Evolution of the Earth and Life
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Journey to Land: Fishes and Tetrapods

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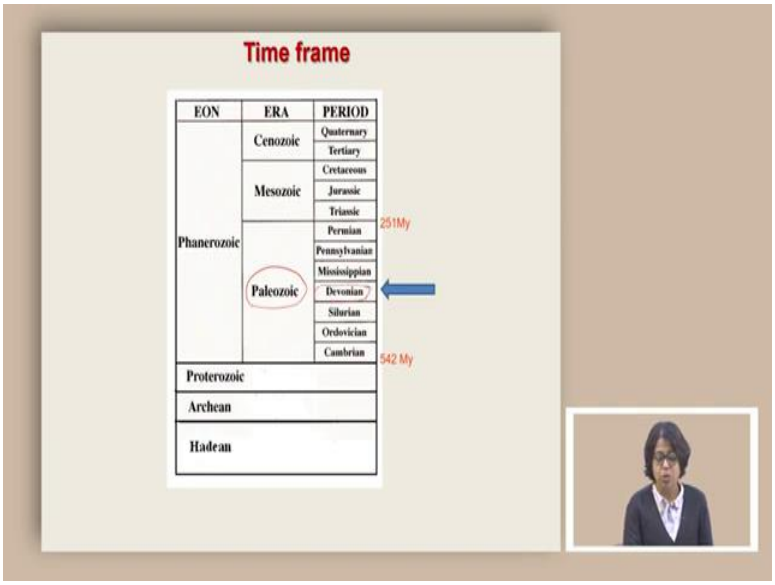

Welcome to the course Evolution of the Earth and Life. Today, we are going to talk about the transition of life from water to land. The timeframe that we are going to talk about will roughly range within this ERA called Paleozoic. And the events are going to take place somewhere around a particular period call Devonian.

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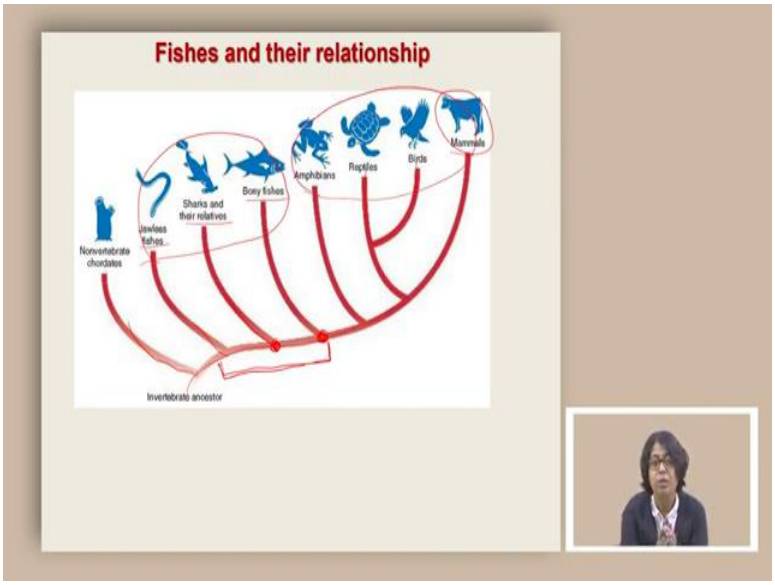

If I look at organisms that are primarily dominating the water today, we are going to find that it is all kinds of fishes. And if we look at the relationship of these fishes with other organisms we are going to find something quite interesting that we know that there are organisms called mammals and these mammals are somewhat related to other organisms, such as reptiles, birds, and then we also have something called amphibians. And these amphibians are also related to fishers. So, if we really have to draw how groups are related to each other we are going to find these kinds of branching pattern where in each of the time we will see some of the groups branching out.

