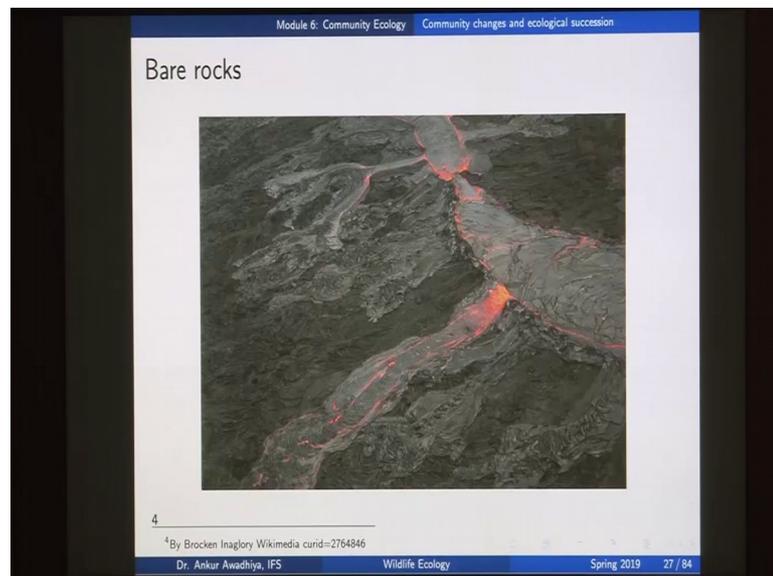


Wild Life Ecology
Dr. Ankur Awadhiya
Department of Biotechnology
Indian Institute of Technology, Kanpur

Lecture – 17
Community changes and ecological succession

[FL] We carry forward our discussion on community ecology and today, we will have a look at succession. Now succession ask the question how does a community form and how does a community change. So, ecological succession is one of the ways in which the community changes.

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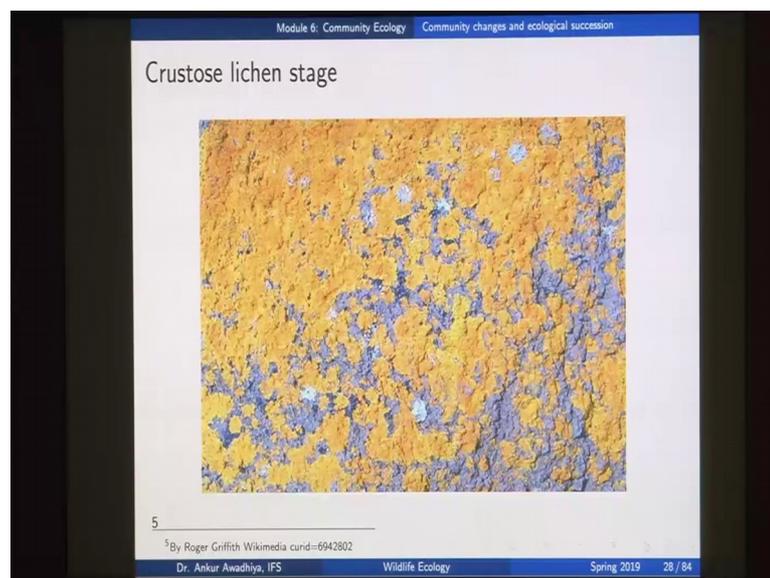
So, it asks the question suppose you have a bare piece of rock so, you have this rock that has come up because of say some volcanic activity. So, this would be primarily a basalt rock or for instance there is a granite rock that is deep inside the earth and because of some tectonic activities because of some earthquake related activities, this rock comes up to the surface of the earth. Now this rock does not have any soil associated with it. It is just a bare rock.

So, how is it that this rock is converted into soil and then how do different kinds of communities or different kinds of populations come into this place and then form a community and then will that community remain constant with time or will that community go on changing with time and if this community changes, what are the

factors that are responsible for these changes. So, all of these things are considered in the case of succession. So, in this case, we have this, this magma that is coming out and here we have the rocks that have been formed now these rocks are very hard rocks. So, essentially if you put any plant here the plant will not be able to grow. Even if you say make a hole somewhere here and put a plant inside the plant will not be able to grow because it does not have access to water, it does not have access to the minerals.

Now this rock is all full of minerals it has all the nutrients that a plant might need, but then all of those nutrients are logged inside the various minerals that are formed that, that are there in this rock. So, all these nutrients have to be released by some process and that process is the ecological succession.

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So, once you have these rocks in a short time, you will find that there are some lichens that are coming up onto these rocks. Now lichens are extremely hardy species. So, here on the background this grey color is the rock and these yellow colored things are the lichens. Now these are very simple organisms these are very primitive organisms and they do not have a huge nutrient requirement. So, essentially they can make use of those small little minerals that are present on the surface of this rock or maybe those nutrients that are brought along with the wind when it blows some dust on this these rocks.

So, any small amount of nutrients any small amount of minerals that are available these lichens can make use of that plus these lichens are photosynthetic organisms. These are

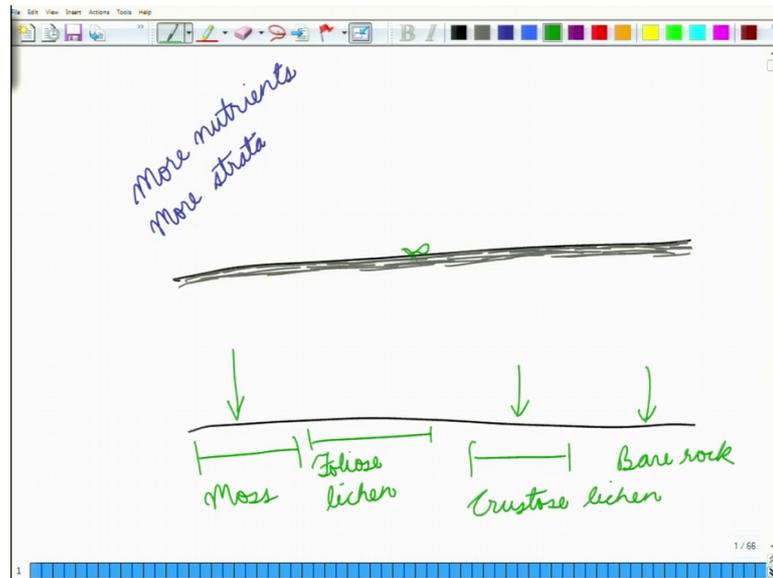
photoautotrophs. So, they can make use of the sunlight to produce their own food, at the same time their requirements for water is also very less. So, any amount of rainfall that comes into this area the lichens will absorb that water and maybe store it into their bodies or maybe if this area is close to the oceans and the air has a lot of humidity. So, these lichens can even make use of that humidity. So, what are these lichens doing here?

These lichens once they have come up on the surface of these rocks, they will use the nutrients that are there on the surface or the nutrients that are brought along with the dust particles; they will make use of the water, they will make use of sunlight and they will start to proliferate in this area. And at this particular stage, there is no competition there is nothing other than lichens. So, the lichens can have all the space for themselves.

So, they are able to cover the whole of the surface. Now when you have any organic substance that is growing up in any area and with this substance starts to degrade you will have a number of organic acids that are formed. So, when you have these lichens and when these lichens die out of probably even while they are living, they will be creating a number of organic acids and some of them will be released into the rocks.

So, that is a very small amount of assets that is being released, but nonetheless it plays a very important role because once you have these mineral acids once you have the action of chemicals on these rocks, there is some more amount of fragmentation. So, probably earlier you only had the surface of the rock that was available for the growth of these lichens.

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Now because they have released some assets, then probably a very thin shell of these rocks has now started to disintegrate. Now once this shell starts to disintegrate what is happening is that you have much more amount of minerals that are now available for the growth of any plant material.

Because earlier you only had the dust that was there you only had access to those minerals that were exactly on the surface, but now that you have this thin shell that has started deteriorating. So, more and more minerals will start breaking apart more and more nutrients will be released and so, now, some more plants can come into the place. And what are those plants?

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The next stages the foliose lichen. Now earlier we had the Crustose lichen. Now in the case of this crustose lichen, you can see that these are in the form of a crust that has come up on the surface they look like a crust or so, that is why they are called as crustose lichen.

In the case of folios lichen, these look more like leaves. So, if you look at these portions carefully, it looks like you have some leaf kind of arrangement in this place. Now crustose lichen are followed by the folios lichen. The requirements of folios lichen are a bit more than that of the crustose lichen. So, the folios lichen cannot come up as the first organism or as the pioneer species.

But once you have a these rocks that have been broken apart especially on their top surface so, dove because you have more amount of nutrients that are available. So, there is more nutrients plus there is more amount of strata that is available for any a autotrophic organism to make a small indentation or make a small attachment to the rock.

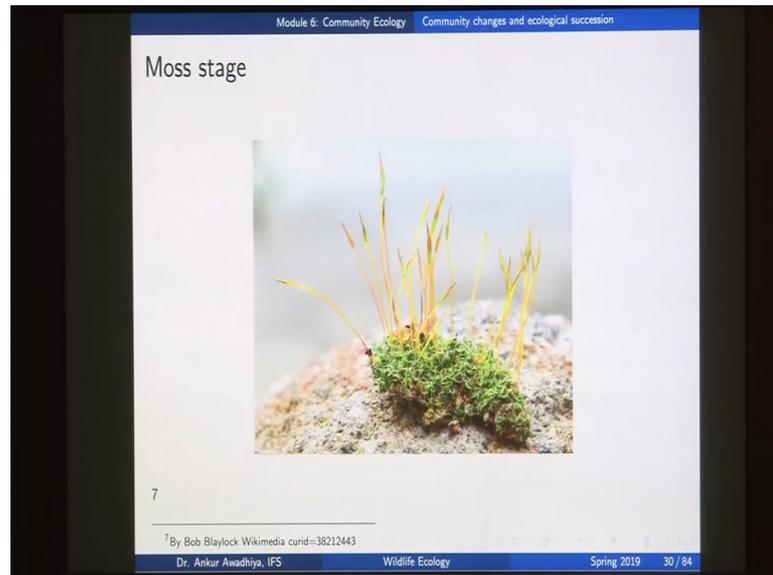
So, once that happens and when you have these folios lichen. Now the properties of folio lichen are that they have a slightly larger nutrient requirement, they have a slightly more three dimensional structure. So, they are coming out of the surface plus they are able to perform photosynthesis in a much more efficient manner than the crustose lichen. Now in the case of the crustose lichen their photosynthetic efficiency was less and in the case

of the folios lichen their photosynthetic efficiency is more. Now once you have both these kinds of organisms in this area, what do you think, who is going to out compete whom? Now of course, the folios lichen who have a better photosynthetic ability, they will be able to out compete the crustose lichen.

