The Evolution of the Earth and life
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Recent Extinctions

Welcome to the course, Evolution of the Earth and Life. Today, we are going to learn about contemporary extinction.

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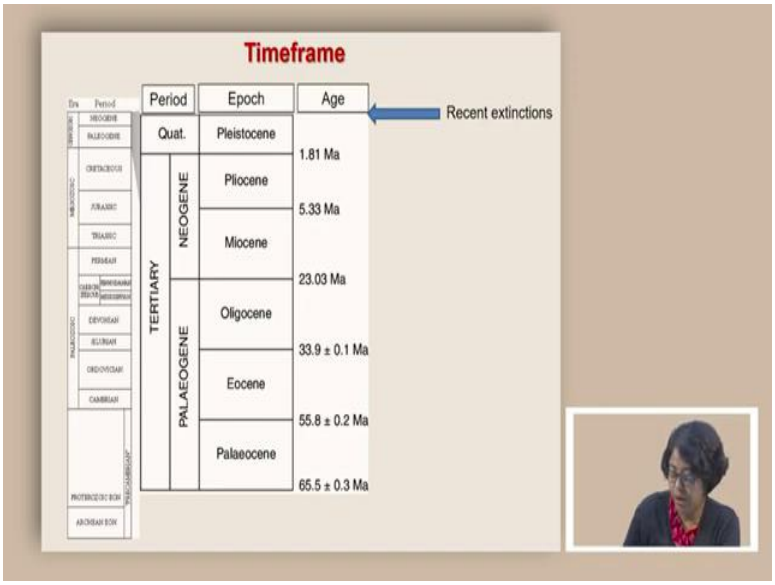

Let us reorient ourselves with the timeframe we are in Quaternary, towards the end of it. And we are going to look at the present day extinction events.

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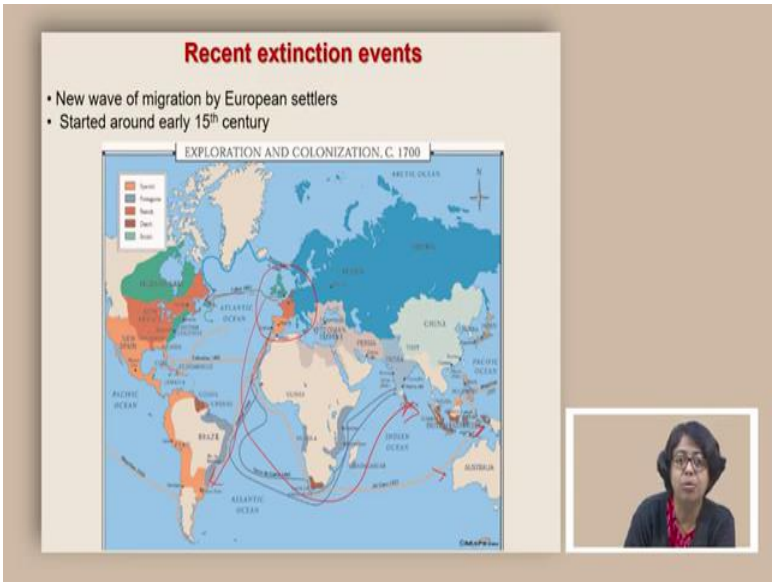

Which started somewhere around the fifteenth century. Now, this recent extinction event is not completely discreet from the extinction wave that started all the way back at the late Pleistocene, but this has a slightly newer nature, and which has something to do with the migration and settlement of groups of people along with their own organisms that they were introducing to newer places.

This new wave of migration of European settlers started around early fifteenth century, where primarily people from Europe started to explode the world, and they started settling in places where initially only the indigenous human population was there. So, if you look at the routes where they went from Europe, primarily from the western part of Europe, they went all the way to Africa.

They went to the Americas, both the North America as well as the South America. They went to Asia through different routes and Australia and New Zealand. And it is not just the settlers who went to these places. They also brought their own food grains. They are often brought grains which are not indigenous to the space, place where they were going. They also brought their pets.

They often brought their own diseases. So, it was a complete mix of human population who were isolated for quite some time. And what was the effect of such changes on the biota is something that we are going to look at today.