Now, there are different ways of making these diagrams but one thing is for certain that any branch which goes off this time is before then this branching out diagram. So, this is one of the points that are very important and we draw conclusions from fossil record. Now, what it tell us is that there are all kinds of fishes and these fishes must have branched out before the branching out of amphibians, reptiles, birds and mammals. So, we are talking about a history which is happening somewhere around these events and we are going to see how the transition of these groups and the groups which we know more about will live on land look like. So, this is going to be the idea of these branching.

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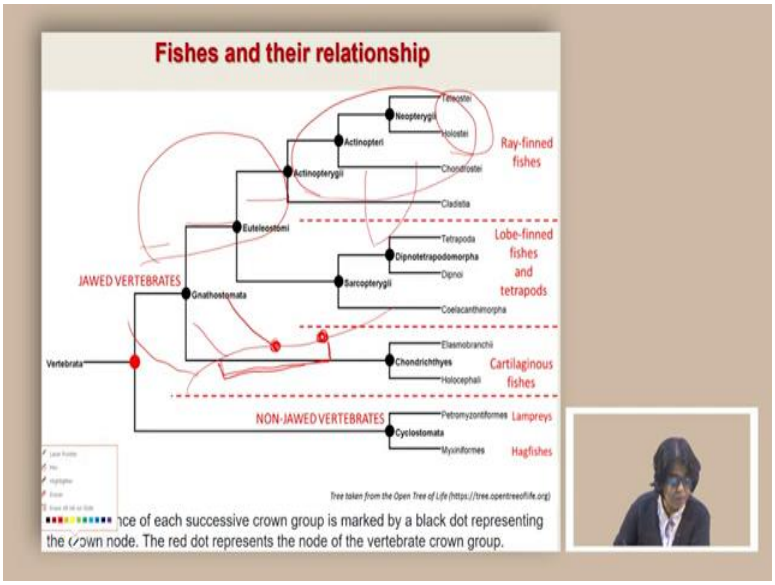

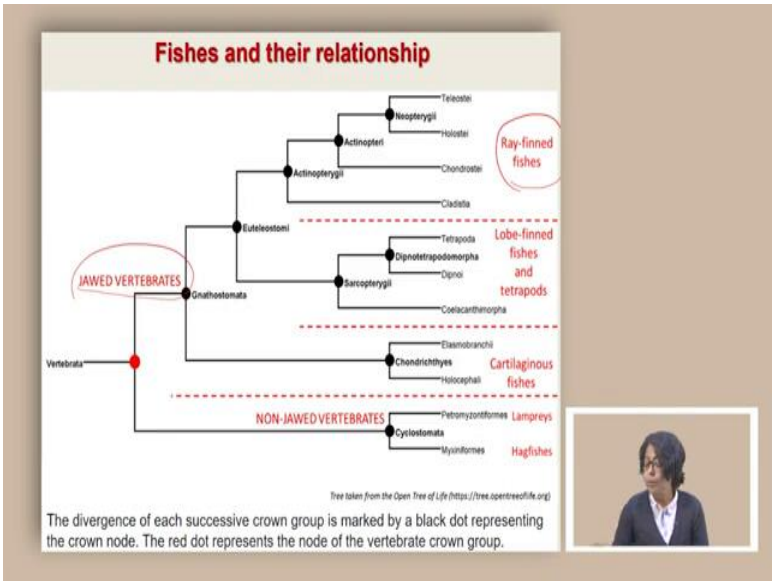

Now, if we go to the different types of organisms and different kinds of fishes, that we can find, we will find that there are different types of fishes that we can find today. And we can classify them in terms of whether they have jaws, they do not have jaws at the very beginning, but within the jawed animals there are different types of fishes.

One type of fish is called a cartilaginous fish instead of their bony structure, they have only cartilages such fishes include things like sharks and then we also have officials which we see very commonly today which are called ray finned fishes and we are going to look at it in more detail. But then there are branching's which include interesting things all the lobe finned fishes and something called tetra pods.

