there have been these tilts of the of the land surface. So, at some point there was a lot of incursion of marine elements coming in as well. I mean now you know it as a river that flows out but there was some of the you know water was coming in and I think there are fossils that are there of uh I forget but I read in the there is a very nice description in the book indicia.

And if you are if you are interested in what is called this deep natural history which means you know you are looking at everything in a more wholesome kind of way you are looking at reverse and geographical features and wildlife along with the earth's history so to say. So, that is a very nice book that you can get started on. And this describes this also very nicely I just post I will just paste this in the forum.

So, that that can that can give you some ideas. Umesh, there is an over dispersion question for you yes Manjari yes. So, what over dispersion is doing is basically measuring the variability of traits in a community. So, let us say you have a community of 10 bird species and you are interested in the traits of these birds. And let us say you are interested in the morphology or the structure of the peak of these 10 different bird species.

Let us say all of these 10 birds have very, very similar beaks in that case functionally in terms of beak morphology these birds will be clustered in this community shows a clustering of functional traits. Whereas, if you have a community where you have uh you know traits that are very, very different from each other. Let us say each beak of each of those ten bird species is very, very different from each other.

Then the overall space if you think of it conceptually the space occupied by beak morphology is very large and therefore this is an over dispersed community in terms of beak morphology. The same concept applies also to relatedness of phylogeny where you have if you have a bird community of 10 species that are all very, very close to each other closely related to each other then that community will be phylogenetically clumped.

Because all those bird species are related to each other whereas if you have a community of ten bird species which are not related to each other let us say each of those 10 bird species is from one from a different family then you know you can that community would be phylogenetically over dispersed or you know less related to each other. So, that is that is what over dispersion means both in terms of phylogenetic genetics in terms of relatedness as well as over dispersion in terms of state space, functional traite space.

Deepak has a question on the Jerdon's Courser which is about double jeopardy uh. So, double jeopardy is a situation where a species that is geographically restricted also tends to have small population sizes um. So, the Jerdon's Courser definitely yes is is geographically restricted to a certain kind of habitat and the population size is also small and therefore yes it would be vulnerable to both environmental stochasticity and demographic stochasticity.

So, environmental stochastically being let us say there is a sudden drought that affects the the range of the Jerdon's Courser that can have an effect on the population of the Jerdon's Courser that arises from the fact that the environment is unpredictably variable. And the other issue is demographics stochasticity. So, let us say the population size is very small then you know random fluctuations in birth rates and death rates can cause the population to go extinct.

So, I think yes you are right in saying that the Jerdon's Courser could be a case of double jeopardy. Yeah, Umesh, there is a question for me, which is about the Sholakili and the Palghat gap. So, actually I was trying to answer this in a more broad way Sulochana. So, you know the thing about the gap and barriers is that it really depends on the species. So, let me give you an example.

So, let us say you have two forest patches and there is a road going in the middle. Okay, now like is this something that that creates a barrier or is it connecting something but that depends on what the organism is. So, if it is an organism that lives it is an open habitat organism then the road actually may facilitate movement of the species through what would have been otherwise you know forest and it was not able to go through.

But now it is able to go through but on the other hand if it is you know in the two forest patches then the road may be a barrier but then that is not so black or white because it depends on what species it is. Because some species may be able to move across very small divides, let us say a two-lane road should not be very difficult for a frugivorous bird to navigate.

But if it is a eight-lane highway and your species of interest is a frog, then maybe that is going to be a barrier. So, what is a barrier actually depends on what species it is in the sense that where it lives and its ecological you know some of those traits. Is it able to move uh you know through this particular kind of habitat or not? So, for Sholakili which is found on the mountaintop Palghat gap you have to go down and then go up.

The straight line distance is not much but these birds never fly straight line. So, you know what they say as the crow flies, the thing is that mostly only the crows fly that way the understory birds actually follow the terrain they follow habitat features and terrain features, which means that they just they do not fly across the mountain they have to come down and go up.

And for them to come down and go up they cannot do it without the help of the habitat. So, which means that they wait for the climate to change (I mean they wait I am just saying all of this in a very superficial manner), but they do not actually wait but when the climate changes and the gap also has a conducive climate. They are able to move across but when the climate changes and you know the wet habitats go up then they are isolated and the gap is a barrier.

I think I hope that is clear and there is also a follow-up question about how the road is a barrier. I think road you know that is it is just simple, I mean if it causes mortality or there is. So, there are different kinds of things. One is that if an organism is simply not able to move across physically and this is a question a lot of people who do not engage with ecology ask. For example, birds can fly.

So, why do not they just fly from one place to the other. It is like saying that you know why do not primates cross across these rainforest fragments, I mean they do have legs right they can they can just walk across but the point is if you are a canopy upper canopy primate you just do not come

down that is just a behavioral attribute you are specialized to that and that has come as a consequence of it is a behavioural specialization sometimes but it is come as a consequence of millions of years of evolution.

So, you do not just ditch that one day and decide to cross something. So, that is. So, there is a behavioural component as well as a physical limitation component. The physical limitation is if you are you know a terrestrial organism and if there is a water body and you cannot swim then that is a physical limitation. But the behavioural components are slightly more complicated you have to understand the species.