So, the crustose lichen made way for the folios lichen and the folios lichen in effect were able to displace out the crustose lichen from this area. Now where are we getting all these lichens from? These lichens are coming from the spores that are there in the air or are being brought about from the winds. So, they were not present initially when we had these rocks you do not have any plant material, but then along with the air you will have some spores that will come and land here, you will have some amount of dust that will come in land here and then probably in the next rains will have this process of succession that has started from the crustose lichen into the folios lichen.

Now, when you have these folios lichen, they are able to generate much more amount of organic material as compared to the crustose lichen and in effect they are able to generate much more amount of acids when they are living and also when their bodies are decaying. Now in that case you will have that the layer of rocks that was exposed it now depends a bit. So, in place of having a very small shell, now you have a slightly long larger shell and in this case as well you do not actually have soil here, but then because these rocks have not now broken up on their shell. So, you have a scope for something larger to come up. Now from the folios lichen stage the next stage is the moss stage.

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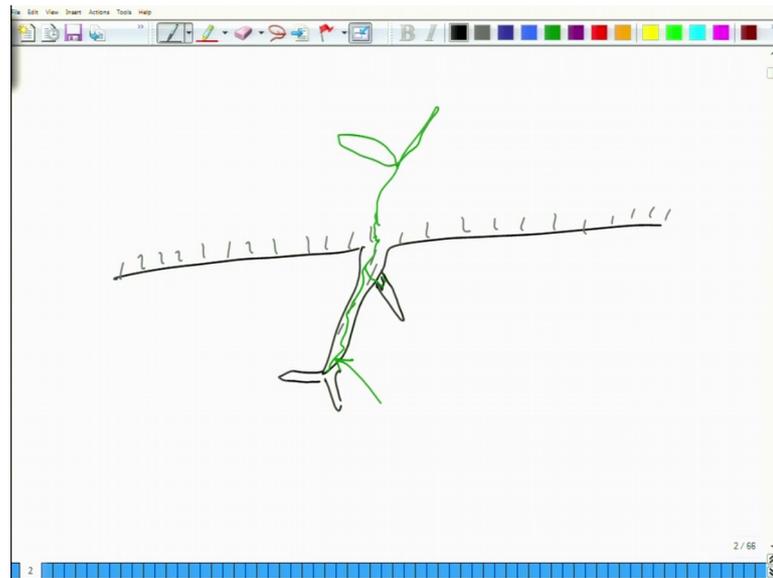


Now, the moss stage will come up when you have these rocks whose surface has been broken up to a larger extent. So, they cannot come before the folios lichen or before the crustose lichen, they will come only after that and once they have come up. So, now, you can see that these are all more greenish in color. So, they have much more better photosynthetic ability and then because of the inter specific competition, they will be able to displace off the folios lichen that are president there.

Now of course, it is not necessary that all of these area should have a complete cover of mosses. So, it is possible that in this particular rock, you have this area the first area that has say mosses, you have some other area that still has your crustose lichen, you can have some other area that has your folios lichen and so on. Because in this particular region your succession is started much before, then it was able to do in this area or probably in this area which you only have a bare rock.

So, in a large chunk of rock it is possible that you have different stages in different places, but then after a while this is the way in which your community we will move from one organism to the next organism. Now in the case of these mosses; they are doing much more photosynthesis, they have some roots that are now coming up. And once you have the roots, they will able to break up the rocks even further why?

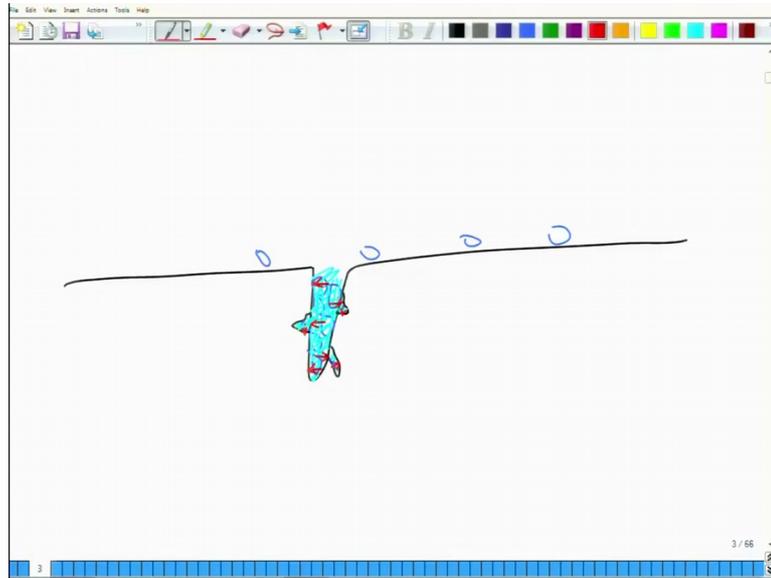
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Because if this is your rock and then you have this crack which was there and the top surface is having some amount of broken portions in which you can have the nutrients. Now if you have a plant that is coming up in this area so, this plant will be having roots and probably the roots will reach much deeper. So, in this case your roots are able to reach this point and are probably able to secrete some chemicals inside this crack.

So, probably some acids because the roots also want to make space for themselves. So, in that case you will have some more amount of degradation that is happening very deep inside and once that happens then probably this crack will enlarge. And similarly if you say have a very small crack here and you have a root that is coming up here so, this crack will also start to enlarge. So, in effect what is happening is that, this rock surface is now getting more and more cracked and in these cracks there would be other processes as well.

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So, for instance if you have a rock and you say have this crack here. Now in the night time probably there would be some amount of dew that would accumulate.

So, dew consist of your water droplets probably some amount of water droplets will start accumulating inside and once that happens and if the temperature is very less. So, in that case these water droplets might start to freeze. So, they will form a piece of ice inside. Now we know that the density of water is highest at 4 degrees Celsius. So, as your temperature is going down as it reaches 4 degrees.

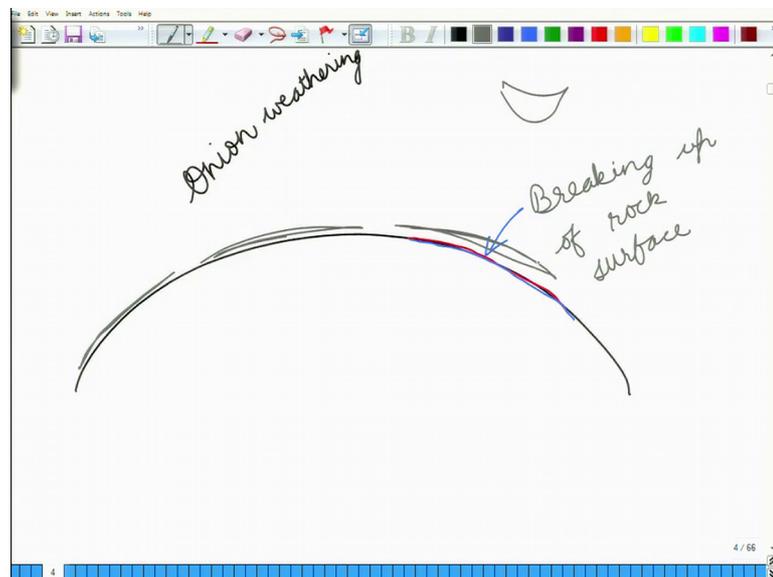
So, you have the densest amount of the densest sort of water, then once they the ice starts forming. So, you have reduce its temperature from four to three to 2 to 1 and then 0 and maybe even to the sub zero temperatures. So, what is happening now is that the density of water is now reducing which is why which means that the water is now becoming lighter which is why you have ice cubes that float on the surface of water because they have a lesser density.

Now, if something has a lesser density it means that it has a larger volume and once you have something that has a larger volume, it requires more amount of space. So, when these ice particles when they start freezing in this area, they also exert some kind of outward force on this particular crack and on this particular rock. So, what would that lead to? That would lead to some secondary cracks that develop on the surface and once

that happens, you will have water that comes into these areas as well then later on when it forms an ice here.

So, you will have larger quantities of ice that are being formed and then they again start exerting the forces on the surface of these cracks. And ultimately this crack starts to expand in size; you will have more and more number of cracks on the surface of this rock. And this process is also accentuated by the presence of the plant species because they are also living there they are also secreting out some assets which are further weakening the rocks and so on.

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Now not just ice, but you can also have a situation in which you have a surface of the rock and when you have the sun that is shining in the daytime.

