

ABC Listen. Podcasts, radio, news, music and more.

We're going to start today about 550 million years ago when something quite extraordinary happened on this planet. Suddenly, simultaneously, groups of animals appeared, weird animals, and they began to take over a planet that was once owned by single-celled creatures.

This was a biological big bang of sorts, and the very beginning of our family tree, which evolved over the following 20 million years. Now, 20 million years might sound like a very long time, but in evolutionary terms, it's just a blip. This was a rate of growth that's never been seen again on Earth. Diego Garcia Bellido is here. Diego was consumed by this time period, an epoch known as the Cambrian explosion, when complex life on Earth rose and rose and rose. Diego was a paleontologist at the South Australian Museum and at the University of Adelaide, and Diego, who is Spanish-born, was drawn to South Australia because on Kangaroo Island, which was underwater all those millions of years ago, there's a site that is rich in fossils from that era, and these are not just skeletons. These are fossils that have somehow still preserved the soft tissue, the preserved guts and eyes and skin, and even nervous systems from these strange, alien-like creatures still intact after hundreds of millions of years. Hi, Diego.

Hi. It's a pleasure to be here, Richard.

This time period is called, as I said, the Cambrian explosion. Speaking generally, what can you tell us about what happened in this era?

Well, basically, the first geological period of the phanerozoic, the time in the planet where there's multicellular life, saw the huge, as you just mentioned, the diversification, the radiation of all of the big animal groups we see today, so the arthropods with the jointed appendages,

the mollusks with the shells, the echinoderms, even our ancestors, the chordates, appear for the first time in the fossil record in the Cambrian, so it's a very rapid sort of filling of the ecological barrel, so everything is up for grabs, and animals become really good at exploiting the various empty niches, and that's why very rapidly, within 15 to 20 million years, we see an occupation of all of those possibilities of making a living.

What did the world look like before they appeared on the scene?

So, the Ediacara biota is the one preceding the Cambrian explosion. The Ediacaran geological period is the one just immediately before the Cambrian, so at about 550 million years ago, and we see a world that is occupied on its surface by microbes, by cyanobacterial filaments, and other bacteria, and on top of that sediment, we begin to see multicellular organisms.

This doesn't mean they're all animals. There are a lot of things there that are just making a living, some of them feeding from the microbial mats, some from food particles in suspension, and a very quiet environment where nobody was eating, nobody, and that changed with the beginning

of animals, and because, as you know, animals feed, need to feed from other things, and that was the beginning of the arms race that we see in the Cambrian, and it's still ongoing today.

The planet would have been mostly underwater at that time?

Not the planet as such. Life was all marine, so in terms of how much emerged land, there would have been similar to what there is today, give or take, but the continents would have been totally barren. There was no life on land, so any big storm would have swept a lot of sand from those continents, eroded into the basins that trapped the Ediacara biota of the Flinders ranges, and also, in the younger Cambrian, the fossils from Kangaroo Island, those birchishale type fossils, those soft

part preserved bodies, in the perimeter of what was Australia at the time, which was basically just the western part of the continent. The eastern hadn't been deposited yet.

Right, so life is all underwater, and the land such as it is, is barren and rocky, and where was Australia? Was it roughly in the same position as today on the planet, or was it floating somewhere else? Because as the continents move around, Australia has had many positions. At the Ediacran and Cambrian time, it was actually straddling the equator. Adelaide would have been at latitude about, you know, between zero and 15 degrees north or south. So we were on equatorial to tropical waters, so that means there's a lot of sunlight, the shallow environments that we preserve in the Flinders ranges, we're teeming with life, but that life wasn't like the one we see today. It's a very alien life, and to some extent, that's why this is attracting the attention of NASA, which is supporting our research in the Flinders ranges, because if we go to another planet, we're not going to see what we see around us today. We're probably going to see things that have very little to do with, you know, humans walking around or trees covering the land. We would be seeing organisms probably in the water, and it would look very different, more like the Ediacrans than what we see in the Cambrian. So this world before the Cambrian explosion had life, had these single, very, very kind of very basic creatures. I know this might be a silly question, but were any of them wriggling? Diego, I mean, were they moving? I mean, were they right?

Well, only at the end of the Ediacran. So we've got life, we believe, starts about the first record we've got of it is about 3.7 billion years. So the planet is four and a half billion. As soon as it cools down and we have liquid water in the oceans, soon after that, we probably have life. And the first evidence of life is about 3.7 billion years. And it's about 3.3 billion years of single cell life. It's at the end of the Ediacran that we begin to see cells sticking together and living together to create multicellular organisms. Until then, it's just filaments or single cells floating in the oceans. And yes, some of those early complex life in the Ediacran were already moving. They were wiggling around. Some of them were even capable of scratching that microbial mat that was covering the shallow, very well lit tropical waters and feeding from it. So yes, we begin to see movement in the very latest Ediacran, not before that.