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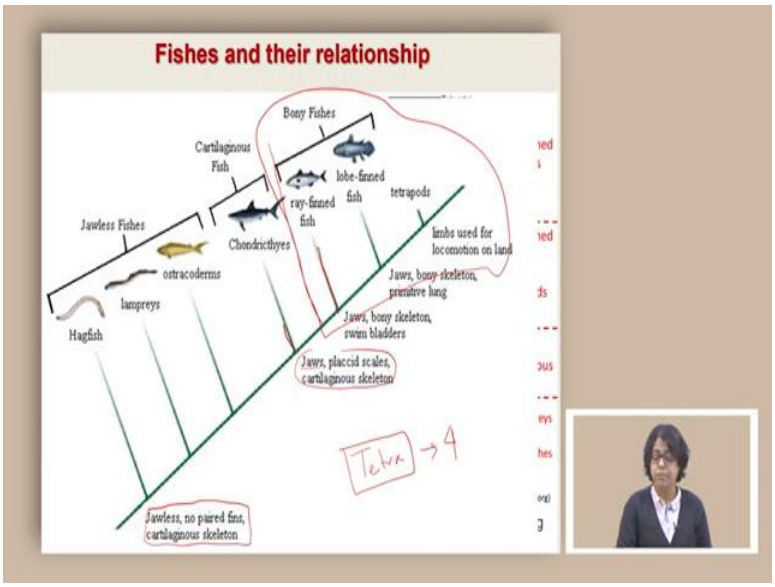

So, again if we look at how the groups are arranged to one another these are kind of branching's we are looking at and the way it is organized is every time there is a branching we are also writing down the characters that are common between all of these groups. So, for example these groups we will find that they are jaw less they do not have Jaws, they do not have beard fins, and they also have cartilaginous skeleton, but then we come to this part where these branching tells us that we are now looking at a group which has jaws which have a particular type of scale and also cartilaginous skeleton.

The next branching gives us a slightly different idea. it has jaws instead of cartilaginous skeleton, it actually has bony skeleton and it has swim bladders. So, that means it can also control how far up in the water column they can go and go down go up and go down. So, these are some of the relationships of how fishes look like.

So, for today's discussion we are going to focus on this kind of part where we are primarily looking at bony fishes and we are going to see how some of these bony fishes show a transitional phase from fishes to tetra pods by tetra pods we mean organisms that have 4 limbs because tetra means 4 and pod means literally the limbs. So, from fishes which can swim to organisms which have 4 limbs and which can walk we are going to see that transition.

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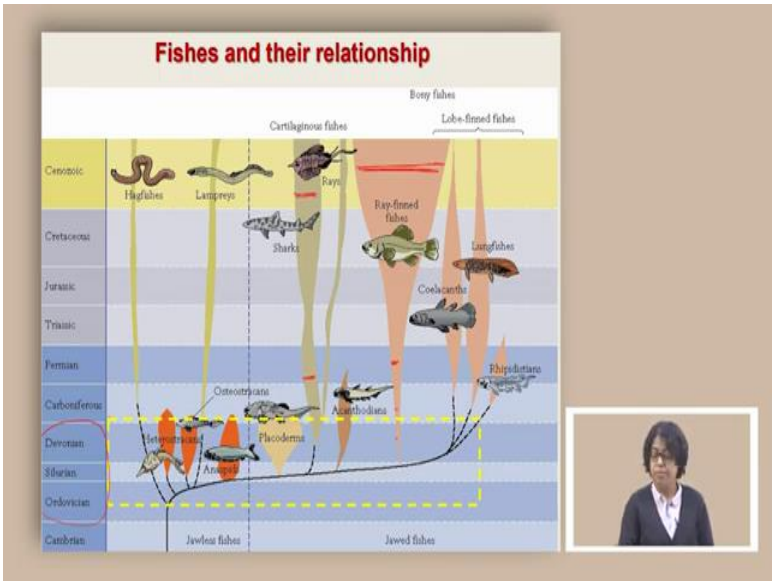

So, now, if we look at their relationship with time we are going to see that there are various kinds of fishes that we are finding in this particular time period Ordovician Silurian and Devonian primarily in Devonian, the way these pods are created are by counting how many

different types of fishes are there and if you find more numbers these pods become thicker, such as here, such as here. And if there are not that many that number is represented by this very small narrow region of this block. So, clearly, we see that many of them are appearing right around Devonian. So, this is an interesting time to study fishes.