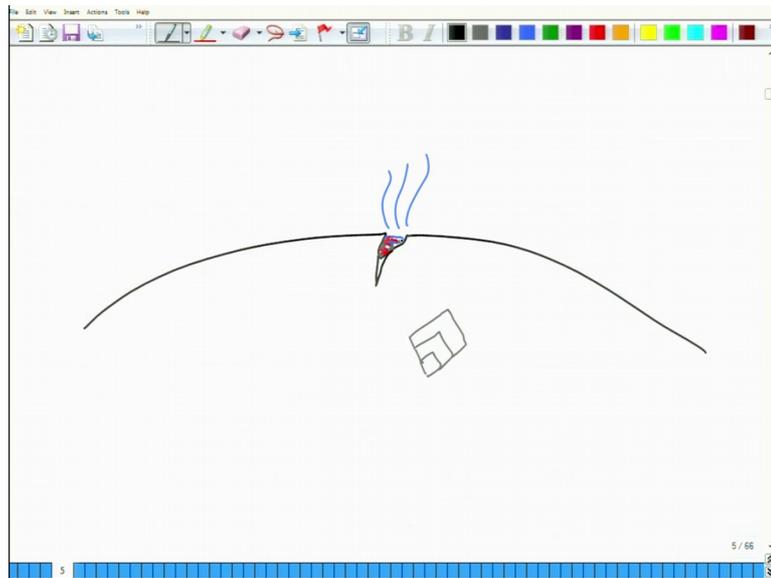
So, probably this area becomes very warm and then in the night time when the area cools down. So, this area is now suffering. It is now becoming cold and. So, it is the off shrinking. Now for a number of materials when you heat up the material, the size increases; when you cool it down, the size reduces. Now in this case because of the continuous action of sun and the moon you will have some expansion in some contraction that is happening on the surface at all times.

Once that happens that will also lead to the breaking up of the rock surface and in the case of rocks such as granite, this is known by the term of onion weathering because just

like if you take a piece of onion, you will have a number of a leaves that are one. So, similarly in this case you will have a rock that will look something like this.

So, after a while you will have see a small section that has come out here, a small section that has come out here, a small leaf that has come out here and so on. So, in this case your rock is now getting separated layer by layer. So, just like in the case of an onion, you have layers that are forming on the surface which are also leading to cracks here.

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Similarly if you have us a rock with a small crack and probably, this area is close to the seas. Now if this area is close to the seas then you might have some amount of sea water that is coming into that this area or probably some amount of salts that are being blown along with the wind and are getting deposited here.

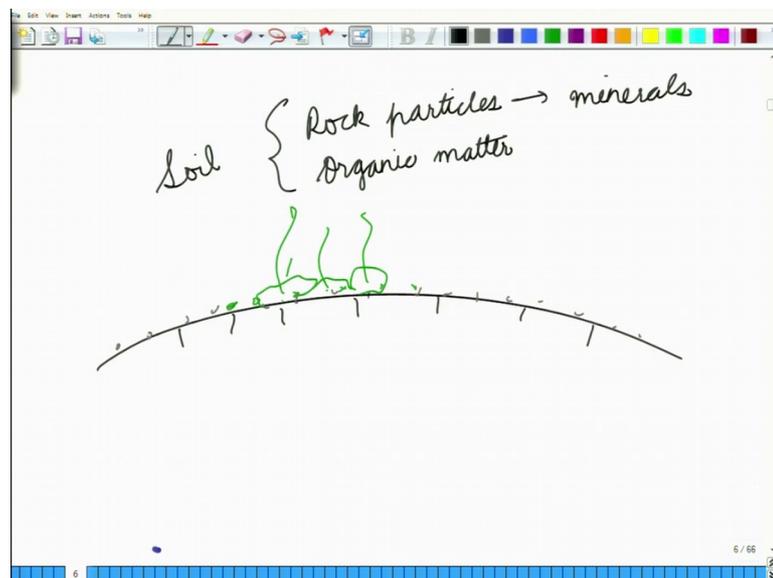
Now, what happens? If you have say a small amount of salty water brackish water here and when a you have the sun. So, this water starts to evaporate. Once that starts to evaporate the, the salt particles they start accumulating here. Then later on maybe some more amount of water came along with the salts. So, you again that evaporated.

So, after a while you will have a salt solution that is of a very high concentration and in this high concentration when you again have the sun. So, you will start seeing crystals of salt that are forming here. Now again once you have this crystal formation the salt crystal that was earlier say small in size that will start becoming larger and larger in size. Now

during this process of crystallization as your crystal is expanding, there also it will start exerting forces on these surfaces and because of these forces the rock might crack further.

So, when we are talking about succession, it is not just the biotic organisms or the different populations that are playing a role, but at the same time the climatic conditions or the prevalent conditions are also playing a role in this case. Now once you have these cracks you started with the lichens, now you have reached the moss stage. Now the moss will further accentuate the cracks and after a short while when these mosses start to die, their bodies will start converting into the humors. So, now, you have an area where you have this rock.

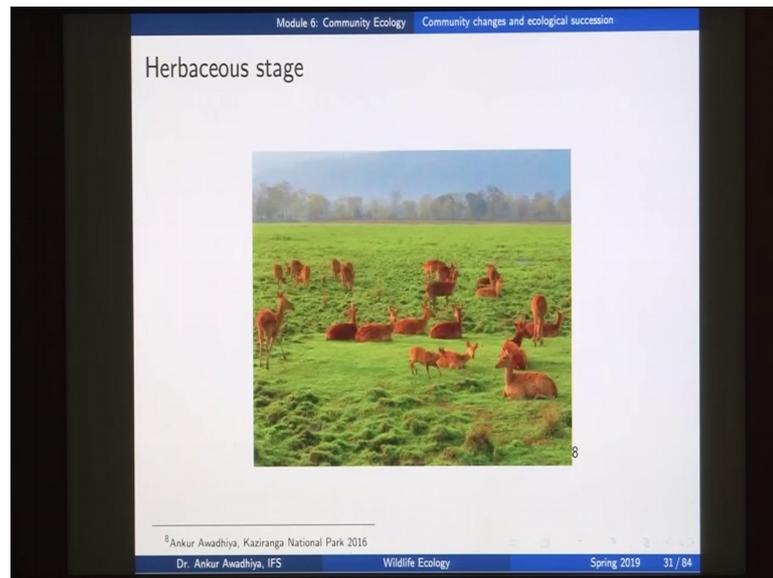
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This rock is cracked in a number of places, then this rock has also been converted into a powdery form at a number of places. Now, these rocks also have some lichens and maybe some mosses that have come up and they are also dying. When they are dying you are also having some organic material that is coming up into this area. So, what do you have now? You have rock particles which is providing you minerals, you have the organic matter which is coming from the dead tissues of these different species. Once you combine both of these together, what is this is soil? So, now, you have soil in this area.

So, because of the action of the climate because of the action of different plants, now this rock has this top layer of the rock has now been converted into soil. Now once you have soil in an area, you will start seeing some other species maybe you will start seeing crosses in that area.

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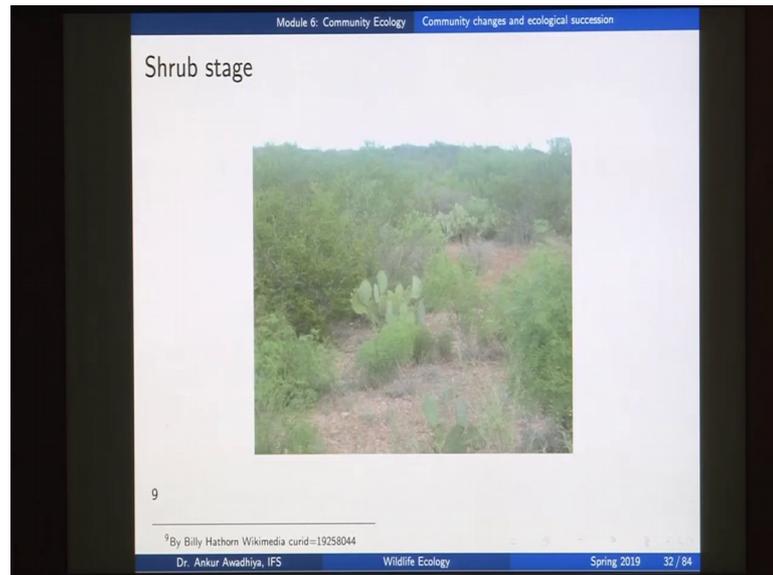


Now, grasses are much more prolific species, they are able to perform photosynthesis in a much better way. And once you starts seeing grasses in this area so, the mosses and the lichens; they have now been out competed. So, they are they get removed from the system and now you have lots and lots of grasses.

Once you have these grasses they are now further breaking up the soil or they are further breaking up the rock surface that is down there because of they have because they have a very extensive root system. So, in the case of your mosses you did not have an extensive root system, but now you even have a more extensive root system you have a much better photosynthetic ability. So, you are able to generate a much larger amount of organic matter.

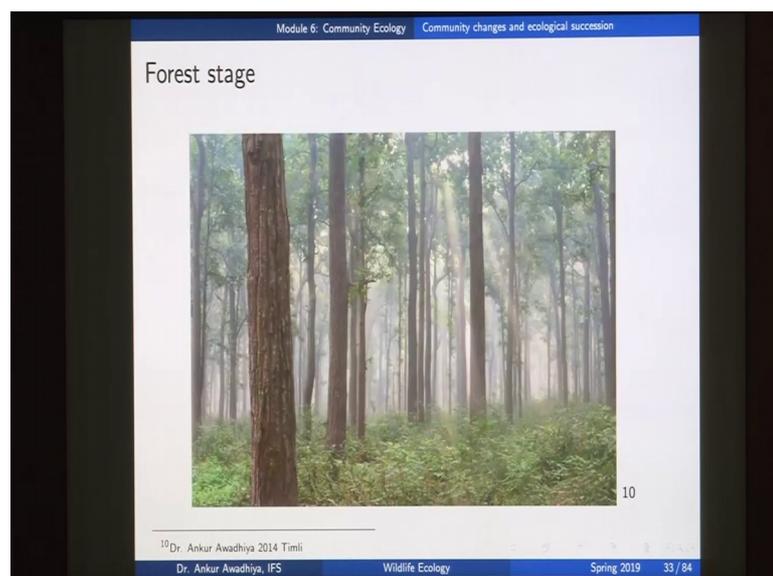
So, in this process the rocks are now breaking up even further and after a short while these grasses will make way for shrubs.