So these creatures are living off, I'm guessing here, sunlight for photosynthesis and the nutrients from the water and the soil that are sort of floating around them. These are not carnivorous, if that's the word, or they're not predators, these creatures. What happens when the first predators start to evolve, when life gets more complex and you have multicellular creatures that need to eat other creatures? That's the beginning of it all. That's when we get the beginning of the Cambrian explosion. So with the appearance of predation, meaning animals are feeding on other things, those are the things, especially if they're animals, they need to defend themselves. Otherwise, their genes won't get passed on to the next generation, which is what we're all here for. What happens is that you need to defend yourself. And there's many ways of doing that. You can secrete a skeleton, and that's what mollusks did. They have the shell that protects them by valves and snails and so on. Or you can have spines, and that's what sponges did. They have these mineral spines that is going to stop a predator from chewing on them or try to deter it at least. Or you have to move into the sediment, borrow yourself into the sediment away from the predator or swimming to the water column or hide under a rock, et cetera. So this is the beginning of this arms race that was started with those earliest predators. And as you were saying at the beginning, the very rapid evolution that we saw in the Cambrian in this feeling of the

ecological, empty ecological barrel up to then has never been seen afterwards, even after the mass extinctions. So mass extinctions are after a few millions of years, the planet recovers. And there's a lot of empty niches that can be occupied. And there are new diversifications, radiations of animals. That's what happened after the dinosaurs. And the giant reptiles like ecthosaur and plesiosaur

start out. That a lot of space niches were vacant. And that's where mammals began to radiate because there were so many empty possibilities for making a living.

So there's nothing going on very much for millions and millions and millions of years.

And suddenly we get these multi-celled animals that are eating other animals and then bang, there's a feeding frenzy and there's very rapid fire evolution. It's in this arms race,

you're saying. Absolutely. Absolutely. What animals do some of these very early creatures relate to in the modern world? Do we have anything in the modern world that resembled them at all?

Yes, there are a few animals that have some resemblances with modern animals today. So things that may look externally like horseshoe crabs. And these are the trilobites. They've got a hardex skeleton outside to protect them, just like modern day crayfish and lobsters do.

And those would look somewhat like what we see today. And we also have mollusks, very early mollusks that are not that different from what snails would look like today. We have even some early ancestors of ours. Some of the earliest fishes begin in the Cambrian and they look somewhat similar to very simple fish. So yes, you can see already that we're beginning to see similar forms to the ones we have around us today, but not exactly the same.

Diego, I wonder if this is in any way similar. But when my kids were really young,

we bought them a little sachet of something that was called billabong bugs. And you know these things, they're like, they come in a little egg form. They are triops. Yeah, it's a species called triops australiensis. And they're distinct as they have three eyes. And we put them in a fish bowl, in a fish, watch the eggs hatch. And they turned into what looked like little trilobites.

Absolutely. And then they began to eat each other, Diego. Then they began to consume each other.

There was like a, you know, two dozen of them, then there was 12, then there was four. And then there was one. One big one. One big one. That was wild. Yeah. Well, that's animal life. That's what we do. We eat other things. And it's, you know, survival of the fitters. Darwin already mentioned that. And I think it's, it just applies at every level. So when these first animals emerge,

do they change the entire planets in its shape and form or the composition of the atmosphere and the water? Yes. Well, there are things that are going, you know, happening in the environment that are affecting animal life and vice versa. So things like oxygen thresholds, we seem the geological record seems to be telling us that there is a gradual increase in oxygen. And that the might have, we might have crossed or the planet might have crossed during the Edeachron and Cambrian, an oxygen threshold that allow for animals to grow in three dimensions. The Edeachrons are mostly bidimensional. They're flatter spancakes in a lot of the cases. So an increase in oxygen allows for that oxygen to get to the cells. But for that to happen, you need organs and those organs and those gills that are absorbing the oxygen through their, their cuticle and moving that to the center of the body to reach the inner layers allows those bodies to grow and to be more active. Muscles need

oxygen. And in the absence of oxygen, you cannot have things running around very fast because they just don't have the energy to do that. So yes, we animals evolved in parallel with the planet, but also we change what happens around us. For instance, during the Carboniferous, there was a

lot more oxygen than today. Today we have about 21% oxygen in an atmosphere. Back then we were reaching 30% oxygen in the atmosphere and above, which was starting fires, even without spark. And that was because of the life in the planet. That was, there were the plants producing that oxygen, the big forests of the Carboniferous that have produced the coal that we have used for, for, for many centuries and hope to, you know, start cutting down on the, on that consumption. And, and yes, this is the normal path of the planet is that the biosphere is exchanging all the elements are affecting each other.