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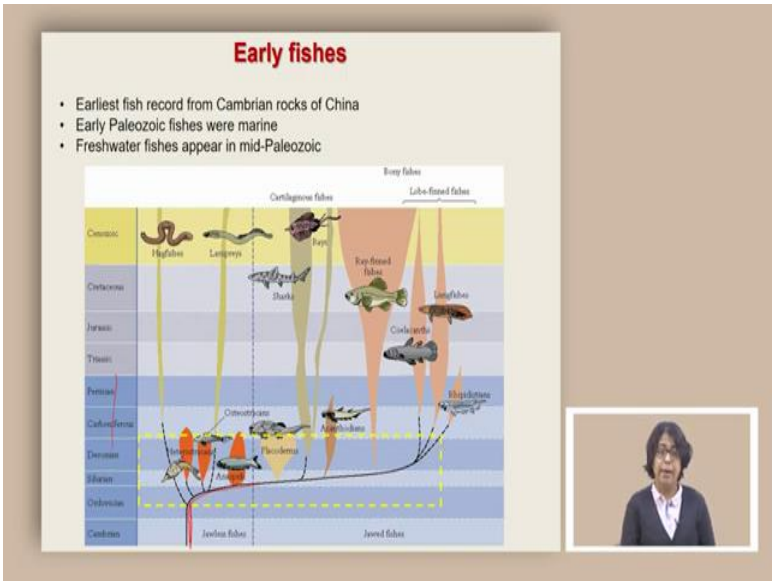

Now, this is not the first time the fishes appeared. If you look back in fact these deal of this classification starts all the way in Cambrian. It is true that in Cambrian the fishes that we are talking about probably were jawless fishes, but they started in Cambrian and early Paleozoic fishes. So, that means all kinds of fishes that we are looking around this time were probably fishes that were marine. And the reason we believe that they are marine because they are always found from the marine rocks the rocks which show a signature of marine sedimentation.

Only in mid Paleozoic so Devonian and beyond we started finding fishes which started to live in aquatic freshwater habitat. So, they started moving from marine fishers to freshwater fishes. But again, today we are going to only talk about marine fishes and some of their transitions to land.

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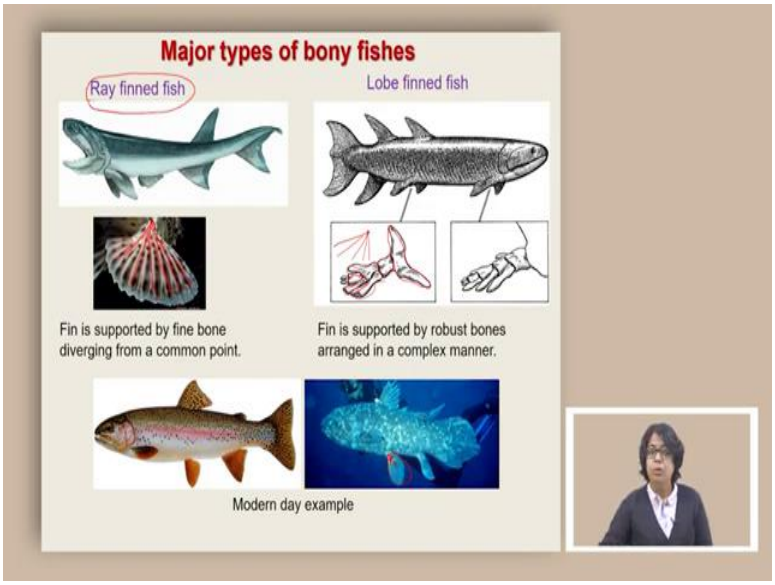