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Now as we are moving from the grasses to the shrubs, we will observe that the requirement of different nutrients will change again because grasses can grow in the low nutrient environments, but your shrubs will require typically a higher nutrient conditions. Now these higher nutrient conditions are brought about because the grasses were able to break the rocks break the soil. And so, much more amount of nutrients now becomes available for the growth of these plants and after the shrubs you will start seeing.

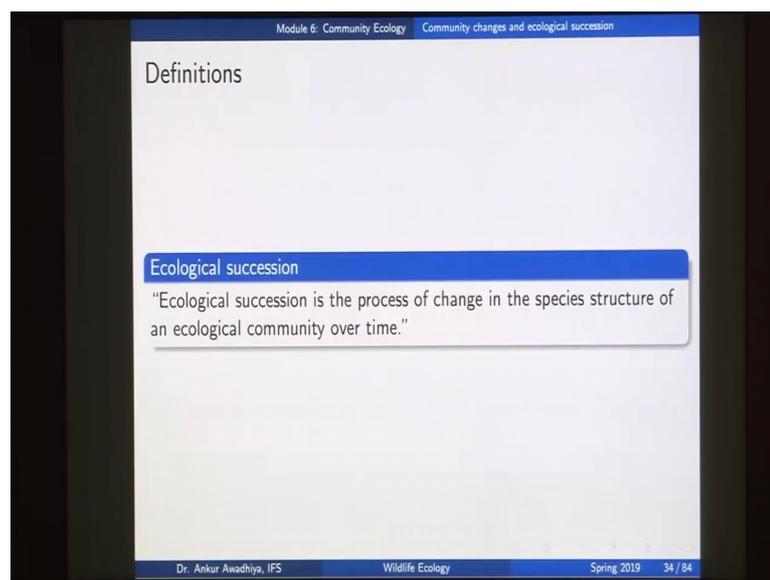
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A forest in a short while now a forest is typically referred to as a climax community so, this is typically the end where your succession is going to end. So, you start from a bare rock you move from lichens to mosses to grass to shrubs to trees and ultimately you reach to a climax stage which is the forest stage. Now this is what succession is all about. So, when you talk about succession you are asking which species is making way for which species. So, who comes after whom that is what you are asking when you are studying succession.

So, for instance even in the case of royalty when we say that there is this particular prince who is going to succeed his father as the next king. So, that is succession. Here in the case of ecological succession, we are asking which community is getting succeeded and which community is succeeding the previous community.

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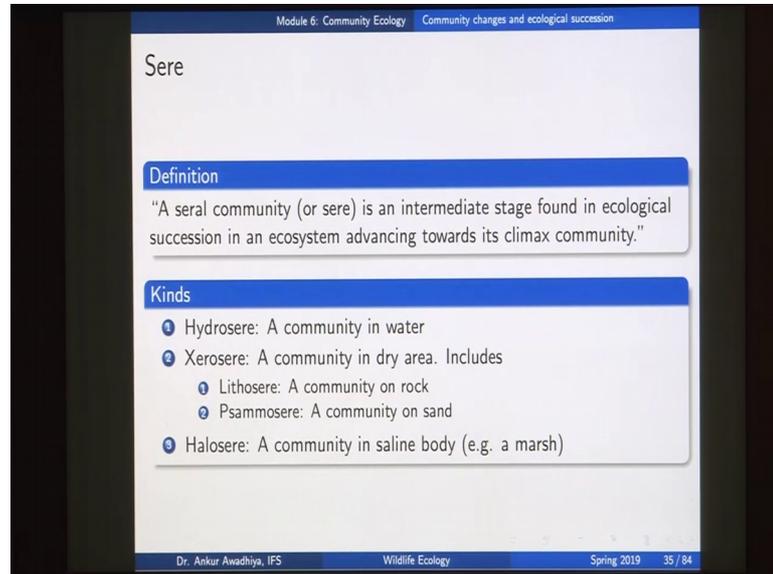


Now, we define ecological succession as the process of change in the species structure of an ecological community over time. Now we have this ecological community which was having your lichens in an area maybe it was having say two or three different species of lichen. But then slowly and steadily the species structure is changing, you are getting other species such as grasses you are getting shrubs.

The earlier species are getting out completed, they are dying off, they are making way for these newer species and so, the species structure of the ecological community is

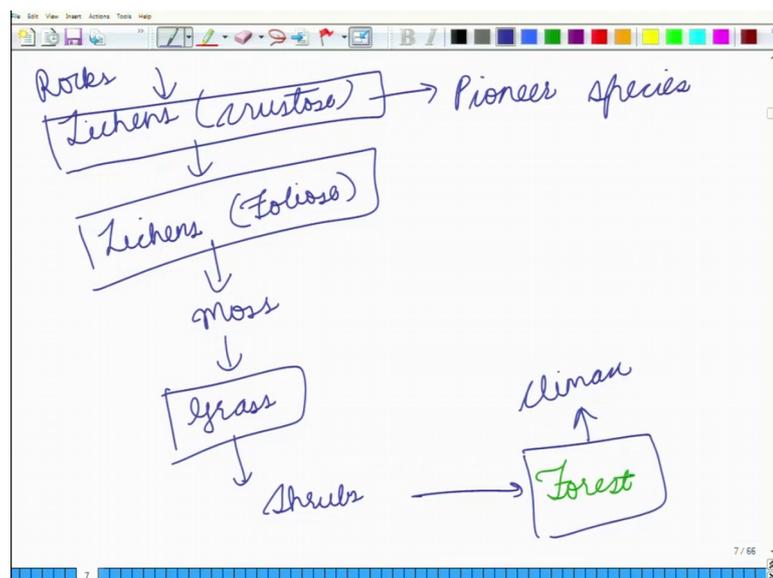
changing at all times. And the process of this change is known as ecological succession. It takes place over a long period of time.

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And we also have this other term which is called as sere or a seral community is an intermediate stage found in ecological succession in ecosystem advancing towards its climax community.

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So, essentially when we were referring to a community that ultimately became a forest. So, this community started with your lichens which was both crustose and then followed

by your lichens that have foliose structure. So, crustose lichen followed by foliose lichen, followed by your mosses , followed by grass , followed by shrubs and followed by the forest; so, all of these different communities.

So, if you are talking about our community that is all full of lichens that is called a seral stage in this succession. If you talk about a community that has grass that is a seral stage in this succession. So, a seral community is an intermediate stage it is not the final stage, but it is the intermediate stage that is found in ecological succession in an ecosystem advancing towards its climax community.

Now in this case the forest is the climax community. Now when we talk about seres, they are of three different kinds the first one is known as a hydrosere. Now hydro is water, sere is your serial community. So, this is a serial community that is found in water and we will have a look at it in more detail in a short while. The second one is a zero sere now zero is dry. So, dry community a community in a dry area this includes a lithosere. So, a lithosere is a community on a rock as we just saw and it could also be a psammosere. Now psammosere here is you have sand and community. So, it is a community on sand.

So, if you look at ecological successions that are happening on on sandules that is their example of psammosere. The third kind is a halosere now halo is salt sere is a community. So, you have a community in salt or a community in a saline body such as a marsh.

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Module 6: Community Ecology Community changes and ecological succession

Pioneer species

Definition
"Pioneer species are hardy species which establish themselves in a disrupted ecosystem and trigger the process of ecological succession"

Characteristics

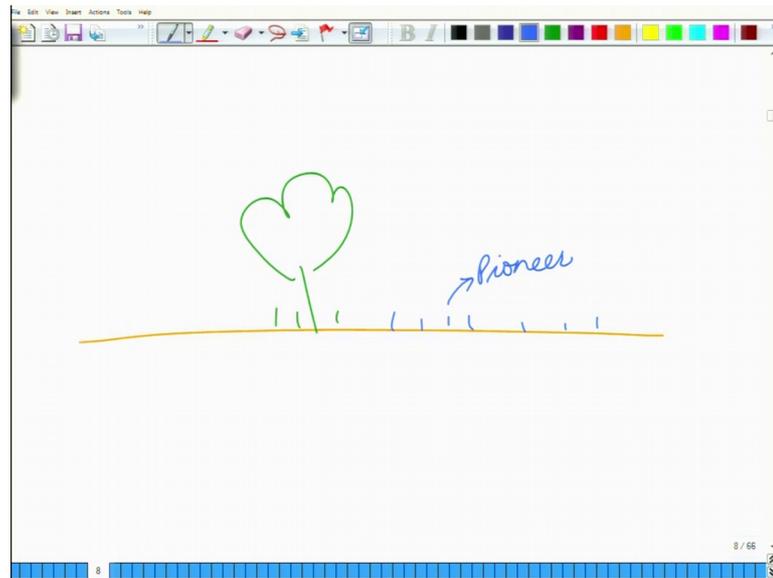
- 1 ability to grow on bare rocks, nutrient-poor soil or water
- 2 ability to tolerate extreme conditions such as heat and cold
- 3 less nutritional requirements; often photoautotrophs
- 4 small size
- 5 short life span with rapid growth; mostly annual species
- 6 ability to disperse through spores or seeds; prolific seed production

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Now when we talk about the succession, this succession proceeds from a pioneer species towards a climatic climax species. Now in this case, we had started with rocks and the first community that came up was this crustose lichen. Now this would be called as a pioneer species because this is the first one to come up. So, it is a pioneer. So, pioneer is the first one, climax is the last one and everything in between is a seral or a seral community.