Now we've had evolutionary theory since Charles Darwin. When did people become aware that this was a thing, the Cambrian explosion? And how did they fit that into the models they had at the time of how life arose on earth? Well, actually Darwin himself was already aware that there was something that he couldn't explain. And that was Darwin's dilemma. His dilemma was, wait a minute,

if I say that evolution is a very slow process that takes, you know, thousands and thousands of years, and that there was no creation, how could we see out of the blue this emergence of animal groups in the Cambrian? And what we've realized is that, that the rates of evolution were not gradual as he thought at the beginning, they changed speed. And not only that, there were ancestors to those, to that, to those animals. The life didn't appear multi cellular life didn't appear out of the blue at the base of the Cambrian. And you have all of those trilobites, those mollusks, those are counterdome, the ancestors of sea urchins and sea stars, etc. But rather it goes deeper in time into the Ediacaran and further back. So it's a long line communicated off of parents and daughters or children through the eons from the first cells 3.7 billion years ago. But only that it sped up the speed at which that was evolving changes at the end of the Ediacaran or towards the end of the Ediacaran and the beginning of the Cambrian especially. Does that mean now we now understand that life doesn't evolve up a steady line? It tends to sort of gallop right ahead in complexity and then we'll plateau for a very long period and then gallop ahead again. Yes. So in moments of changes in the environment, evolution needs to adapt. And if the environment is stable, there's no need to adapt. You're doing what you need to do. You're feeding and you're having offspring and you're passing those genes on to the next generation. Balanced environments are what is best for it, except when there are changes say an impact from an asteroid like the KPG or the Cretaceous Paleogene extinction that wiped out the dinosaurs, then you have to adapt. But otherwise you're doing it right. You're just maintaining your population or growing your population maybe at the expense of somebody else.

So there's always extinction. But those mass extinctions are the ones that sort of trigger these massive changes. And that's when evolution goes faster because there's more ways, more chances for evolution to take advantage of particular gene sets or traits. So that's what happened with the Cambrian. It was much, much faster because anything that you invented say an eye with many lenses could give you such an advantage that it just propelled you forward at a much faster pace. So there's nothing for very long periods of time, well not so much nothing, but the global system sort of exists in great stability until a crisis comes. As you say a meteor crash or a super volcano or something dramatically changes the conditions very quickly on Earth. There's a species mass extinction and then again it's an open playing field that life can then move ahead in all these other different directions. Do you sort of see any, I don't know, do you have any thoughts about the general nature of life that it behaves

in that way? Life itself has certain qualities to it. It's opportunism or something Diego?

Well what I'm seeing when I look at the Cambrian, one of the reasons I devoted my interest, my scientific career to this is because I read Stephen J. Gould's Wonderful Life. In it he reevaluates the discoveries of the Burgess Shale in the early 1900s and how the group from Cambridge University they say, wait a minute, let's look at this in a new light and see what we're finding here and that showed us that, wait a minute, the boxes that we see today, for instance with arthropods, there are four classes, we've got the insects with wings and six legs and antenna, we've got the crustaceans in general, marine with 10 body appendages and two pairs of antenna, etc. We've got the chelicerata with the chelicerata like spiders and scorpions and then we've got the millipedes but back then there were a number of other types of arthropods that do not fit into any of those boxes and the fact that there are many more groups than the ones we see around us today, these are like branches in a tree, you see a tree, the tree of life and some of those branches from the time the tree was one meter to the time it's, you know, 30 meters like today, a lot of those early branches broke off and disappeared and all you can see is a little scar on the bark of the tree, the rest of the branches nowhere to be found and those early branches are the ones we see in the Cambrian, we see that the Cambrian is different than what we thought and even Darwin thought, so instead of a cone of increasing complexity as he mentioned of diversity, what we had during the Cambrian is a major radiation, so you have a lot of small branches and then extinction cuts some of those branches and only a few are left and those few remaining ones are the ones that we see the descendants of now, the crustaceans and the myriapods and so on. So the model's not so much like a tree, it's more like a slime mold that's sort of opportunistically groping its way forward to wherever the food is. It's like a bit of a paddock where some of those grasses do grow a little bit higher and the other ones just, you know, die out, so yes, it is not quite a cone but rather this tapestry, this flat area in which from time to time you see some branches that are actually growing into trees and the same happens now that we're looking at the Ediacaran, we look at the Ediacaran and we see, wait a minute,