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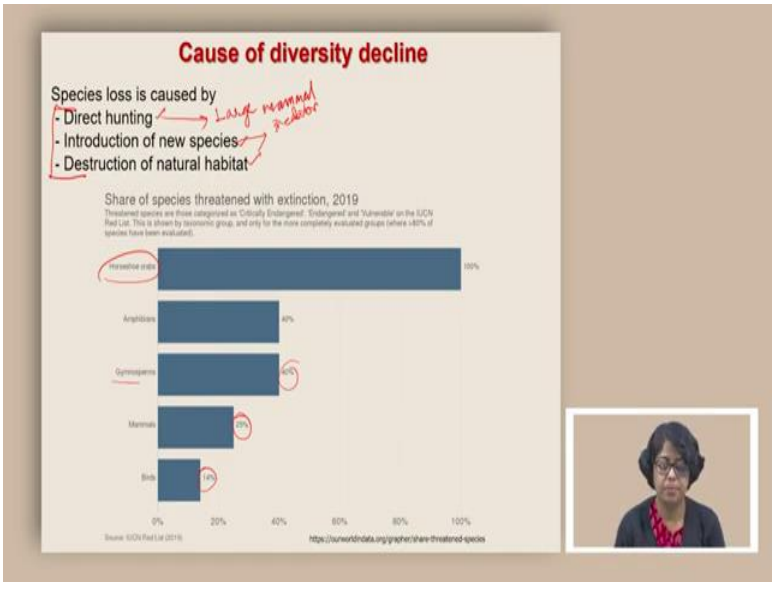

As a result of these exchanges, we also started to see a major diversity decline. And this diversity decline was primarily caused by three mechanisms. One is direct hunting, the second one is introduction of new species, and third one is destruction of natural habitat. Direct hunting is relatively easy to understand as a mechanism for extinction because it simply says that by killing off all the individuals of a population of a species, the species is going to get extinct.

And that happened, especially for large organisms, primarily mammals, which have a relatively small litter size, small number of offsprings, and often longer gestation period. So direct hunting often affects the large mammals and the any other organism which has a relatively smaller population size.

It also impacts groups which are easy to hunt. The second one is introduction to new species, because these species can be predators, and especially for islands where the ecology has developed without the presence of large predator, because large predator are difficult, because the large predator, especially mammal predator, it is not possible for those mammal predators to go to islands to start with, especially we if we are talking about remote volcanic islands in the middle of the ocean.

And therefore, there is no natural mechanism for the development of mammal predators in those islands. Consequently, the animals which are surviving in the islands, they have evolved in the absence of such large predators, and they often change their habits of survival. Often the birds become flightless. Often, they basically nest create nests on the ground. They lay eggs on the ground, and all of these become threatened when there is an introduction of a new species.

Sometimes these introduced species are predatory. Sometimes they can also have a competition with the surviving fauna of the islands, and often these lead to extinctions. The last one is the destruction of natural habitat. Even when there is no direct hunting to a species or there is no introduction of new species to a particular area of the earth, if the natural habitat is destroyed, then the species cannot survive primarily because it does not have a place to live and it does not have the natural food that it has evolved on.

So therefore, these are the primary mechanisms of extinctions that we see today. And if you look at the share of species that are threatened with extinction in 2019, we will see that there is horseshoe crabs, which are aquatic, which are marine. Then there is amphibian, which is 40 percent. There are plans 40 percent. And then among the mammals, 20 percent, 25 percent of the mammals are threatened with extinction among birds.

It is 14 percent. So, this shows that even today, even with our conservation efforts, we still have the threat of extinction. Today, we are going to study some of the classic cases of extinction during the human time scale, and we will try to understand what were the primary mechanism of extinction for those cases.