Now, pioneer species are defined as they are hardy species which established themselves in a disrupted ecosystem and trigger the process of ecological succession. Now they may come up in an area where you did not have any community beforehand or they may come up in a disrupted ecosystem. Now what do we mean by a disrupted ecosystem?

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So, probably you have a forest and in this forest you have a number of trees probably you have some shrubs, you have some herbs and so on and then you have a forest fire because of which all of these die out. So, now, you have a community in which you have disrupted something. So, probably a few trees remain in this area, but then everything else has been disrupted. Now what would come up in these areas? So, the first species to come up in this area we will again be call a pioneer species because it is the first one to come up in this disrupted ecosystem.

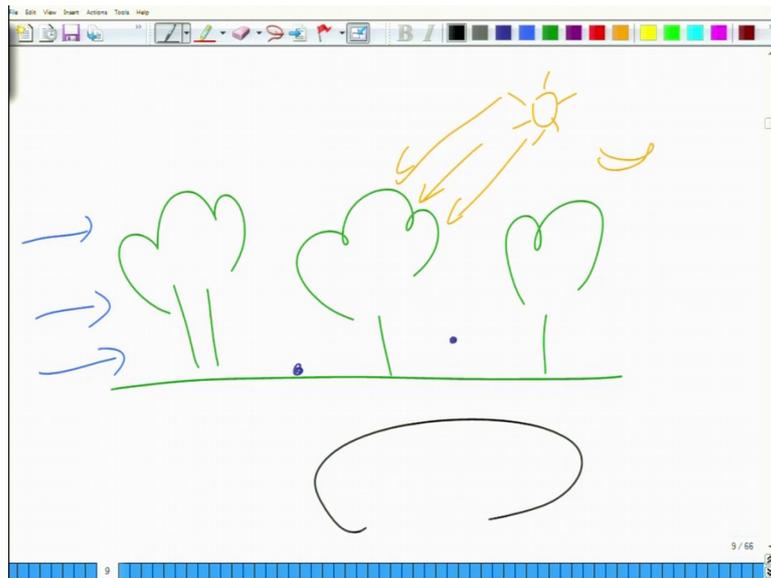
So, pioneer species are hardy species which establish themselves in a disrupted ecosystem and triggered the process of ecological succession. So, if you do not have a pioneer species, you will not have the ecological succession because there is no other species that can replace these pioneer species. Now why is that so? Because of their specific characteristics the characteristics are their ability to grow on bare rocks nutrient poor soil or water.

So, they are the first one to come up and they can come upon bare rocks where you do not have any soil or they can come up in a soil that is nutrient poor or they can even come up in a soil that is or they can even come up in water that is also nutrient poor. Now what are the examples of these soils that are nutrient? So, consider a glacier.

Now, a glacier when it is moving from one place to another it is also grinding the rocks that are below the glacier. And once this glacier melts the rocks that have been ground up

they come up in the form of a soil in that soil is extremely nutrient poor; it does not have any organic materials, it does not have a number of minerals because it has never been acted upon organically. So, the organisms that can come up in search of soil that will also be the pioneer species; that other characteristics are the ability to tolerate extreme conditions such as heat and cold.

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Now when we are talking about a community that is coming up on a piece of rock. So, in the daytime it is getting exposed to very hot conditions, in the night time it is getting exposed to very cold conditions.

Now if we have a community that is coming up in a forest. So, in this forest you have much more moderate climatic conditions because all the time you are having a high moisture level. If you look at a location say here or a location see here. So, you have a high moisture content you are not exposed to the direct rays of the sun because the plants are turning it out and then you are also not exposed to a very cold condition because the air movement that would have happened in this area is also being starved because of the trees. But in the case of a bare rock, you will be exposed to all the conditions.

Now, the pioneer species are able to tolerate these extreme conditions, they are able to tolerate extreme heat. They are able to tolerate extreme cold, they have less nutritional requirements and they are often photoautotrophs because they are photoautotrophs because there is nothing else available for them. So, only those species can come up and

have less nutritional requirements. If there is a species that requires say nitrogen phosphorus potassium in high concentration maybe in a water soluble form that is available in soil that cannot be a pioneer species.

They are typically small in size because again you have less amount of nutrients that are available, you have very extreme conditions and so you are not able to or these species are not able to support a very large body size. So, they are small in size. They often have a short life span with rapid growth and they are mostly animal species. So, they are not perennial species, they cannot remain there for a number of years, they probably come up in those conditions that are favorable and then they die off.

So, probably in the very extreme summers, they will die off probably in very extreme winters. You will not see these the species probably these species will come up in the spring season in that area. Now because you have spring season only once in a year so, these the species will come up only once in a year and then will die off. So, they often have a short life is span as against forests species or the climatic or the climax species that have a very long life span.

Then they have the ability to disperse through spores or seeds and they are also prolific seed producers. Now there they have to be those species that are able to disperse through spores or seeds because otherwise when you talk about a bare piece of rock say, of a volcanic origin. Where do you get these? Spores in the first place or where do you get this pioneer species in the first place

So, they have to have a dispersal mechanism through either air or through water. So, they have to go out spores or seeds and typically these plants are also very prolific in their seed production.

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Module 6: Community Ecology Community changes and ecological succession

Climax

Definition

"A biological community of plants, animals, and fungi which, through the process of ecological succession in the development of vegetation in an area over time, have reached a steady state."

Kinds

- 1 Climatic climax: controlled by the climate of the region
- 2 Edaphic climax: controlled by the soil conditions of the region
- 3 Catastrophic climax: controlled by some catastrophic event such as wildfire
- 4 Disclimax: controlled by some disturbance (man or domestic animals)

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On the other hand, we have the climax species. So, in our example the forest was the climax species. Now a climax species is defined as or a climax community is defined as a biological community of plants, animals and fungi which through the process of ecological succession in the development of vegetation in an area over time have reached a steady state. So, essentially when you talk about a climax community, it is a steady state community. When we see a steady state it means that it is able to remain as this community for a very long period of time.

So, once you have these sal forests in this area so, probably they will continue for hundreds of years because they are in a steady state there is no other factor that is now pushing them towards some other community or towards some other change. So, it is a biological community of plants animals and fungi. Now why does it have all these together? Unlike a pioneer species that is making way for itself in the case of a climax community you have so many species that are together that they are able to support each other.

So, when you have the plants that are growing. So, these plants will be giving out leaves. These leaves upon dying they will fall onto the ground and if you do not have fungi, then you will not be able to break these leaves down into the nutrients again. Or if you do not have say these animals here so, in that case probably there would be some species that would try to out compete everything else.

Now because you have these predatory organisms because you have these animals and because you have a rich biodiversity with a lot with a number of decomposers. So, this community is able to sustain itself for a very long period of time. So, that it has reached a steady state. Now there are four kinds of climaxes that have been recognized. The first one is a climatic climax which is controlled by the climate of the region.

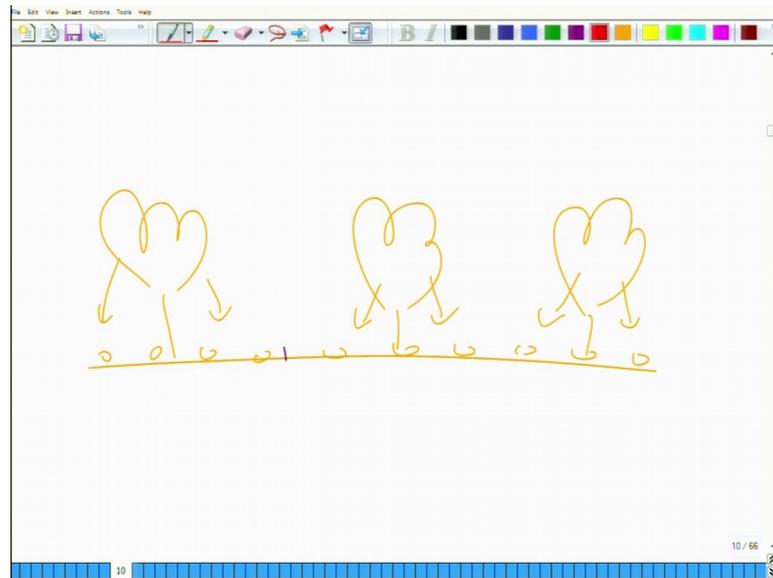
So, for instance when we talk about a sal forest that is a climatic climax. So, it will come up in an area that has sufficient amount of moisture that is probably a cooler area. So, that is the species that will come up and that will come up and the community that gets formed because of these sal trees the forest that would be a climatic climax because it has been determined because of the climate and it continues to remain there for a very long period of time.

The second one is in edaphic climax. So, that is controlled by the soil conditions of the region. So, different kinds of soils will be having different kinds of climax species or climax communities. So, that is when you have a condition like that it is known as an edaphic climax.

The third one is a catastrophic climax that is controlled by some catastrophic event such as wildfire. So, a good example would be your teak forest. Now in a teak forest, you have these deciduous a trees in the form of (Refer Time: 35:57) and these trees shed their leaves when you shed when these trees shed their leaves, you have ample amount of dry fuel that is available there and so they are very frequently prone to forest fires.

Now once you have the forest fires in these areas so, a number of other species that are now trying to push it towards some other serial stage will die off.