let's not shoehorn all of these things into early sponges, early jellyfish, early sea pants, early arthropods, etc. Maybe evolution is just trying things and some of them take hold for a few millions of years and then eventually something more effective or better adapted comes around and just, you know, causes these other forms to become extinct and I think that echo of the Ediacaran and the Cambrian is still pulsating there but the number of branches from that tree that we can get new shoots out from are already determined to be, you know, within the arthropods an insect, a crustacean, a myriapod or a chelicerid. We can't invent a new type of arthropod, it's too late now so we only have those big four classes to choose from and that's where radiation progresses. Deggo, you grow up in Madrid in Spain, what did your interest in this kind of science begin? Both my parents are biologists, they shared a lab, they worked on Drosophila, the fruit fly, looking at the genetics, how the development of these organisms works, what are the genes activating and deactivating through from the time it's an egg, fertilized egg to the time it's an adult and so during dinner time we, you know, my family would have conversations or they, my parents would have conversations on trying this new experiment or that other or we had guests coming over to dinner that were colleagues of them and I just grew up in an environment like that where I saw that science was a way of life. Not only that, with the sabbaticals that my parents had in the mid-70s, in the early 80s and then in the 90s, one of them we came here to

Australia, just showed me that science is not only amazing because you're discovering new things, you're thinking about what's out there but it's also allowing you to meet other people, see how other people do things, see all the cultures, all the countries. So I thought that's what I want to be, I'll never be rich but I'm going to have a hell of a life traveling to places like, you know, Australia or the Saharan desert like I'm going next year or Antarctica where I went a few years ago, South America, etc. So this is a very, it's an amazing way of life.

When you talked about your parents bringing colleagues around the family table for dinner, how distinguished were some of these colleagues Diego?

Well, my father working on development in genetics, a lot of the people that he interacted with were some of the brightest minds, some Nobel laureates have been to dinner at our place.

Nobel laureates like who? Among them Francis Crick, the person who with Watson described the double helix structure of the DNA. We've had the people that worked on Drosophila by Thorax Complex at Lewis, a number of geneticists and that's the environment I grew up with, very bright minds, having very interesting conversations, most of which I wouldn't be able to comprehend but at least we saw that these people were normal people just like you and me, that they just have a passion for the science they were doing.

What a trick, you had Francis Crick round the family table for dinner as a kid, did all these people give you a sense, not just of the wonder of it all but the pleasure of science, to the kind of pleasure that is there to be gleaned from finding out about the world?

Absolutely, one of the things I find from what I remember of these occasions is that they were all enjoying life. These were happy people, happy people because they were enjoying what they did, Sunday night and a Monday rather than just, ah, got to go to work again. For them it was a discovery, it's a process of I want to test this new theory, I want to try this other idea I had the other day, I want to work with this colleague that's coming over from Germany or from the UK or from Canada, so it's a life where you see that these people are enjoying it and I thought, well, you know, if I could have a bit of that, I would count myself a lucky person and I think I can count myself a very, very lucky person. Your parents were lab people but you're an outdoors kind of guy, who in your family gave you the inspiration to become an outdoors kind of science guy?

My parents indeed were both lab people but out of the four siblings, I'm a biologist working on evolution, I've got two other biologist siblings, one of them animal behaviour and the other one marine sciences and then one physicist. We enjoyed the outdoors and we would go birding and I would

collect bits and pieces of flint that I always thought were obviously some long lost arrowhead from, you know, 20,000 years ago in the middle of Spain but I think one of the ones that had the biggest influence was my grandfather, my father's father, he was an archaeologist, he dug up Roman and Greek cities around Spain and studied them and Spain is very rich in archaeological remains and that's where I saw that also being out in the field and digging up things can open up our understanding of the past and I think I sort of combined the biological aspect with the archaeological

aspect of my grandfather and ended up doing paleontology, digging up animals to try and understand how our earliest ancestors looked like and how were they related to all of their animal life. You're not a dinosaur man as you said, you go right to the very start, right at the very beginning, who or what brought you to the very first animals Diego? Well I had a really good lecturer and he was a bird ecologist so he was monitoring a migration of common cranes, he was

also looking into great bastards but he didn't teach us about what he did, he taught us about the giant diversity of the animal phyla, the animal groups in the planet from those that are biggest blue whales to those that are smaller than the sands of grain in which they live, in amongst which they live and I think somebody that invites you to think big and learn from what other great minds have come up with, sort of planted that seed is like wait a minute, the earliest radiation of animals is where the biggest questions are, dinosaurs are very interesting, they've got spines, they've got big teeth etc but they are at the end of the day they're reptiles whereas the explosion of animal life in the Cambrian is just basically the big bang of all that we see around us and that's where I saw you know the biggest questions are back there and that's that's what took me to to work on early Cambrian animals and then expanded into the Ediacaran because that's where the roots of the Cambrian animals are

more conversations anytime on the abc listen app or go to abc.net.au/slash/conversations