Now, there are two types of fishes as I already said that we find today. The most common one is called a ray finned fish and ray finned fish means they have a fin, which are diverges from a central point and looks like a ray. And that is why they are called ray finned fishes. And they are one of the most common ones that we see today. On the other hand, there are very unique types of fishes which instead of having ray finned s have something called a lobe fin.

It means that instead of these single point and diverging patterns of support of the fin bones, they have muscular pattern of the fin it has bones and these bones are not really radiating from a central point they have different parts of the bones which are all contributing to the muscular robust structure of fin and these fins are much more robust compared to the ray finned.

In today's ocean we find mostly the ray finned fishes. However, there is one example. It is called a Silla Kant, which is thought to be an extinct fish for a very long time till it was rediscovered. And what we found that it also has something called a lobe fin and it has these muscular structure and inside there are bones which are arranged in complex manner and it is not really like the ray finned fishes which are diverging from a central point and without very complex structure.

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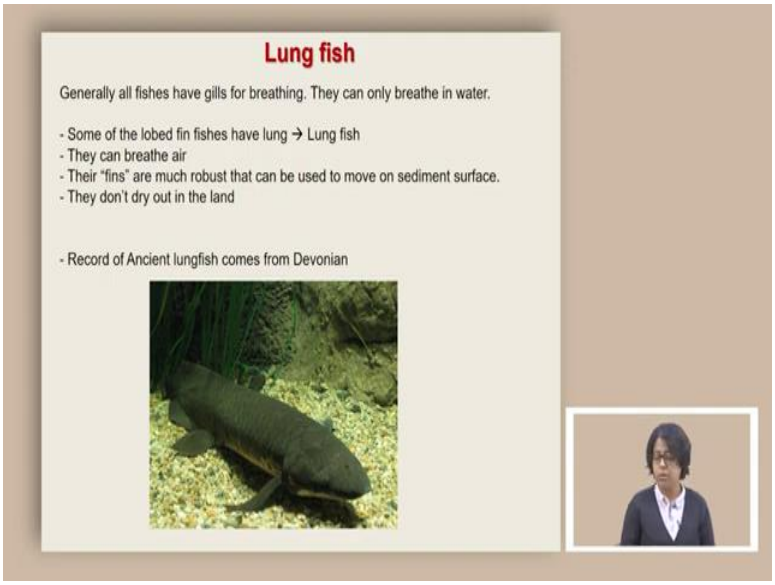

So, now, we are going to talk about another type of fish which is interesting because not only do they have fins which are lobe fin, but it also has a very different quality a very different way how they breed. So, generally all fishes have gills for breathing, they can only be breathing water. However, some of these lobed finned fishes have lung and therefore they are often called lung fishes.

So, they can not only breathe in water they can also breathe in air. And they are fins are much more robust. And they can basically move in sediment surface. So, often this African lungfish has been found to breathe air especially when the rivers dry up or the ponds dry up. And then they are in money puddle where there is not enough water there is not enough air inside the water. And also, there is not enough water for them to swim.

So, what they do they start breathing air they basically take a gulp, and they take air bubble and they basically breathe through it. More importantly, they move from one part to the other part in this money puddle using their fins. Both fins are the lobe fin. So, they already show characters, which tell us that they can survive in the on the land for some time. Interestingly, some of these lung fishes have been recorded from the fossil record of Devonian rocks. So, that is why people started thinking about that rocks of this age Devonian may be a good place to search for such kind of fishes which can tell us something about this first tetra pods.