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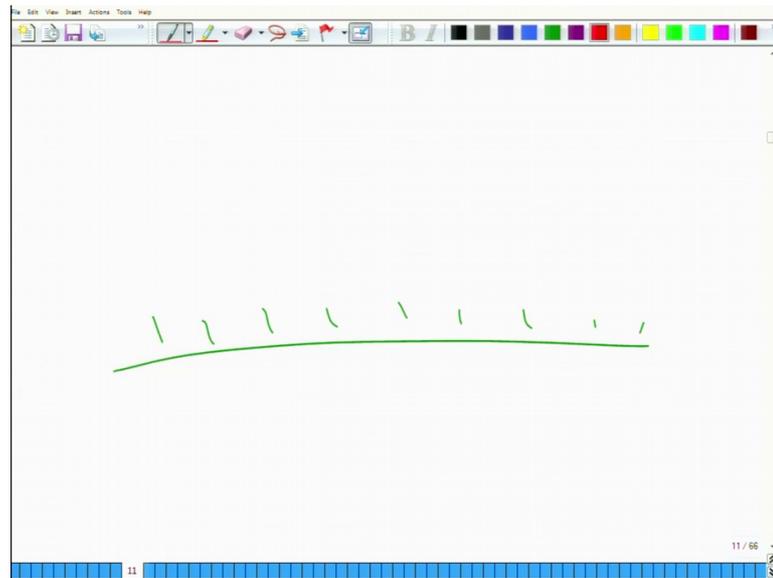
So, in this case what we are saying is that you have these forests, you have these teak trees and probably you are having some other trees that are now coming up.

Now these teak trees when they shed their leaves so, you have a lot amount of fuel that is available on the forest floor. And when you have a very high fuel load so, typically these forests get engulfed in a large size fire or these are rapidly or these are frequently exposed to forest fires.

Now once you have these forest fires, then the species that are not able to resist these fires they die off. So, these species die off, but then the teak plants because they are fire resistant. So, they are able to survive. Now if we do not have forest fires in these areas, then probably these teak forest will start converting into something else. So, they will start converting into a forest that is probably having more amount of moisture in that area, but then because we are having these forest fires every year or year after year.

So, in that case they are able to maintain themselves as a teak forest or as a teak community. So, in this case the climax that has been formed is formed because of this catastrophic event and so, it is known as a catastrophic climax. And the fourth one is a disclimax and that is controlled by some disturbance which could be man or domestic animals and a good example is grasslands.

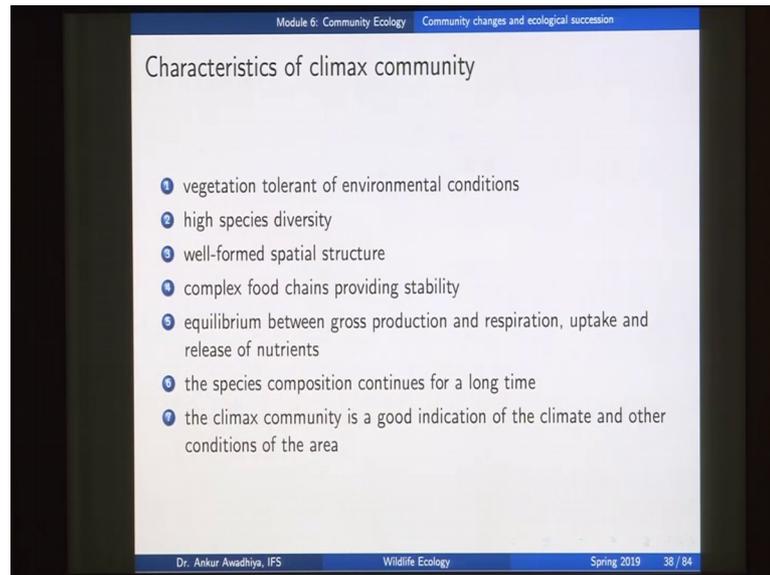
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So, in a grassland; so, suppose you have these grasslands and these grasslands are being used for say cattle grazing. Now when that is the situation if there is any shrub that is coming up in this area, the man would come and it would kill off these. So, these would be uprooted. So, because of the action of human beings, these climax these communities are not able to evolve further.

So, they are not able to convert into a shrub line or maybe into a woodland or into a forest. So, such kinds of communities that are governed or that have reached their climax stage because of some disturbance either due to man or due to domestic animals. So, these kinds of climates communities are known as disclimax communities.

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Now whatever the kinds of climax that we see the climax community will have certain characteristics. What are those characteristics? The vegetation is tolerant of the environmental conditions. So, for instance when we talk about a sal forest, you will not get a sal forest that is there in a marshy area because it is an intolerant of the environmental conditions.

It will only be formed in those areas where the environmental conditions are suitable. So, the vegetation that comes up in a climax community, it is tolerant of the environmental conditions. The climax community typically has a high species diversity, it has a well formed spatial structure. When we see a spatial structure it means that we have a good top canopy middle canopy a say low your shrubs your ground cover and so on.

So, it has a well formed spatial structure, there are complex food chains that provide stability to this community. So, if you have a very simple ecosystem so that cannot be a climax ecosystem. You will typically have a very complicated structure you will have a number of food chains you have a very complex food web. So, that even if there is some amount of disturbance probably one particular species dies off or it gets reduced in its numbers so, in that case there should be some other species that is able to support the community.

So, in that case you will have very complex food chains that will provide stability because remember that in the case of a climax community, you want to have a situation

that it is a steady state. It should persist it should prevail for a very long period of time. So, for that you require stability which is provided by complex food chains in food webs. Then there is equilibrium between gross production and respiration uptake and release of nutrients. When we mean what do we mean by this equilibrium if there is more uptake of nutrients and less the release of nutrients.

So, in that case your community we will suffer some sort of a change because you will have a soil that is getting depleted year after year. So, in that case the organisms that are living or the vegetation that has come up, it might change there might be some other species that would out compete the presented species because the presented species require much more amount of nutrients. They are taking up much more amount of nutrients, but then the soil is getting poorer and poorer with time. So, that cannot be a situation because if that be the situation, then your community will change with time and a climax community cannot change.

Or suppose you have a situation in which the uptake of nutrients is less the release of nutrients is more. So, in that case your soil is changing the soil is becoming more and more fertile with time if that is the situation. So, in that case we will have some other plants that are better able to use these nutrients and they will come up and they will start out competing the present species. So, there again you will have a situation that is not a climax situation, but as an intermediate situation.

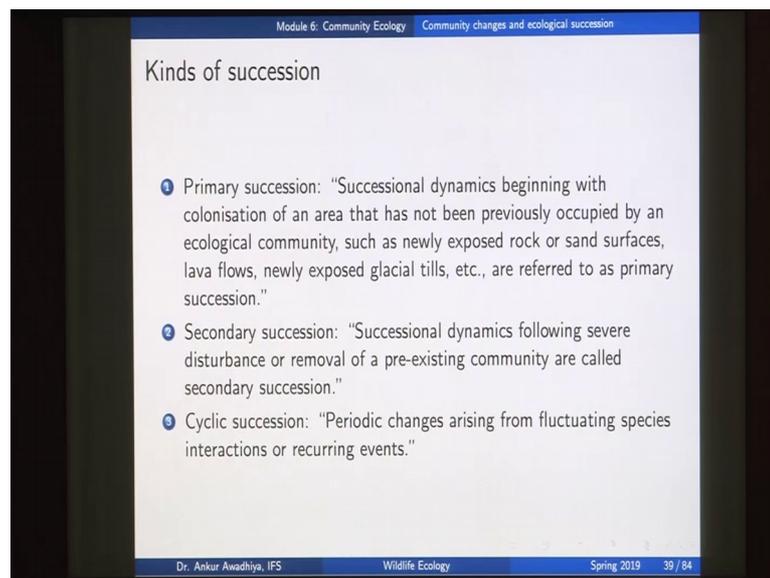
Similarly you have equilibrium between in gross production and respiration. So, on an average the amount of energy that is coming into the system is also getting lost because of respiration because of having a number of animals in this area. Suppose you have a gross production that is greater than respiration. So, in that case you will start accumulating more and more biomass in this system and once that happens because it is changing with time we will say that it is not a climax community.

So, a climax community needs to have an equilibrium between a number of things such as gross production and respiration and uptake and degrees of nutrients. Also the species composition continues for a long time again because it maintains a steady state. So, the species composition is not going to change.

The climax community is a good indicator of the climate and other conditions of the area. Now because you have these climax communities that are tolerant of the

environmental conditions. So, if you have a climate community that has come up, you can just use the species that are found in the climax community to get an idea about the general climate and other conditions of the area; what is the soil type, how much amount of moisture, do you have what is the climate of that area? You can all you can tell about all of these just by looking at the climax community because that is dependent on the environmental conditions and that is going to continue for a long period of time.

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Now we have talked about succession. Now let us look at the kinds of succession. There are three different kinds of succession. The first one is called as a primary succession. Successional dynamics beginning with colonization of an area that has not been previously occupied by any an ecological community such as newly exposed rock or sand surfaces lava flows newly exposed glacial tills etcetera are referred to as primary succession.

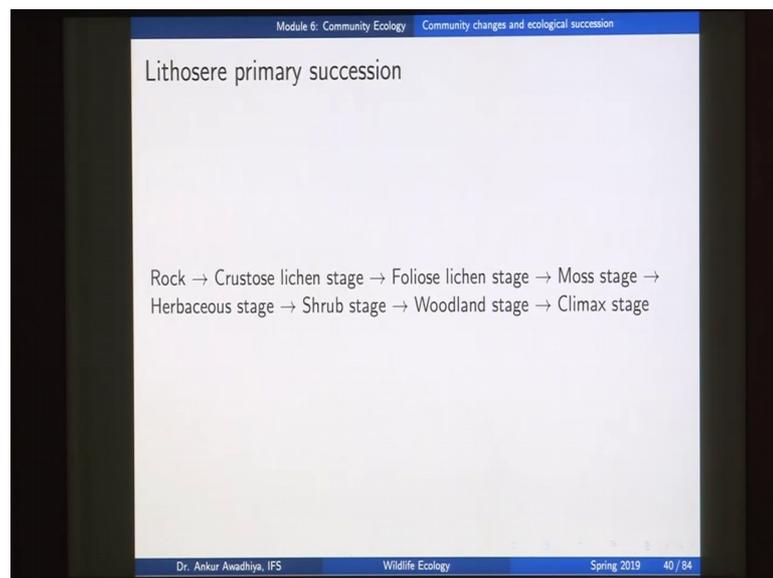
Now in the case of a primary succession, it begins with an area that never had an ecological community beforehand such as the bare rock situation that we just saw. The second one is a secondary succession a secondary succession is successional dynamics following severe disturbance or removal of a pre existing community are called secondary succession. A good example is a forest that suffered with a forest fire and in that forest fire all the plants died off and so, you have an area that is now devoid of any vegetation.