Diego your first major dig was in Canada at a place called the Burgess Shale, you mentioned that earlier on, how did you get the invitation to attend a dig there? Through my father I got in touch with Simon Conway Morris because sometimes the people that work on development and the people that work on paleontology they get together for these interdisciplinary meetings and so my dad knew Simon Conway Morris who's the paleontologist one of the ones that did the sort of the revision of the Burgess Shale and so I spent a summer with him in Cambridge looking at some soft-bodied fossils

from Pennsylvania and while I was there being a biologist he said well Diego you probably do need to get a bit of experience in how geologists actually extract fossils and why don't you write to Des Collins from the Royal Ontario Museum and offer yourself to join them at the Burgess Shale excavations that they're leading from the Royal Ontario Museum in Toronto and I said yeah sure what are the chances anyway I wrote the letter sent it to Canada and you know six months later when I had given up hope on ever being involved in such an enterprise I get the letter back from Des and he says Diego if you're willing to fly yourself to Calgary I'll pick you up and I'm going to feed you and house you for two and a half months and you're going to work for me digging the Burgess Shale and of course I couldn't say no to that amazing offer and that was my first contact with Burgess Shale fossils and that was the first the summer of 1995 instead of staying in in in Spain and joined the summer after my last year of university I went to Canada and worked my butt for excuse my French and I just basically dedicated became part of this this amazing discovery that is early Cambrian life it's all very well for a scientist to say come to the Burgess Shale but what does it mean to actually get to the Burgess Shale site Diego okay so the Burgess Shale itself the fossil site you have to first get yourself for three hours from Calgary get to the middle of the Rockies to the boundary between Alberta and British Columbia in a little national park called Yoho just beside Banff which is one on Jasper close to that the famous skiing resort and etc and the Burgess Shale is about three a two thousand three hundred meters of a sea level so you have to hike you know about a kilometer up in altitude gain a kilometer in in in altitude and also about you know 10 or 12 kilometers so it's a good three hour hike to the Burgess Shale to the base of the slope and then every morning we would have to hike up the 200 meters almost vertical slope up to the core itself it's exhausting but it's so rewarding the views from out there off the landscape around you the glaciers the emerald lake just below you the the forest the conifer forest as far as the eye can see several ranges

of of no covered peaks and you turn around and you got the best fossils in the planet showing or preserving the complex early complex life of the Cambrian so it's it's a win win win win anywhere you look at it exhausting but very rewarding so these are fossils on the top of the Rocky Mountains are we to assume that they were once underwater like the ones in the Flinders ranges and elsewhere you've been going looking at yes yes so imagine you go out into in this case in Adelaide you go out to the Gulf the Gulf is being filled by sediment coming out of the Adelaide hills that is a process physical process geological process that has happened over and over through the whole history of the planet sediments are deposited in basins marine in most cases and then get compressed and uplifted to form mountain ranges right even the peak of Mount Everest is Cambrian to order vision in age and there are fossils up in the peak in the top of Mount Everest underwater fossils at the top of Mount Everest wow absolutely because those are sediments that were deposited in marine environments many many millions of years ago okay well so once you get there and you see these fossils what do tell me what's so special about the fossils that can be found in the Burgess Shell at the top of the Rockies there so uh fossils are mostly basically just shells and bones and exoskeletons things that are already mineralized why because being mineralized there's very little energy in them for animals to feed on first second they're more resilient to being broken by the currents or by movement of the waters or sediment falling on top of them etc so bones shells and and exoskeletons are the typical fossils but in very special circumstances like the Burgess Shell like Imubea Shell in Kangaroo and all the flintest ranges Ediacarabayura these organisms the decay of the organism after its death it stopped in some cases because it's buried alive like the Ediacran and the Burgess Shell fossils or in some cases like the Imubea Shell because it's in a deep deep ish environment 50 60 meters but is very low in oxygen if you don't have oxygen and you bury something the scavengers can't get to it and bacterial decay slows down or even holds all together so the combination of those factors early burial or axis or absent of axis by predators and scavengers and and decaying organisms is going to enhance the capacity of the soft tissues in those in those organisms so you don't lose the soft parts they're actually preserved you know for millions hundreds of millions of years see this is insane this is insane the idea that you can have these impossibly ancient trilobites with not just the skeletons but some of the soft tissues somehow that's not been I mean wouldn't their bodies have been full of bacteria like ours but then devour devour the eyes and the flesh and the guts and what have you I don't understand how that hasn't happened is it because it's so cold up there why how do I go how's this not happened so the reason for it happening is because in this early animal evolution world the burrowers the things that are capable of drilling into the sediment to access the buried things were not as powerful they could go maybe 10 centimeters maybe 20 centimeters not not like today where we're very good hyper selected uh uh animals are now capable of drilling you know probably 10s of centimeters down into the sediment not only that sure sure but wouldn't they also have like bugs in their guts as well they would but because it's buried and there's less oxygen it's basically like freezing the body why do we see mammoths because all the decaying processes are halted by the temperature in this case it's not temperature it's lack of oxygen so when you're digging and uncovering these fossils that's they have some of what the flesh intact can you do you have eyeballs intact on some of these things not intact they've been changed into a different mineral but there's still the information from the tissues so that it's not squishy they have been replicated by minerals in most places clay which is the fine elements of