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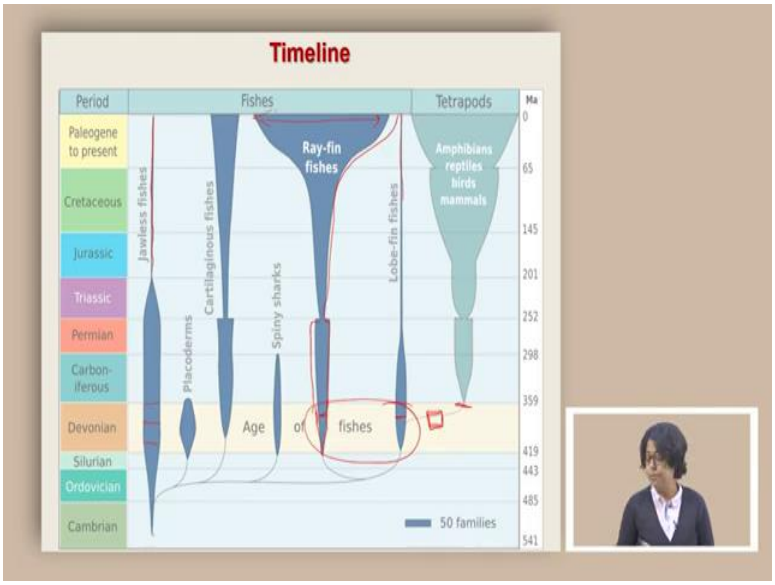

So, let us take a look at the timeline. Again, we are looking at different kinds of radiation, different kinds of diversification events of different fishes. And as we have seen that jawless fishes for example started in Cambrian they have quite a bit of diversity in Devonian, but then after Triassic, it started to become narrow showing that only there are a few types of jawless fishes that continue today.

On the other hand, if we look at the ray finned fishes, they started increasing in number of types all the way in Devonian and then they started increasing all the way till Permian, where it dropped for a bit and then again it started increasing. And today there is a large variety of ray finned fishes. When we look at the lobe fin fishes, we can clearly see that they do not have very high diversity today, although they had almost comparable diversity in Devonian in comparison to the ray finned fishes.

And we started finding records of tetra pods somewhere after Devonian. So, we started finding organisms which have complete ability to walk and survive on land somewhere after Devonian. So, now if we really want to find the transition between these fishes and the tetra pods so somewhere here and here so the dotted line somewhere here an organism which presents a transitional form from the fishes to tetra pods we have to really understand well first of all, which kind of rock should we look for and what kind of organism are we expecting?

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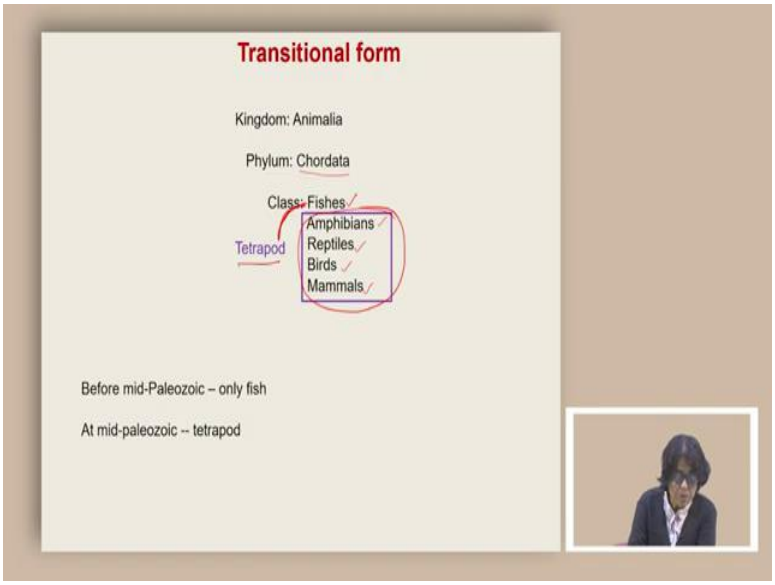