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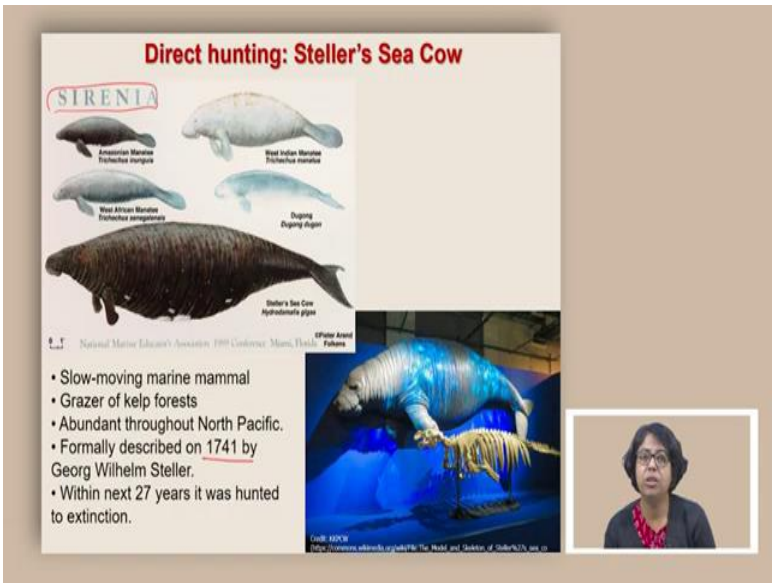

One of the classic cases of our recent extinction was Steller's sea cow, which was extinct primarily due to direct hunting. So, sea cows are marine mammals. They are part of this group called Sirenia, and they are related to manatees, dugongs. These are animals which live in the water, primarily in the marine area, and they graze on the kelp forest, and they are slow moving and they have to come up to the surface of the water.

Generally. They also are shallow marine, so they tend to live in near the surface of the water, and they breathe the air. So, they cannot really go down too deep and stay there for long because they have to breathe air and therefore, they have to come back to the surface. And they were abundant In North Pacific. North Pacific is a place where it is quite cold, and these animals were adapted to this place.

They had very thick fat layer. It, they were formally described in 1741 by George Wilhelm Steller, and that is why the name Steller sea cow was given to them by within 27 years of the first description, these animals were completely extinct from this region. They were primarily hunted because of their fat, especially the sea going sailors, they preferred their fat because it will not go bad even during long voyage in the ocean.

And therefore, they indiscriminately killed them every last individual primarily because of their fat and meat, which supplied them with food during the long voyage in the sea.

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The other case of direct hunting was Tasmanian Tiger. These are marsupial animals, and they were very abundant throughout Australia, New Guinea, Tasmania, and they were interesting animal because the, for the European sellers they were very unfamiliar. European settlers were only familiar with the placental mammals, the mammals which lay youngs. And these were marsupial mammals, which has a hatch, which actually has a pouch where the young rests something like a kangaroo.

But European settlers were not very familiar with such marsupial mammals, which also can hunt. And they were, because of this unfamiliarity, they started blaming all of these Tasmanian tigers for any loss to their cattle. As a result, the government announced a bounty on Tasmanian tigers. They were killed indiscriminately, and when they were killed, the person who kills them also got money as a reward.

And they were formally described in 1808. They were formally described on 1808 by George Harris. And within little more than 100 years, it was hunted to extinction. So, the last representative was kept in a zoo, and it eventually died in 1936. By the time it was brought down to couple of individuals, the entire world became conscious about these organisms and that they are not going to be around for very long.

And therefore, every museum and every museum of natural history from all over the world, they started to collect the Tasmanian tiger specimens. Often the specimens were kept in the museum to demonstrate one of the soon going to be extinct organism.

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Apart from direct hunting introduction of new species, can also be devastating for the indigenous organisms, which grew and evolved in an environment without those introduced species. And it is especially problematic for small birds or birds in general. In the islands, often the birds start to nest on the ground.

They make the nests on the ground, they lay eggs on the ground in those nests, and also, they lose the ability to flight. And this has been one of the common causes of extinction of birds in remote islands. So, this particular one is called a Lyall's wren. It is also called a Stephen Island's wren, because it was very common in New Zealand, especially in Stephens Island. They were extinct in 1895, 1 year after the introduction of cats.

