WEEK 2 A FOSSIL ECOSYSTEM

ACT – Anusuya Chinsamy-Turan
RG – Rob Gess

ACT I'm absolutely delighted to have with me today Rob Gess. Rob is a research scientist at the Albany Museum and is also a research fellow of the Palaeosciences Centre of Excellence. Rob has this incredible experience of working in the Devonian rocks and he is one of those persons who have an untapped resource of all these wonderful fossils that have come out of site. So, Rob, please can you tell us about some of the wonderful fossils from about 360 million years ago?

RG Okay, well what we've got at Waterloo Farm which is my principal site is basically a fossil ecosystem which was a sort of coastal lagoon and it's got a lot of material in it from terrestrial ecosystem, mainly plants, and also a lot of marine... More marginal marine things like fishes. And it's right up against the sort of ceiling of the End Devonian extinction event. So it gives us a kind of picture of life immediately before the Devonian extinction event which is quite exciting and includes most groups of vertebrates from the Devonian.

ACT We know at the end of the Ordovician a large number of fishes went extinct, but we also see this wonderful radiation of fish in the Silurian and the Devonian and now we have this incredible diversity at this time. Is that right?

RG Yes, you could say that during the Devonian vertebrates reached their broadest diversity in the entire history of earth. There were groups of vertebrates around in the Devonian that have been extinct ever since and what we have now is a kind of subset of what was around in the Devonian.

ACT Really? And what kind of fish were there?

RG Well from Waterloo Farm we've got a lot of huge... we've got about 20 kinds of fish. So the majority of specimens that we have are Placoderms and these were some armour plated fishes. Their whole head and trunk was covered in a sort of armour plating and there was a sort of ball and socket joint that allowed the trunk armour and the head armour to move, which was important because jawed vertebrates need to be able to open and close their mouths. Also Acanthodians which we call spiny sharks. They were a bit like sharks but they had a sort of bony spine on the leading edge of all fins other than the tail fin and we also have sharks and a large range of lobe-finned fishes including Coelacanths and Tristichopteridae which are ancestral to Tetrapods. And ray-finned fishes as well which are a really minor component of most Devonian ecosystems including this one, but today they make up 80% of the fish that we have in the world.

ACT Exactly, so at the end of the Devonian we see the rise of these other fish that really become the dominant group. Is that right?

RG Yes, well this is the interesting thing. In the Devonian most ecosystems are actually dominated by Placoderms, these armour plated fishes, and then large bony lobe-finned fishes were also very common and the most common kind of non-Placoderm bony fishes in the Devonian were lobe-finned fishes. But of course nowadays there are only a few survivors like modern Coelacanths, Lung Fishes and all of us. Tetrapods are in fact lobe-finned fishes as well.

ACT Exactly, yes.

RG So what one had was at the end of the Devonian you lost but there was total extinction of all Placoderms and the vast majority of spiny sharks. Some of them continued till the Permian and then died out then and the most groups of lobe-finned fish also became extinct at the end of the Devonian. So that really left ray-finned fishes and Tetrapods and just a few remnant groups of lobe-finned fishes.

ACT So at your locality you had this diversity of high latitude sharks. Is there something special that you want to tell us about that locality?

RG Well we got very nice sharks. What we have at the locality which is very special is that we have soft tissue preservation.

ACT So you have the outlines of the bodies of these sharks preserved?

RG Some of the very baby ones. I've got one about 2.8 centimetres long.

ACT 2.8 centimetres, that tiny? Wow.

RG Yes, that's a tiny little baby. These sharks probably gave birth to live young. My current belief is they were actually coming into this estuary, this coastal estuary to breed, as were the Coelacanths.

ACT Okay.

RG So they were breeding in the estuary. And then we have a lot of cartilage. Obviously cartilage normally breaks down.

ACT Yes.

RG It decays because... But we've got nice... We've got skull, jaws, all sorts of shoulder girdle remains which are all cartilaginous from the sharks, which is really interesting because they're a basal type of shark. So they're giving us some kind of idea about early conditions in sharks.

ACT Goodness, wow.

RG And of course the soft tissue also means that we've got lamprey fossils, which are the oldest lamprey fossils in the world. Of course lampreys are jawless fish.

ACT Exactly.

RG In fact they're the only jawless fish that survive until today. There's one from the Cretaceous and then there's also a couple from the Carboniferous from North America. But the only Devonian one in the world is our one from South Africa.

ACT Which is called?