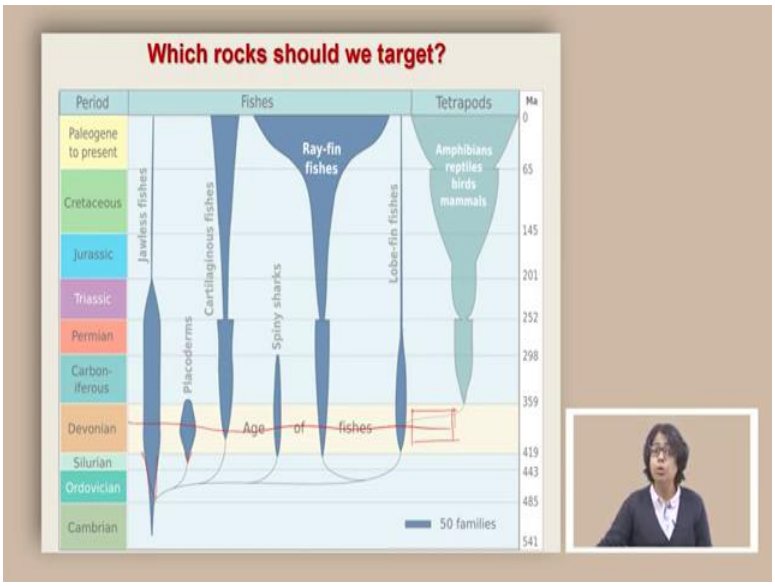

So, let us again summarize what we have learned so far. And also, what do we understand in terms of the classification? So, we are broadly talking about the kingdom Animalia within the kingdom there is a phylum called Chordata that means all the groups which have a notochord we are also part fit, our notochord nerve chord is covered by vertebra. So, therefore we are also called vertebrates. Now, there are different classes.

So, we have fishes, we have amphibians, we have reptiles, we have birds and we have mammals. Now, all these except fishes are animals which have 4 limbs and therefore all of them are all tetra pods except fishes because they do not have 4 limbs. So, what we are interested in is how this transition from fishes to tetra pod look like. So, because we know from the plot that I have shown you that before mid-Paleozoic we are only finding fishes.

So, before the end of Devonian or let us say before the beginning of Devonian we only are we are finding different kinds of fishes even sort of mid Devonian we started finding only fishes. And we started finding tetra pods only after Devonian. So, a time when we can find this transition cannot be before Devonian. Because before Devonian, we do not really have that many fishes that we can expect to see a change. It cannot be after Devonian because we already started finding the tetra pods.

So, therefore the correct time to target would be a time within Devonian probably middle to late Devonian. But even just trying to look at all rocks containing fossils in Devonian is not enough. So, we need to know exactly what kind of animal are we looking at. So, therefore, we need to really have some understanding of how transitional forms should look like.

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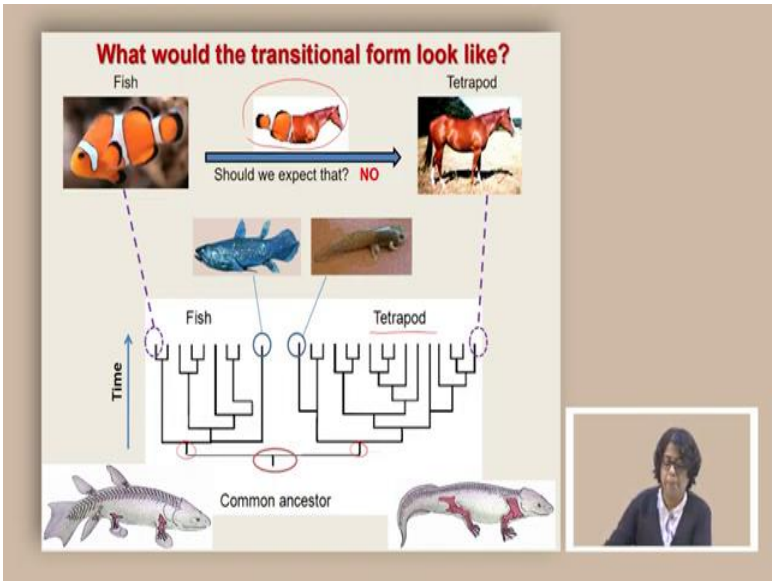