Now when succession starts again in that area, that is known as a secondary succession. The third one is cyclic succession which is periodic changes arising from fluctuating species interactions or recurring events a cyclic succession. A good example is that of the Brahmaputra floodplains.

. So, every year you get floods in that area. So, the species that are already there they get a they die off because they get drowned and then every year you have a succession that it starts have an issue. So, every year you get a grassland and then after a while you will get a flood again. So, all the species will die off and then again you will have the grasses that are coming up in this area. So, that is a cyclic succession.

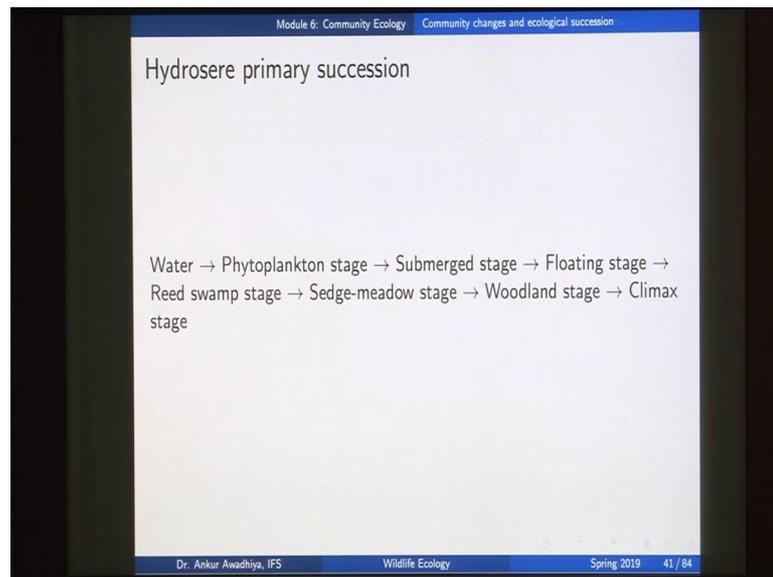
So, primary succession is succession in an area which never had any community, a secondary succession is in area which had a community, but everybody died off and a cyclic succession is a succession that occurs in an area with some recurring events.

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Now let us look at some examples of primary succession. Now the first one is lithosere that we have already seen. So, from rock you move to crustose lichen to folios lichen to moss to herbaceous stage where you have the grasses to shrub stage to woodland stage and finally, to the climax stage. So, that is a lithosere which is rock community.

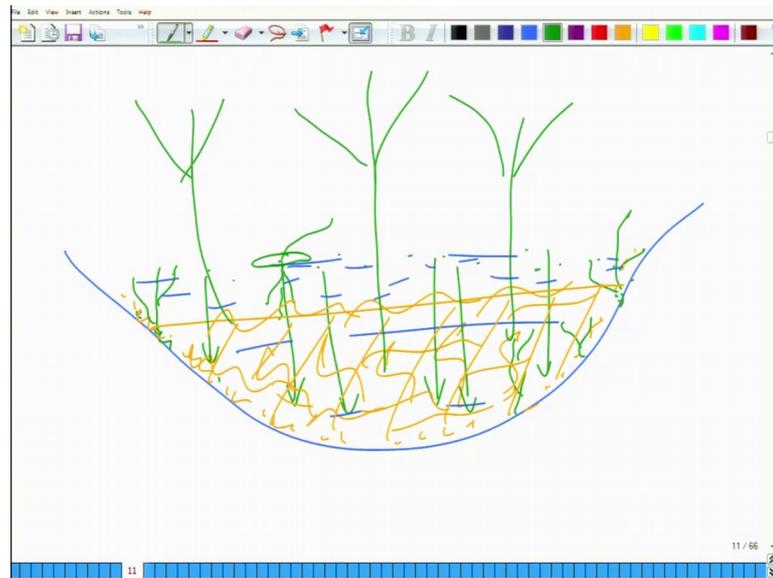
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The second one is a hydrosphere which is a water community. Now you have this water community and you have a primary succession. So, you have a body of water that has newly come up. So, probably there is an area that just got filled up with water. So, what will happen? From the water stage you will move to the phytoplankton stage because the phytoplankton will be the first community that will come up.

So, these are the pioneer species from the phytoplankton, we will move to a submerged stage. Now in the case of a submerged stage, you will have some plants that are coming up and they are submerged.

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So, probably this is your water body and the first thing that will come up will be the planktons that will come on the very top because that is the photosynthetic zone. Now once these planktons have started dying with time so, you will have these bodies that are now coming down and once that happens you have some amount of soil that has that has started accumulating in the bottom.

Now once you have these soils which are formed because of these organic materials that came from these planktons. So, now, you will start seeing some submerged vegetation. So, you will start seeing some plants that are coming up which are submerged. After this submerged stage, you will start seeing some floating vegetation a floating vegetation is something that is coming up. It has these roots here and it is getting all the nutrients just from the water itself. It is not getting into contact with the soil.

Now from the floating stage the next will be the reed swamp stage. So, now, in the reed some stage, it will be coming up in the marshy areas. So, typically what is happening is that all these plants that are now forming they will also start dying off with time and so, the bottom layer is now increasing with time.

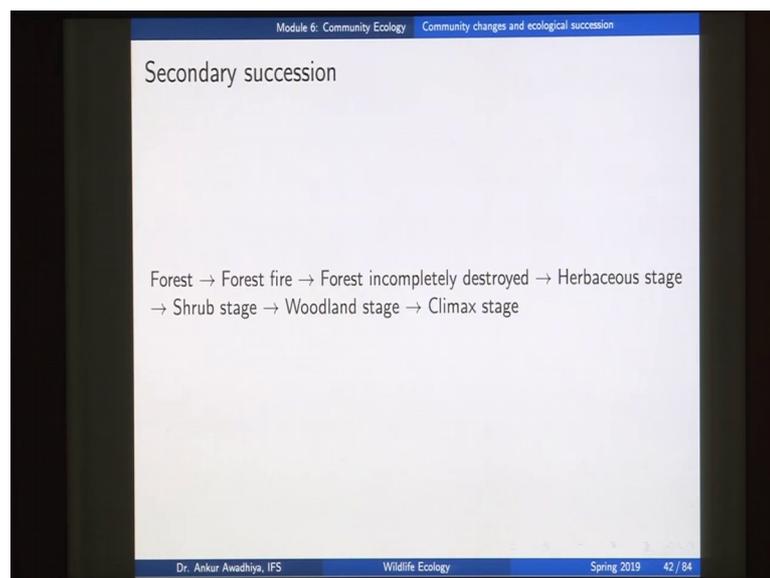
Because you now, have much more amount of accumulation much more amount of organic material that has come up. So, now, this area has started converting into a marshy area. Once it converts into a marshy area, you will have the reed state. The reed will be followed by a meadow stage sedge and meadows that will come up after the meadows.

So, meadows are very much like tall plants that are living in that area and that this is equivalent to a shrub stage that we see in the lithosphere. Now after this stage in meadow stage, you will again have quite a lot of water that is being taken out because of transpiration quite a lot of organic matter that is getting deposited because now you have large size plants. So, more and more amount of soil is getting formed, more and more amount of humus getting form.

So, from the sedge in meadow stage, you will move to the woodland stage where you start getting some trees in this area. So, typically with time your organic matter is increasing in this area. So, once we have much more amount of organic matters we will have the situation where this much area is now or all filled with the organic material and you have a very slight amount of water that is there on the top. So, here you will start seeing large size plants.

Now from these large size plants they will be using up more and more amount of water and after a while you will start seeing trees in this area and from the trees you will move to the climax community which is determined by the existing prevailing conditions in that area; what is the climate in this area, what is the availability of water in this area, what is the soil that is coming up in this area and so on.

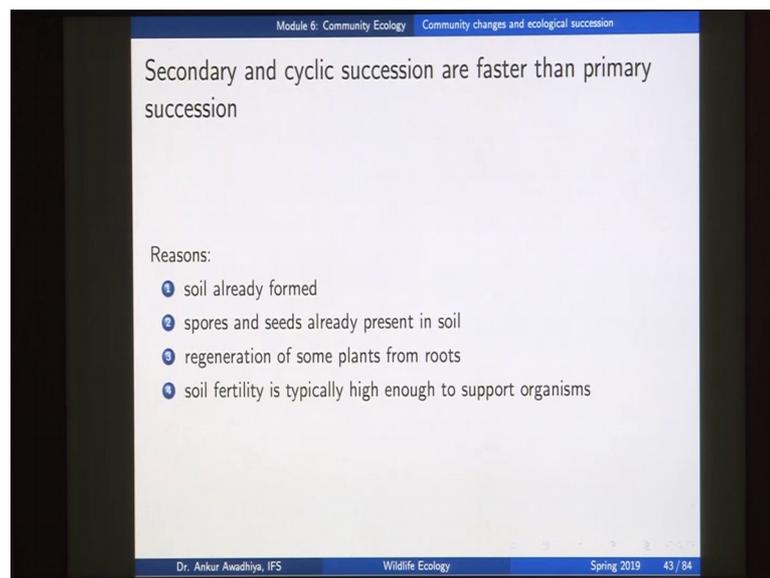
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Now that is the primary succession. What about the secondary succession? A secondary succession is something like you have a forest, you have a forest fire. So, you have a

forest that is incompletely destroyed. From there you have the herbaceous stage because you already have quite a lot of soil in this area. So, you will not start with the lichens and mosses, you will directly start with the grasses. So, you will have the grasses that come up followed by the shrubs, followed by the woodland, followed by the climax.