Yeah, over to you Umesh. Thanks Robin, I have a follow-up question from Manjari about double jeopardy which is double jeopardy observed only for populations that are surrounded by barriers or reasons that are surrounded by barriers. Again, you know Robin has been talking about barriers and how barriers that are operating to prevent birds from dispersing from one region to another might not be obvious to us.

So, we typically you know think of barriers like rivers or mountain ranges or you know the open ocean as being a barrier but there could be barriers that are invisible to us. For example there is this bird species called the Bugun liocichla which is extremely range restricted it has a two square kilometer global range of this bird is two square kilometers. And it is that there seems to be no reason why the Bugun liocichla cannot expand its range beyond those two square kilometers.

So, but you know it is not visible to us why what those barriers might be? Are those barriers (like Robin is saying) they could be behavioural, they could be interactions with other species. So, the concept of the barrier is not particularly a straightforward one. So, Manjari I would say definitely you know like a small island for example a population on a small island will definitely be subject to double jeopardy.

And that is a case of a very clear barrier surrounding the island which is the ocean that is inhospitable to birds of the terrestrial birds on the island. But there could be cases where the barriers are not particularly apparent but any geographically restricted population that is small will

be subject to double jeopardy regardless of whether we can see those barriers or not. So, basically you have a small range size and within that range size you have low population density that will subject you to double jeopardy.

Actually, Anirudh actually the Cornell's work of Balanus and Chthamalus from that if you remove Chthamalus then Balanus colonizes the entire the tidal range of heights on these tidal pools whereas if you remove Balanus, the Chthamalus actually does not expand. So, the they looked at that as well. So, there is competitive exclusion by Balanus. So, Balanus was excluding Chthamalus from a part of that site and if you remove Balanus then Chthamalus would expand its range.

But the opposite is not true. So, Balanus is basically a superior competitor in this case. It out competes and excludes Chthamalus from certain parts of the tidal flats but it is not as strong a competitor and removing Chthamalus does not actually have an impact. I also have a question on this extreme speciation with species like Forest Owlet and Bugun liocichla which are not in oceanic islands, where Narcondam hornbills the surrounding habitat and the microclimate are not that different from.

So, Rashika, this is the question that we have thinking about for a long time is actually. It is about it seems as if you know surrounding habitat and micro climate and more that different and the question is actually Forest Owlet have thought to have a much smaller range than it actually does today. So, Forest Owlet range is not all that small but in the case of the Bugun liocichla you know it seems as if there is there is no reason why it should not expand to other areas.

Because the microclimate and the habitats are look identical to the naked eye but there could be something about the biology of the species that just simply is forcing them to be restricted to a small population size that could be because let us say there are other species that are superior competitors. So, the Bugun liocichla is found in this particular habitat and then you know other closely related birds that are competing with it for resources are simply not allowing it to expand in its range.

So, it could be a variety of both abiotic reasons which is you know climate micro habitat kind of reasons as well as biotic interactions that that cause this kind of rarity. We do know that competitive interactions are very, very important in structuring communities. So, for example if you have two species that are very, very closely related on a mountain they will compete with each other very, very strongly to limit ranges in either the higher the lower parts of the mountain.

So, it could be these biotic interactions as well. Krishna has a question on bird dispersion which could be driven by the need to disperse if they have all resources and no reason they might not disperse. That is that is true Krishna very often what we see though is that a habitat for a particular species will be at what is called carrying capacity. So, let us say you have a one hectare area or let us say one square kilometer area.

And that one square kilometer area can support let us say 10 individual birds of a particular species and we are talking about one species at the moment. So, one square kilometer can support 10 birds (10 individuals). If there are eight individuals in the habitat and in the breeding season two more individuals are added then they can be accommodated on that same in that same area. However, if the carrying capacity is overshot you know if you have suddenly now 14 birds on this habitat patch that can only support 10.

Then either one of two things will happen either those extra four birds will die because they are out completed by better competitors of their own species or these four birds will be forced to move out of that habitat patch and colonize some other area which is below carrying capacity. So, bird dispersion is definitely driven by the need to disperse especially out of habitats that have reached what is called carrying capacity which is the ability of the habitat to support a certain number of individuals.

Robin, I think you have a question which is, is vicariance the same thing as allopatric speciation? Sorry, I do not see that. It is in the chat box Robin at 453 by Sulochana Kumar. The question is, is vicariance the same thing as allopatric speciation. Well! yeah yeah I guess you could say that but they are usually used slightly differently I suppose so, Umesh do you have a good answer to that by the way.

So, vicariance is when there is a geographical barrier that causes speciation yes and allopatric speciation is where you have two different geographical ranges and where there is no exchange of individuals between those two populations and that is what is causing these populations to diverge and speciate into two new species. So, I suppose vicariance is one form of allopatric speciation that is probably the right way to say yeah you are right.

So, vicariance can result in allopatry and allopatric speciation but that need not be the only form of allopatric speciation yeah thanks Umesh. So, much yeah ,I think we are now running out of question, I mean sorry running out of if there are time, questions they could be put on the forum and we will try our best to answer them as soon as possible. So, yeah, the yeah especially the Coalescent theory I do not think can be answered like that that easily.

So, I think that would require a full lecture by itself but I think there is a little bit of that in one of the lectures coming up. So, hold on to that thought actually yeah good point yeah Rishika. So, maybe we will get back in touch after that lecture, all right, thank you.