So, we are talking about fish such as this and a tetra pod a good example would be a horse. So, are we really looking for a transitional form which would look something like this? Clearly not. Because when we think about the different types of fish they also evolved through time when we think about tetra pods, they also evolve through time. So, just by looking at the most recent example of tetra pod and fish and combining them together would not give you the transitional form you actually have to look for organisms which are representing very, very ancient fish and very, very ancient Ichabod.

And then try to figure out what might be a transitional form look like which will present both the ancient fish as well as the ancient tetra pod. So, probably we are talking about things which are more like Silla Kant and more like something like a salamander and a transitional

form between them. And that is what we are expecting to find in the fossil record. Now, the question is do we really find a fish which is somewhere here, and which is very old? At the same time? Do we find some of the tetra pods which are very old and sort of comes around the same time? The answer is yes we do.

So, there is an organism perfectly fine lobe fin fish called us Eusthenopetron that we find around the same time. And then we find a very early tetra pod which is called etheostiga. Again, around the same time so if we are looking for a transitional form probably we are talking about something which is in between these 2.

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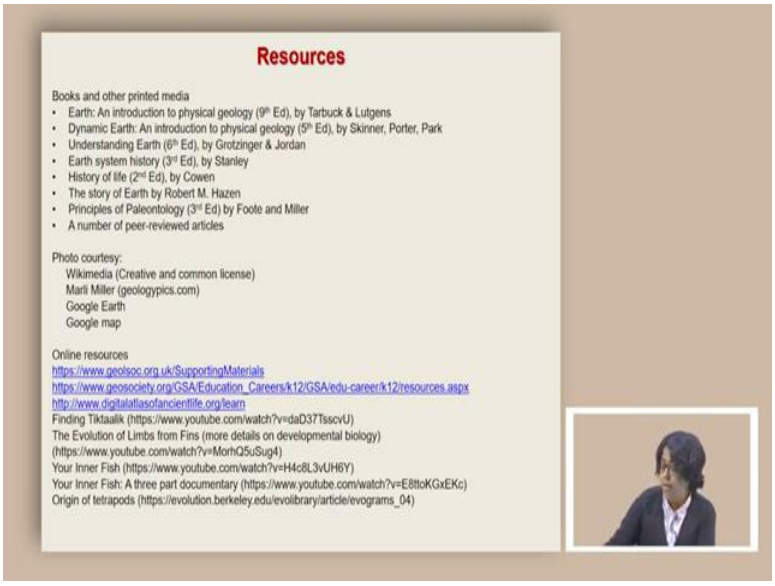

So, in summary, in today's class we learned that to understand the transition from fish to tetra pod it is important to understand a bit of the history of the fishes. So, Devonian was the time

when major diversification of fishes happened. Although the first record of fishes come from Cambrian. We also learned that there are different types of fishes the most common one being the ray finned fish, but there are fishes such as lobe fin fish and some of them can breed air the ones which are called lung fishes.

We also understood that in order to find the transitional form from the fishes to tetra pod it is important to focus on our time, which shows the record of fishes as well as bar right after that the record of tetra pods and therefore, Devonian would be a time to look at when it comes to transitional form. It is also important to understand that we should look for a transitional form that represent somewhat often very old lobed fin fish as well as very early tetra pods. Here are some of the resources that I used to create the slides and here is a question for you to think about. Thank you