So, these island was not really a place where cats were there, and cats were primarily brought by the settlers. There was a lighthouse which was being built. And during this time, a lot of people came from Europe, and even before whichever European settlers came they also bought their pet cats. And the feral cat population increased in these islands, and they started hunting these wrens.

These wrens were very easy to hunt because they were flightless so they can be chased. And these birds essentially started eating them and destroying their nests and eggs. And overall, it was declining for quite some time, but people did not recognize it. And then there was a point where the cat of the lighthouse owner and the name of the cat was Mr. Tibbles. This cat killed the last individual. So, it is not that cat actually made the group co-extinct on its own.

It was simply attacked the last individual. So even if it did not attack the last individual, it was already destined for the extinction because there was no other individuals alive. So, this was a study which showed that how introduction of new species, which is as small as a pet cat, can be devastating for indigenous organisms which are growing in an isolated land.

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Habitat disruption can cause significant harm to indigenous organism. One example is this Spix's Macaw, the Spix's Macaw, it is blue parrot, and they were abundant in Brazil. They primarily dependent on spurge shrubs, and they were restricted. Their natural habitat was quite restricted because it was completely dependent on that particular tree for nesting, for feeding for roosting.

And when the, when Brazil went through massive deforestation, these habitat were destroyed, and therefore these birds basically lost its habitat and there was no replacement for it. And eventually they went extinct from the wild in 2000. So, there are still Spix's Macaw in different zoos. So, this particular picture is from a zoo in Singapore, and you can still see them in the zoo, but in the wild they have been completely lost.

Another example is Javanese tiger. These tigers were common in Southeast Asia, but because of the growth of the cities and farmland, there was a massive destruction of the wooded forests. And as the forest cover started to decline, started to decrease in area, started to shrink, all the tigers lost their natural habitat. So therefore, part of it was also direct hunting where people were killing these tigers for their skin as a memento, as a pride trophy.

But at the same time, their overall population was also declining because of loss of habitat, and eventually they went extinct. This also shows the vulnerability of even large organisms such as tiger to these deforestation. This also increases the human wildlife conflict because then because of loss of habitat, they try to come to places where there are human settlement, and therefore the conflict increases.

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One of the classic cases of extinction where people were aware of something is going on. And one of the cases where people has done considerable amount of research is the case of dodo. Dodo was endemic to Mauritius. It is a large bird. It was first spotted by the Dutch sailors in 1598 when they went to the Mauritius.

So, Mauritius is a small island in Indian Ocean. It is close to Madagascar and Africa. And Mauritius had its own indigenous flora and fauna because it was so isolated from the other parts of the world. And dodo was one of the iconic features of Mauritius. Now, the extinction that actually the last dodo already disappeared, that recognition came only in early nineteenth century, although the extinction actually happened in 1662.

So, for a very long time, people thought that they were simply hiding in the forest, but it is only this recognition came in early nineteenth century that even with considerable search, there was no live dodo that was found. And this became such an important discovery that it also penetrated common language often in order to describe something that is definitely dead. We used this idiom which says dead as a dodo.

So, dodo is not just dead, it is actually extinct. So, there is not a single living specimens of this particular bird that we can find today. But there are lots of stuffed dodo that we can find in various natural history museum throughout the world. It used to be a prized position for various collectors. Even in Mughal durbars, there are paintings of dodo, which were sent as a gift from different parts of the world.

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Now, what killed them? It was not a direct hunting because apparently the dodo meat was not suitable for the settlers and they did not eat it. However, one possibility was that they were over hunted for dodo gizzards, and these dodo gizzards were used for a pet food. But more importantly, there are other considerations. One was that dodo used to lay eggs on the ground, and they had only single eggs in one point of time.

As a result, their niche, their size of the population was also small. And once the introduced pets, like dogs and cats started to eat those eggs, their population started to show a steady decline. Another important aspect was their dependence on dodo tree. So, they were also closely related in terms of their roosting and eating and food on a particular type of tree called dodo tree.

This dodo tree they used to have the seed and digest part of the fruit and basically remove a layer on top of the seed, and then the seed would come out through their excretion. And due to deforestation, a lot of dodo tree disappeared. And that also led to some consequence in terms of the dodo population. And once dodo population went extinct, there was a very problematic situation for the survival of dodo tree because these dodo tree seeds are dependent on dodo gizzards.