in in the mud and sometimes the carbon also in those organic tissues has blended with the clay and has produced the information has replicated and kept that information so we see what a gift Diego what a gift I mean you know we go and we try and replicate we still don't really know what a t-rex looked like do we and here you are you're finding fossils that are vastly older than a t-rex and you know kind of almost exactly what they look like yeah they're like if they were trapped in between two two glass slides some of them you can see the gut from the mouth to the anus you can

see the last meals inside the gut you can see the muscles you can see the skin the eyes with all the lenses in this atheropods they have multiple lenses in their eyes what we call compound eyes you can see the nervous system the circulatory the blood vessels are preserved in very very exceptional

circumstances and these the burger shell the emu bay shell etc cheng yang in china cai li these are localities that preserved these complex animals in their entirety not just the outside but also the insides so uncovering these creatures do they does their strangeness hit you i mean they are they as you said earlier they really don't have many creatures on the earth today that look anything like them are you struck by the weirdness of the things you're pulling out of the out of the top of the rockies yeah and and this happens in in in cheng yang and also in emu bay what we're looking at is a long-lost world it's a planet that has the earliest representatives of animals and at the time as we were saying before evolution is trying many different things and see which ones work and some of them work for a few generations others for hundreds or thousands of generations and others just evolve into something that looks familiar to us today but when you look at them some of them have for instance a babinia is one of those emblematic fossils from the birdish shell it's got five compound eyes in the head big ones it's got a trunk with spines at the end and it's got flaps in the side of the body it's a segmented body wow and and a big tail at the end to prepare propel it through the water so there are some really really weird things out there and we they just look unfamiliar to us because they didn't make it or the descendants didn't make it to today so that's how amazing looking at you know past life and evolution is because they're showing us what this planet looked like how different those animals were back you know 510 million years ago very different very so you mentioned their emu bay shale that's kangaroo island isn't it what is that what brought you to australia yes so in 2006 there was a camber in conference here held in adelaide and they organized a trip a long trip want to see the caiman of the flurry of penicillus or just south of adelaide into kangaroo island looking at the emu bay shale what was originally discovered in the in the 40s and 50s and they thought they had collected everything they they could from there and they also took us to the flinders ranges and i saw niel pinna ediacara uh fossil sites on that trip i realized that wait a minute this is a and tap resource and i came to to emu bay the following summer uh for winter summer in northern hemisphere terms so in september we came here and we dug up 300 meters south of the original

side of emu bay and we started pulling out complete soft-bodied uh fossils soft-bodied organism fossils and that was the beginning of what now we know as as probably one of the only soft-bodied site in the caiman in the whole southern hemisphere and one of the best in the whole planet which is right here in australia right here in south australia ki so these creatures you you're pulling out with soft-bodied tissue that's been mineralized like like the rest of the body