RG *Priscomyzon riniensi* which is after *rini* which is the traditional name for Grahamstown.

ACT Okay, wonderful. But Rob now we have this wonderful insight about what's happening in aquatic environments, but on land do we have any clue about what's happening 360 million years ago?

RG Yes, well this is what's really nice about this site as well is that in addition to what was living in the estuary we had a lot of particularly plant material coming in and falling into this estuary and being preserved in this anaerobic black mud which preserves soft stuff. So we have a really good, which I'm still describing... A really good flora of plants from really small kind of undergrowth plants through to *Archaeopteris* trees and *Archaeopteris* trees are one of the earliest... They're actually the earliest widespread type of proper woody tree that you get in the world.

ACT Really, and how big are we talking? I mean is it massive?

RG We're talking full size trees. I mean I've got a tree stub which is about this wide.

ACT Really? Wow.

RG Yes, so the interesting thing about *Archaeopteris* trees is that they were the first widespread trees that had progymnosperm type wood and that meant that they could live away from water bodies.

ACT And grow quite tall I would think.

RG And grow tall because they had to be able to pump the water from deep down right up to the crown. So I'm not sure exactly how tall they grew, but they got big. And that really ties in very much with the End Devonian extinction because the... It's kind of almost the opposite of what's happening now with the greenhouse effect. The first forests spread all around the world and in fact the *Archaeopteris* specimens we have from Waterloo Farm are the first record of high latitude *Archaeopteris*. Is that so? So that's given us the idea that *Archaeopteris* forests actually spread around the whole world by the end of the Devonian. Now towards the end of the Devonian one sees these climatic problems start developing and that's partially because obviously forests are made out of carbon and a lot of that carbon comes from the atmosphere in the form of CO_2. So there was a massive drop in the CO_2 level and in addition the CO_2 was also reduced because with the deeper weathering of these trees' humic acid the breakdown of rocks brings about chemical reactions that also absorb CO_2. And that brought about, or compounded by the fact that... And Gondwana was going over the South Pole at the time and there was ice build up on Gondwana, but that was compounded radically by this reduction of CO_2. So one saw huge drops in global temperature and you start seeing these little mini kind of cold snaps leading on towards a really cold phase. So the opposite of what's happening now where people are digging up fossil plants and burning them and putting the CO_2 into the atmosphere and things are getting hot, there they were getting cold. And it would undoubtedly also have had an effect on water PH and atmospheric gasses and that seems to have been how this one species actually triggered the second global extinction event.

ACT Yes, so that's the end of the Devonian extinction.

RG Yes, the End Devonian extinction event was actually...

ACT Triggered by the *Archaeopteris* forests.

RG Yes, there were probably compounding factors, but triggered by the spread of these big progymnosperm forests all around the world and wiped out a very large percentage of life on earth, including the vast majority of higher groups of vertebrates which we've never...

ACT So Rob we know about this incredible diversity in the aquatic realm and we know about the plant diversity, but what about the animals? I mean do we have any inkling about what's going on in terms of animal diversity at this time?

RG Okay, well we have inklings from around the world. We also have local inklings. From Waterloo Farm we actually have described from there the earliest known terrestrial animal from Gondwana, which I named *Gondwanascorpio emzantsiensis*.

ACT A scorpion.

RG It's a scorpion, a terrestrial type scorpion, and the very presence of that indicates that there would've been other invertebrates like millipedes and insects that would've been on land because of course scorpions are predatory. Exactly. And this is interesting also because the creation of shady, cool environments on land by trees and the inhabiting of that undergrowth of those forests by invertebrates are actually the prerequisites for what happened after the Devonian extinction event, which was the emergence of Tetrapods onto land.

ACT Exactly.

RG So in the Late Devonian we start seeing the first fossils of Tetrapods. Those are four legged creatures like us, but in the Devonian they were sort of like giant salamanders that had a big tadpole-like tail. Exactly. And then after the extinction event we see them on land and somehow the sort of unfavourable conditions in the water maybe affected the move onto land, but...

ACT Of course and the land environments were now probably ideal for this radiation. It kind of sets the scene for the rise of the Tetrapods.

RG That's correct, yes and of course we're all descended... Every four legged creature is descended from these sort of semi-aquatic Tetrapods that we find in the Late Devonian.

ACT Wonderful. Thank you so much for coming and thank you so much for talking to us. I think we have learnt a lot from Rob and it's been such a pleasure chatting to him about the diversity of life in the Devonian. Thank you.

RG Okay, thanks.