So, the dodo used to digest the seed, and then only the hard cover of the seed can be removed, and then it would help them for germination. Once dodo is gone, this particular link in the ecosystem was missing. As a result, we are also seeing as a consequence shrinking of dodo tree population. So, the case of dodo basically shows us that it does not have to be a single factor or single mechanism of extinction.

There can be simultaneous mechanisms such as deforestation, habitat loss introduction of new species, and hunting, all of them contributing to the demise of a species.

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Another classic case of quite elimination of species was the land snails of Tahiti. Tahiti is part of the pollination islands, and they had a fantastic variety of land snails. So, at the earlier part, when the natural historians used to visit Tahiti, they recognized that the land snail diversity of Tahiti is one of the most spectacular one.

So therefore, there was considerable study documenting how many different types of lands tales were there in Tahiti. But during settlement, after the human settlers settled because of their ships, when the ships come, there are snails which basically attach themselves to those ships and they can survive the long voyage and eventually wherever they settle, these also get introduced.

Now, these nails started to come to Tahiti and they did not attack the land snails of Tahiti. But these introduced snails become really abundant in Tahiti, and they were doing a lot of harm to

the crops. And therefore, the settlers in Tahiti, especially during twentieth century, they thought that they have to do something to eradicate the pests, the introduced snails which were causing harm to the crop.

And therefore, they started to think of something like a biocontrol, biological control so that they are not affecting the overall environment. They are not impacting the overall environment. They are only going to take care of the introduced species. So, the goal was really good that they did not want to harm the environment.

They were simply trying to reverse. The introduced snail population gets obliterated and the crops are saved. And for doing so, they thought that they will bring a particular type of predatory snail species, which can eat these introduced snails. And they brought these giant African snail as a predator. Another classic case was the land snails of Tahiti.

Tahiti is a small island as part of the pollination archipelagos and Tahiti had a variety of land snails during nineteenth and twentieth century. When natural historians visited Tahiti, they also documented a number of these amazing land snails and their variety. So, we know that before the settlements and during and after the settlements, how many different types of land snails were there in Tahiti, but along with the settlers also came introduced species of snails.

The primary reason for that is their sea voyage in the ships. When the ships are in the dock from where they are starting, often snails crawl up and attach themselves to the wooden structure of the ship, and they can survive for days. And eventually when these ships finally reach their destination, these snails come out of these ships and infest the newer land.

And this is what happened to Tahiti also. There were introduced species, and these introduced species included giant African snail, which was very common. In fact, these are very common type of snails that we see even in India. Now, this particular giant African snail became a pest to the crops. They started infesting all crops and they started eating parts of the crops.

And therefore, the farmers and the settlers in Tahiti decided that they had to do something to eradicate the pest, and they did not want to harm the environment, and that is why they did not want to introduce any chemical pesticide to take care of the population of these snails. They instead thought that they will use biological control and to do biological control, they decided to bring a predatory snail, which can eat this particular African snail.

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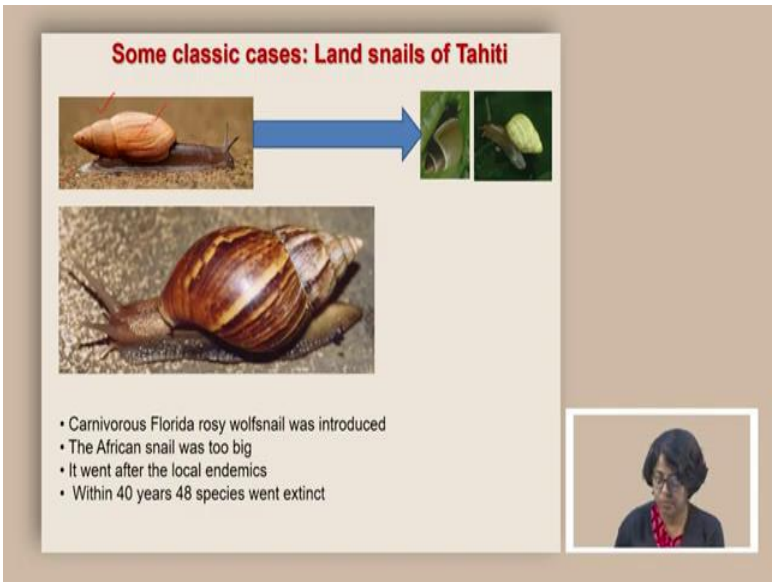