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And typically we will observe that a secondary succession is much faster than a primary succession because you already have soil in this area. So, even if the forest were burnt because of the forest fire you, but you still have the soil that remains in this area.

So, you have in a soil that is already formed, you do not have to start with a rock and start with breaking of the rocks. So, it is much faster. You already have spores and seeds that are present in the soil. So, there would be some seeds that are left unburned and they will start the process of succession.

As against in the case of a primary succession various pores had to be brought by the action of wind or water. Also there can be regeneration of some plants from the roots. So, because you have these roots that are there inside the soil and the top layer got burnt, but the roots remain. So, probably there would be some amount of vegetative growth from the roots itself. So, that will also start and typically the soil fertility is high enough to support the organisms.

So, in the case of a primary succession such as a rock the fertility was less, but in this case the fertility is already high because it was already supporting a large size forest community.

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Module 6: Community Ecology Community changes and ecological succession

Kinds of succession

- 1 Autogenic succession: "Brought by changes in the soil caused by the organisms there. These changes include accumulation of organic matter in litter or humic layer, alteration of soil nutrients, or change in the pH of soil due to the plants growing there."
- 2 Allogenic succession: "Caused by external environmental influences and not by the vegetation. For example, soil changes due to erosion, leaching or the deposition of silt and clays can alter the nutrient content and water relationships in the ecosystems." Other examples include volcanic eruptions, meteor or comet strike, flooding, drought, earthquakes and non-anthropogenic climate change.

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Now, succession is also classified as autogenic succession or allogenic succession. Now auto is self gen is food production. So, autogenic is something that produces itself, allow is outside genic is production. So, it is production from outside.

Now autogenic succession is a succession that is governed by something that is inside it is brought by changes in the soil caused by the organisms that are already present there. These changes include accumulation of organic matter in litter or humic layer alteration of soil nutrients or change in the pH of the soil due to the plants growing there. Now in the case of an autogenic succession, you have the organisms that are already present.

Now, because we have these organisms they are bringing about some changes in the biotic and the abiotic components of that ecosystem. So, for instance you had this rock and this rock had some lichens. So, because these lichens were able to break down the rocks further so, they were making way for new species such as the mosses that is an autogenic succession. Allogenic succession is caused by external environmental influences and not by the vegetation.

So, for example, soil changes due to erosion leaching or deposition of silt and clay can alter the nutrient content and water relationships in the ecosystem. Other examples include volcanic eruptions meteor or comet strike flooding draught earthquakes and non anthropogenic climate change.

. So, what we are seeing here is that in the case of an autogenic succession, you have a plant or a community that is already there and this community is making some changes that is leading to the succession. In the case of an allogenic succession there is no role of the community that is already present, but we bring about a much greater influence from outside that is leading to a succession.

So, a good example is something that we saw in the case of Brahmaputra. So, the Brahmaputra river floods every year. So, because of this flood you have a succession that starts it does not caused by the grasses that are already present in that area. But in the case of an autogenic succession, the succession will be caused because of the organisms that are already present.

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Module 6: Community Ecology Community changes and ecological succession

Phases of succession¹¹

- 1 Nudation: Succession begins with the development of a bare site, called nudation (disturbance).
- 2 Migration: It refers to arrival of propagules.
- 3 Ecesis: It involves establishment and initial growth of vegetation.
- 4 Aggregation: Increase in numbers and population densities.
- 5 Competition: As vegetation becomes well established, grow, and spread, various species begin to compete for space, light and nutrients.
- 6 Reaction: During this phase autogenic changes such as the buildup of humus affect the habitat, and one plant community replaces another.
- 7 Stabilization: A supposedly stable climax community forms.

¹¹Clements, F.E., 1916. Plant succession: an analysis of the development of vegetation (No. 242). Carnegie Institution of Washington.

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Now, we can differentiate between different phases of succession. So, this is typically what you can correlate to the rock example that we have seen. So, this the succession begins with the nudation stage. So, nudation is making something bare. So, it begins with the development of a bare site such as a rock surface or maybe a new lake that has formed. So, that does not have anything else it is completely bare. So, that is nudation.

After nudation you will have migration which refers to the arrival of the propagules. So, in the case of your rocks, you have the spores of lichens that are coming up from outside. So, that is migration in this terminology.

Now remember that we had defined migration as a seasonal movement of organisms from one place to another in typically in a repetitive manner, but in this case when we talk about succession migration is just defined as the arrival of propagules. So, this is not the usual definition of migration.

So, once you have the migration, then you have ecesis. Now ecesis establishment and initial growth of vegetation so, you had these lichens that establish themselves and then they started growing in that area. Next we have aggregation which is increase in numbers and population densities. So, earlier you had a small patch of lichens, now you have a larger patch of lichen and there are a number of like individuals that are there in this population. Now once you have aggregation the next stage will be competition. So, the vegetation has become well established it grows and spreads. So, now, various organisms or various species now begin to compete for space light and nutrients.

. So, when you had this lichen stage probably there were a few moss spores that also migrated into this area, but now you have a competition and in this competition now you are pitting up the lichens against the mosses. Once that happens, there would be some species that will be out competed and some species that will be able to keep themselves fixed in that area.

Now after competition we have the reaction phase during this phase and the autogenic changes such as buildup of humous affect the habitat and one plant community replaces another. Now you have competition between lichens and mosses, but then the lichens have already changed the soil in that area. So, they have made the soil much more fertile and so, when there is a fertile soil that is available. So, the mosses are able to out compete the lichens.

So, the lichens made way for the mosses and one plant community has now replaced another. So, that is the reaction phase. And these phases we will continue because after you have a moss community, you will start again with this phase you will have migration of grass seeds and then there will be a ecesis. So, you have these mosses that are now

establishing themselves, they are increasing in their numbers there is competition, but then there has also been migration of some grass seeds.

So, in that case you will again have a reaction in the case of reaction the masses will make way for the grasses the masses will die out grasses will establish themselves and then again you move with the establishment aggregation competition and reaction.

Now in the next stage the reaction will be with the shrub seeds that have migrated into this area and this process continues again and again. Until you reach a phase of stabilization in which you have reached a climax community. So, now, there is no more change that is possible whatever is there is the most optimum stage. So, these are the phases of succession.

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Module 6: Community Ecology Community changes and ecological succession

Theories of climax

- 1 Monoclimax or Climatic Climax Theory: Advanced by Clements in 1916.
There is only one climax whose characteristics are determined solely by climate. The processes of succession and modification of environment overcome the effects of other factors such as topography, parent material of the soil, etc.
- 2 Polyclimax Theory: Advanced by Tansley in 1935.
The climax vegetation of a region consists of more than one vegetation climaxes controlled by soil moisture, soil nutrients, topography, slope exposure, fire, and animal activity.
- 3 Climax Pattern Theory: Advanced by Whittaker in 1953.
There is a variety of climaxes governed by responses of species populations to biotic and abiotic conditions. The nature of climax vegetation will change as the environment changes, with the central and most widespread community being the climatic climax.

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And when you talk about these climaxes, then one question arises how many climaxes can be there. So, suppose I have a bear piece of rock in the case of Madhya Pradesh. So, in this rock, what would be the climaxes a community that will come up ?

So, in this case they have been a number of observations. So, the first one is by clements in 1916, he put up a theory which is known as a monoclinax theory or a climatic climax theory. There is only one climax whose characteristics are determined solely by the climate the process of succession and modification of environment a overcome the effects of other factors such as topography, parent material of the soil etcetera. So,

basically if we go with this theory it would say that because we have this rock in Madhya Pradesh. So, this rock is governed or the climax community that will come up in this area will be governed only by the climate of this area.

So, essentially whatever is the climax community in the nearby areas, that would be the climax community that will come up on this rock. So, this is mono monoclimax theory that is one climax only. So, in any particular area, you can determine have been issue what is going to be the climax community in that area. The second theory is that of a Tansley which is called as the polyclimax theory. Now polyclimax theory says that the climax vegetation of a region consists of more than one vegetation climaxes that are controlled by soil moisture soil nutrients topography soil exposure fire and animal activity.

So, in the case of Clements he said that there will be only one climax that will come up in this area. In the case of Tansley he said that there could be some other climaxes that could also come up. So, probably this rock is closer to a water body.

So, in that case the climax will be different as compared to when this rock is say closer to another or maybe it is closer to the mountains. So, depending on the situations that are nearby, you will have the climax that comes up. And the third one is a climax pattern theory which was given by Whittaker and he said that there is a variety of climaxes governed by responses of species populations to biotic and abiotic conditions. The nature of climax vegetation will change as the environment changes with the central and most widespread community being the climatic climax.

So, in this case he said that you will not have one particular climax, but then even this climax community will go on changing a bit it will go on changing bit by bit, but the most widespread community will be the climatic climax. But then what comes up actually in this area, you cannot determine it on the basis just on the basis of the climatic conditions or on the basis of the ambient conditions, but then it will go on changing with time. So, it will be near to the climatic climax, but then the actual climax that comes up will be a bit different.

So, in this lecture we looked at succession different kinds of successions, we looked at primary secondary cyclical successions, we looked at different seral stages, we defined a primary community looked at its characteristics, we defined a climax community looked

at its characteristics, we looked at different kinds of climaxes that can come up and so on.

So, a study of succession is extremely important in the case of community ecology because this is a process by which a community changes from one stage to another. So, that is all for today.

Thank you for your attention [FL].