they're dead obviously do we know what killed them and clearly they they died from starvation or of or i mean have they got bites taken out of them do you can you see that yeah some of them have evidence of predation on them but we think this is a slightly different environment from the birger shell the birger shell were animals living in the water column or in the on the surface of the sediment and then get washed into deeper waters where there's less oxygen and they it's like an avalanche of mud and they get trapped in the mud and they just you know they die in our case we think these organisms were living in a somewhat isolated basin from the main open ocean and what was happening is that slightly isolated basin was becoming stagnant so the oxygen levels were low and from time to time they would be so low depleted in oxygen that the animals would die in situ and they would just lie there and then sediment would snow on top of them and cover them and because there was no oxygen that's why we've have the antennae and the legs of those trilobites and then we have fully 100 soft-bodied organisms preserved in there because they just didn't decay and scaven just couldn't get in there because there was no oxygen for them to move into that environment got it so weird to think of creatures asphyxiating at the bottom of the ocean isn't it that's so strange but that's what clearly what happened when you say you've recovered trilobites those those strange cockroachy armored looking things how big do some of these trilobites get well uh the most common ones are about two centimeters long maybe two and a half but we've got uh we recently described a new species uh redlichir x which get to be about 25 plus centimeters in length so these are the size of a dinner plate so these are the largest trilobites known in the cavern in australia huge beasts i wouldn't want to put my finger uh close to them they you would get a nasty bite i can tell you they have spines on them these things don't they yes yes they have the base of their legs so the legs are jointed like a modern day with with a lobster for instance or or a shrimp and the first segment of that leg has got spines in the center of the body and that's what they crush their prey's with and we uh and in some cases even mineralized prey so we're seeing

what we call durophagous animals that are feeding on animals that have shells so this arms race of the cavern is you know it's it's a winner eat a loser and those losers sometimes they were things with shells that those shells weren't hot enough so you're telling me these spines they're like nutcrackers in other words yes they're like cracking open a lobster like we would in a chinese restaurant essentially absolutely the same that's what the function of those short stubby strong spines are in the legs of trilobites and not only that what is more worrying is that we actually find religious that are crushed and what we think is that other religious they were feeding on their peers so basically uh these were um cannibals we've got good evidence that the religion was cannibalistic they are the only ones that could have inflicted that sort of tears and breaking in the exoskeleton of other trilobites because they're really heavily armored you just feed on anything that you can get your legs on in this case okay so we've got trilobites eating other trilobites were their creatures bigger than the trilobites eating them yes well maybe not eating them because trilobites being very robustly armored and having spines on top of that

maybe not them but we know that atheropods need to go through a molt every so often in their lives that's why trilobites are so common in the fossil record to some extent because one single animal can produce 15 20 different fossils whereas if that's a shell of a mollusk or a you know a snail it's the same shell through the whole life so that's one of the reasons why trilobites are common in the fossil record but it also means that these things are very very robust and they

have spines to protect from other things so they were bigger things in the Cambrian and the apex predator as we understand it were the what we call anomalocharis anomalocharis weird shrimp that's the etymology of the name sorry that name means weird shrimp anomalocharis is a shrimp or an atheropod what is this weird shrimp well the reason it was called weird shrimp is because they found the appendages and the appendages look like the tail end of a lobster with the segments and things poking out from under it and they thought wow this is strange we never

find the head we never find and they had hundreds if not thousands of specimens never with the head

that's why it was you know named anomalocharis weird shrimp eventually they realized that they was not the whole animal this was just the head appendage and then they had a whole body with eyes with a mouth that was also detaching from the rest of the body with molting and being fossilized separately uh head shield etc so that big organism that was we thought was the animal that appendage is actually just the head appendage not the tail of the of a body but the head appendage

of the whole animal and the animal reached an excess of half a meter 60 centimeters to 70

a 60 70 centimeter long shrimp good god right yeah that's right wow that's a big shrimp

yeah well they were the epic experts of the time we know that though those

spines were capable of predating on any soft organism and probably some of the molted recently molted atheropods as well so these were the great white sharks let's say of the Cambrian seas so there there are species known as the radiodont and i know don't means tooth or teeth doesn't it

what does radiodont mean so radiodont was a class defined or established by Delella calling the one

that invited me to the bird's shell and he realized that the animal a carry did so the animal carries

and its closest relatives were very different from any of the atheropods we see today and he

proposed this new class that had radiodonts meaning circular teeth or their mouths are what we call

oral cones they're not you know the pieces like you see in the mandibles of a of a shrimp or an ant

that can bite you but these are circular plated oral cones and that's why he called them radiodonta

because their teeth their mouths with teeth were circular like like our mouths or a shark's mouth

is that what you mean ah no it was it was like a like a pineapple let's put it you you see the

circle of the pineapple with the hole inside yeah if instead of the of the fleshy part of the

pineapple you've got like the tissue of your nails slightly harder tissue that is what they were

chomping with it was a circular one and it was like like the the aperture in a camera it would just

close open and close and open and close and that's what they were using to chomp on the organisms

that they were grasping with those appendages in the head you know this is like you know that's a