So, they brought carnivores, Florida rosy wolfsnail, which was supposed to eat this particular African snail, which was an introduced species. But this Florida snail was much smaller than this African snail. As a result, this snail actually did not go after the intended victim. Instead, they started going after all the land snails of Tahiti.

And as a result, the Tahiti land snail became very vulnerable in terms of their diversity and population. Within 40 years, 48 species of indigenous Tahiti snail went extinct, primarily because of this predator, introduced predator. So, the study shows us that although the intention was good not to harm the environment, but we really have very little understanding of how the ecological interaction would go once we introduced a species.

And therefore, before introducing any species such as this Florida snail, it would have been a wiser thing to look at the interaction, overall size, and also which are the species which are already vulnerable. And these are some of the lessons that we can learn for future.

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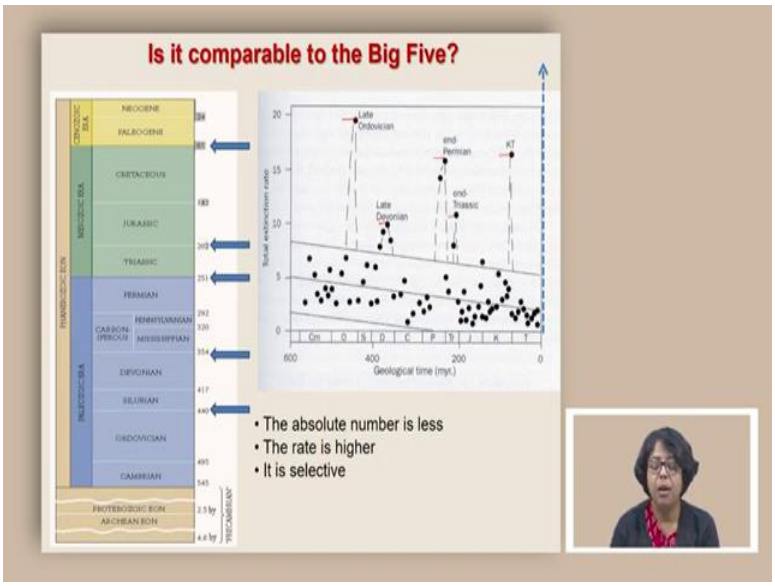

Now the question is if we think about the evolutionary rate and extinction rate in particular, are they comparable to the big five? So, if we look at the recent extinction, is it comparable to any of these mass extinctions? So, can we call it a mass extinction? Now the problem is if you look at the mass extinctions, the big five mass extinctions in late Ordination, late Devonian, end of Permian, end of Triassic, and, and KPG.

Then we will see, first of all, the rates are quite high, but at the same time, the resolution at which we are measuring the rate runs into a few million years. The second problem is that if you look at the pattern of the extinction for any of these big five, they were not selective. However, if we look at the present day extinction, they are highly selective.

They primarily have selection. They primarily attack the fauna, which are relatively large mammal and which has relatively longer gestation period and a smaller number of offsprings. It also is primarily affecting the groups which live in island, especially flightless, large birds, some even smaller birds, which are flightless, which leg eggs on the ground. Such selectivity of extinction was not present in the last big five.

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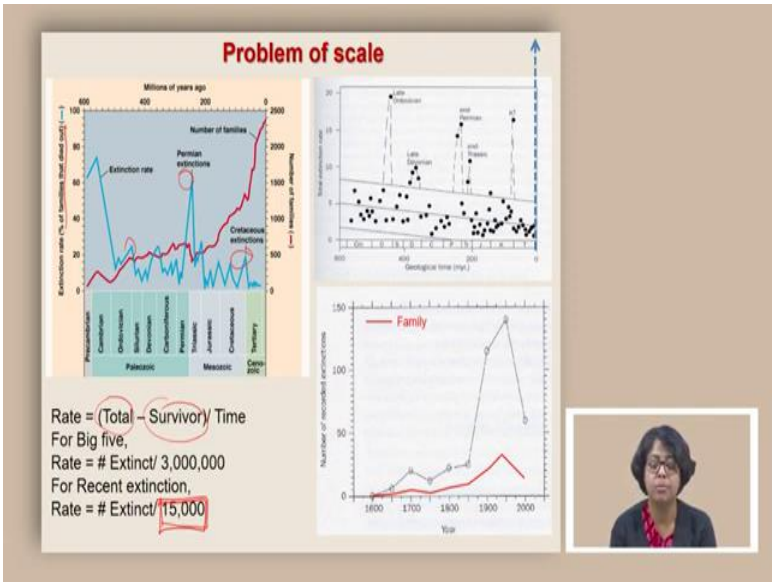

But then there is also an issue of scale. So again, we are going to look at the number of families. So, if we look at the number of families in terms of the extinction rate, we are going to see that the extinction rate, that percent of families that died out this extinction rate, we start to see declining in different parts.

But again, as I say that every time when we are calculating, it has the total number of species minus the survivor, number of species divided by the time. That is how we calculated the rates. Now, if we look want to do it for today, then the problem is that we are dividing it by only last 15,000 years. And even if the number of extinction is the same, just because our resolution is so high, the rate is going to be really high.

Much higher than any of the extinction events that we have ever seen on the during the geologic time scale. And this is one of the problem when we try to compare these two cases, and this is one of the main causes of worry that is it going to be a comparable thing? Can we call this present extinction, a mass extinction?

So, definitely, in terms of the rate, it is comparable. It is actually more than any of the mass extinctions that we have ever seen. But at the same time, the rate calculation has its intrinsic pattern where the duration over which it is being observed plays an important role. And therefore, we cannot really compare the rates between the geologically observed mass extinctions and today's extinction.

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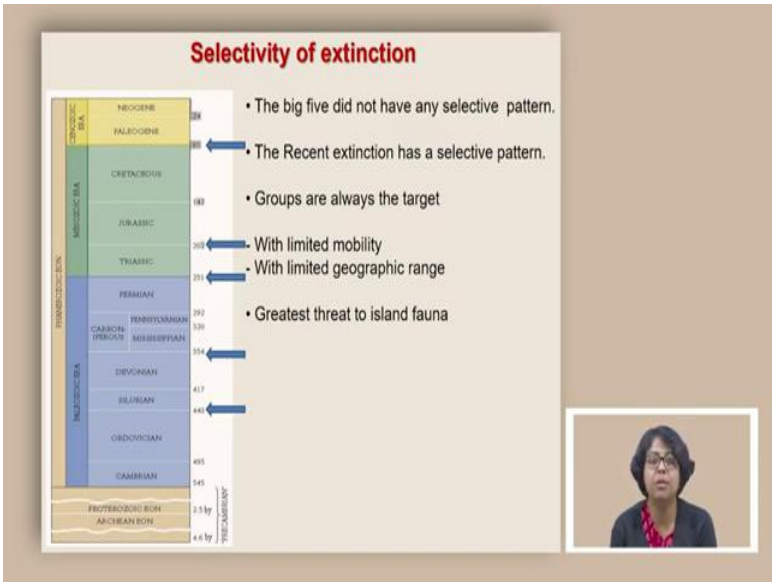

The other thing that makes it quite different is that the big five did not have any selective pattern, but the recent extinction has a selective pattern. The groups are always the target. If they had limited mobility, if they had limited geographic range. And it is greatest for the land the greatest threat is for the island fauna.

And this island fauna does not have to be island in terms of the ocean island. It can even be on the top of a mountain chain where it is isolated from the rest of the world. Now these isolated island foreigners are really vulnerable and we see a major decline in their population diversity and species diversity in the recent time.