Freudian nightmare that's that's Freudian identifies that there's something being like

called and I'm going to use a phrase here called the vagina dentata that is something that apparently

we're all terrified of in our dreams so this is a perfect monster this creature in other words

it is a perfect monster it was very capable of swimming around it got to really large sizes

they are very successful we have you know maybe 40 different species across the globe and they were

everywhere they were from we find them in Canada in China in in in Poland in in in Australia of

course they were all over the planet very very successful apex predators of the Cambrian so

the these fossils that you're becoming more and more interested in are from the Idiacron

period now this is the period before the Cambrian explosion that this is the cusp of

animal life emerging on the planet is it most of them were originally identified as animals but now that we know a little bit more about them we see that there's things that are probably animals like Kimbrella and there are things that are going towards animals but not quite there yet we know that evolution is a slow process and you attain particular characters through your development or your evolution and those are diagnostic of animals but you don't have all of them so you can move and that's something that animals do so you can tick that box but you might not have eyes or a gut which is typical of animals therefore you're not quite an animal but you're getting there and that's the case of Dickinsonia it's got bilateral symmetry and it can move but it was digesting feeding differently from proper animals so it's not it it cannot be actually named an animal as such and besides Dickinsonia or Kimbrella there's a you know another hundred or more species

in the Idiacron that are still we're still struggling to put into the tree of life because they just do not fit the boxes we know for them they're not they're not proper animals and they're not plants and they're not fungi but they're multicellular it's it's a very strange world this one of the of the Idiacron even stranger than the Cambrian you mentioned there that NASA has been interested in some of the research people in your field and you were you are doing are they interested in these creatures that you're uncovering and researching given that they are dare I say it like aliens to life as we know it today absolutely absolutely so we have applied for funding from NASA because NASA realizes that if we go to a different planet we're not going to see what we see around us today we're going to see things that are hopefully multicellular otherwise we wouldn't see the microbes and if they are multicellular they would look more like Idiacrons than like you know the things we see around us today so yes that is that is one of the reasons why NASA is also is interested in in the discoveries of the Flinders rangers in the Idiacron discoveries of the Flinders rangers not only that the last project we got from them is that we are looking at the sediments remember I mentioned at the beginning the microbial mats that are the base on which these Idiacron fossils are found those microbial mats we can identify them from looking at the side of the rock right so we are developing through artificial intelligence algorithms that might allow us to identify the presence of those microbial mats on side view of the beds and we know that those sediments are present and we're getting pictures of of those from the rovers that we've sent to Mars those sediments are present in in in mars but we cannot go there and start you know pulling those bits apart like we're doing the Flinders rangers so the way we might actually figure out if there was live microbial life in mars is by looking at those contacts between sand layers and because they peel off like if there was glad wrap you know in between the beds that's what we can do in the Flinders rangers that's why we turn the beds over and we've got the fossils underneath and maybe something like that was present in in mars we're never gonna well never I shouldn't say I'm not going to be around by the time they send a paleontologist to Mars but the way we can do it from a distance is by studying and trying to analyze the contact between beds in those photographs and see if we see similar things to what we see in the ediacan environment which is very different from the sense that we find once animals are around because we're drilling through those beds right so if NASA one day sends

a probe to the surface of Titan a probe that has a kind of a drill that can penetrate the icy crust and below that icy crust they find in the oceans of water we know are on Titan the moon of Saturn they find strange creatures swimming around there how excited would you be Diego and I think how

suddenly relevant would your profession be well we know life as an it's an experiment it's an experiment with many variables involved if you rewind a tape of life to the beginning and we play it again we would probably see something very very different and that's basically the exercise we would be checking that experiment in Titan would be a similar one we go back to single cell life and play it all again and see how you know as we know there's a lot of contingency a lot of randomness in what happens to the planet if it wasn't for the impact of the asteroid mammals probably wouldn't have succeeded and we wouldn't be here so that applied you know millions of times through the evolution of life in the planet just tells us how smaller chance there is of something like what we see today with bipedal intelligent organisms changing their environment would be would be happening in another planet so if we go to Titan and we were to find that would be I would be the first one glued to the screen and reading those papers because that's that's basically checking how right or wrong we were at interpreting what we see in Lidiakron but it would be the only thing that we've got to compare with it's been completely fascinating Diego I've so enjoyed our conversation and thank you so much thank you so much Richard it's been my pleasure you've been listening to a podcast of conversations with Richard Feidler for more conversations interviews please go to the website [abc.net.au slash conversations](http://abc.net.au/conversations) you