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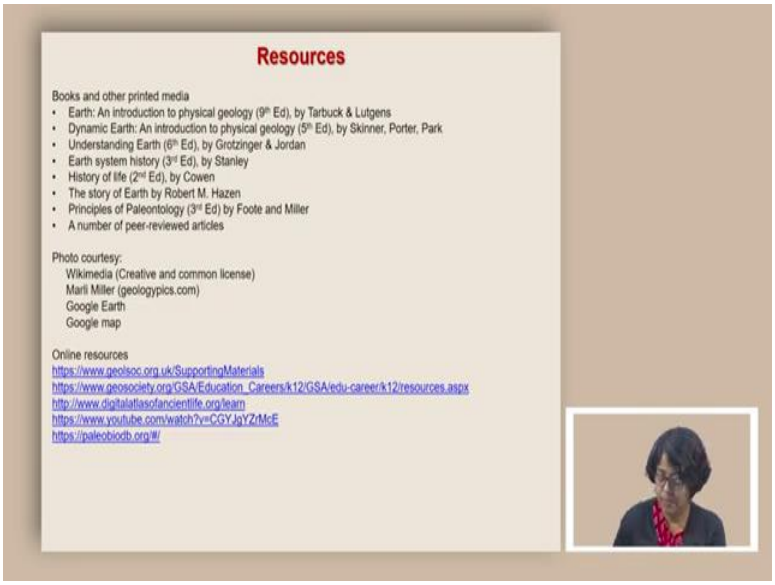

So, in summary, today, we learned about some of the mechanisms of extinction including direct hunting, habitat loss and introduction of new species. We also learned some of the classic case studies, which went extinct during the human time scale and in recorded history. We also learned that it does not have to be a direct hunting to make something go extinct.

And sometimes even with good intentions if new species are introduced to an island ecosystem, it can lead to major catastrophe ecosystem fallout. But when it comes to comparing the present day diversity decline with the big five maas extinctions, we are in the situation where the rates are comparable or even higher for today's diversity decline.

However, the rate calculation has its intrinsic bias because for today's diversity decline, the time window over which we are calculating is very short. It is only 15,000 years. Whereas when we think about the diversity decline during mass extinctions, it was divided by a few million years, at least 1 million year, and that generally brings down the rate quite a bit. So, the comparability is not there.

Also, the other big five mass extinctions were non-selective, whereas we saw that the present day mass extinction or where we saw that the present day extinction shows significant selectivity and it impacts more the island fauna, the fauna, which has limited mobility, which has limitedly, small litter size, and also limited geographic span. Here are some of the resources that I use to create the slides.

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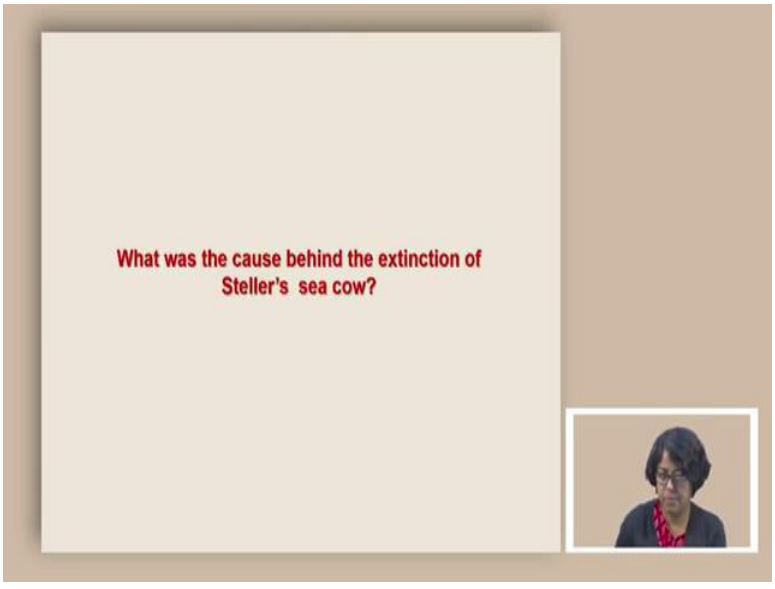

And here is a question for you to think about. Thank you.