

Intro ([00:01](#)):

This session of the 2013 Adelaide Festival of Ideas was recorded by Radio Adelaide through the support of the Vast mid library, University of Adelaide, The University of South Australia library and Flinders University library.

Laura Crutch ([00:16](#)):

My name's Laura Crutch. I'm the director of the Adelaide writers week. And it's a real treat being here to introduce professor John Long, we'll begin with a Ghana welcome. I acknowledge that today we are gathered on the traditional country of the Ghana people of the Adelaide Plains. We recognize and respect their cultural heritage belief in relationships with the land. We acknowledge that they are of continuing importance to the Ghana people living today, and we respect their elders past and present this afternoon. This afternoon session is brought to you by Flinders university. And what we're going to do is John's going to speak and show you some racy photographs. I'm hoping. And then I'm going to bounce back up here. And there's a microphone which I'll remind you in the middle of the auditorium here. And we'll ask you to line up and ask embarrassing questions. I will remind everyone to put their phones onto silent.

Laura Crutch ([01:08](#)):

If you are tweeting. The tweet handle is at ADL FOI. Hashtag is at ADL FOI, and the Instagram is at ADL FOI and hash ADL F O I, which just reveals how little I understand about social media. There you go, please, please don't record anything. As the session is being recorded by radio Adelaide, okay. Really quickly, professor John Long is a palaeontologist and who has for the last 27 years been collecting from the go-go sites in Northern Western Australia. What he's found is perfectly preserved 3d fish fossils, which have yielded many significant discoveries, which he'll be talking about, be talking about with you in a moment. He's the author of many books, 30. I think he said, which are both for children and adults. And I just, you must read hung like an Argentine doc as it will. I guarantee you give her, you give you conversation topics forever. We have spent quite a bit of time on YouTube at my office. As a consequence of the book, John is going to talk to us about his work, the project that is ongoing, and I'm going to turn over to him.

John Long ([02:38](#)):

Thank you very much, Laura, for that wonderful introduction. Can everybody hear me so good? Good. I never thought in a million years, when as a child age seven, I struck a rock and I found a fossil that I would have a career in paleontology, but be one day I'd be an expert in fossil sex, but you never know what you're going to find and finding fossils. There's a bit of a roll of the dice because some days you find something that's really obvious and other days you find something you're not sure about. And then with further research becomes the biggest discovery of your life. And that's what I'm going to talk about today. Title of my talk is death, sex and evolution. And if you think it's rare to find evidence of sex in the fossil record, just have a look at that picture. There are two fossil turtles caught in the act of mating.

John Long ([03:29](#)):

And I got fossilized in that one brief moment of intimacy. So they're 50 million years old. So it does happen. So let's just go over some of the basics of this talk all life reproducers and admittedly some life clones itself. Asexually but what I'm going to focus on is sexual reproduction, where there's a male and a female, and this is sharing of genetic material. Of course, all life has to reproduce in order for the species to survive. And the next point of course is all life is terminal or life dies. And if we're very, very lucky, we

get to become a fossil. That means a small percentage of life is preserved in the fossil record. And fossils can be anything from bones. They can be leaves. They can be even cells preserved. And some of the most remarkable fossils in the world come from Australia, including right here in south Australia, from EDD, ACRA and fossils really are the prime evidence for evolution of life on the planet.

John Long ([04:34](#)):

I mean the prime evidence is actually seeing how life changes through time, modern biological evidence, such as genetics, that that shows how the, the, the genomics of each species are related to one another is icing on the cake that sort of cements evolution. It was a theory in Darwin's day, but it's been a fact for at least a hundred years. Okay. If we go into the Akron Hills in south Australia, we see the beginning of the story with this wonderful paper published by Dr. Jim Galing and Dr. Mary Grocer, Jim Gallan works across the road at the south Australia museum. When they found this beast called *Phononema*, they realized that they were all the same size instead of random sizes on the bedding plane. This is three, sorry, 560 million years ago. It's a coral like animal, like a polyp. That's probably what it looked like.

John Long ([05:27](#)):

And this was the first evidence that these things probably had a spawning time that was once a month or once a year when these things spawned whenever, because they were all at the same size. So if there's random sexual sort of activity, you'd expect to find on the bedding plane, these things will be in all different multiple sizes, but they weren't on every, every layer. They were all the same size. And then on another layer, that'd be all the same size of different size. So this is the first evidence we have in the fossil record of sexual reproduction taking place, but we don't have any evidence of how they did it, or whether they enjoyed it. They probably did, or they wouldn't do it. Okay. The oldest fossil sexual organ in the fossil record is actually from this little creature called an *Osteria*. Now in Austria as a tiny little bivalve crustacean, imagine a crab living inside two shell halves.

John Long ([06:20](#)):

And that's basically what an *Austria* is. And this fossil from England 430 million years old actually had all the soft tissues mineralized inside it. So when it was put through a CT scanner at very high resolution, the scientists were able to determine all these remarkable internal organs and this big orange thing here is actually the male penis compared to a modern day living *Austria* Cod, where we can identify the same tissue structures was very, very large. So they call this thing, *Columba siphon* eclectic switch means the swimmer with a large penis. We don't know what the females were like. We presume they were very similar, but without the penis, but what I'm really going to talk about for the next 20 odd minutes or so is about vertebrates. Now, you and I have a backbone. So we have vertebrates, right creatures that don't have a backbone, snails shells, worms they're invertebrates, but vertebrates include everything from the fishers, the amphibians reptiles, the mammals and groups like dinosaurs.

John Long ([07:21](#)):

So backbone, animals, all vertebrates and all vertebral throat produce sexually male, female exchange of genetic material. In fact, 99% of all vertebrates, the most abundant on the planet are the fish. And most of those fish spawn in water. I shouldn't say 99% of all vertebrates that's wrong. Primitive vertebrates is what I'm talking about. The fishers where the males simply shed sperm over eggs that are already in the external environment, but a few break that rule. And if you look at sharks and rays and they're related kin, we find that there's a form of copulation going on, where the males have clasping organs that come off the pelvic fins this long rod here, which they insert inside the female to deposit a package of sperm.

So this is the first evidence of actual intimacy in terms of a sexual act in living, living, primitive, living organisms.

John Long ([08:22](#)):

The question is, or when, and how did this complex mating behavior first begin? And what's the evidence we have for it and being a paleontologist. The question I was asking, can fossils shed light on this problem? And the theme of this festival of ideas is the real value of something. And I think my talk comes down to the real value of studying disciplines like paleontology. I liken it a lot to astronomy, you know, not a lot of actual practical applications, but real soul searching questions that we all want to know the answer to. You know, we all want to know the answer to what's the size of the universe, or where are we heading. We also want to know the answer to things like where have we come from as a species, where are we heading as a species? What's our deep, distant ancestry, you know, beyond our immediate human sort of span on the planet.

John Long ([09:12](#)):

So I like to study fish that go back 300, 400 million years old, which is the beginning of the assembly of the human body plan. And let me give you some examples. So the very first oldest fish on the planet comes from right here in central Australia. It's called Aaron despots named after the Aranda people of central Australia. And this was a fish with no drawers and no fins, but just a boning exterior sort of covering it's got real bone, real bony tissue. So that's how we know it's a vertebrae. There are a whole bunch of these jawless fish, really crazy wacky things. You know, some of them are really bizarre and yet none of them have fins until you get to the most advanced forms, which have the first pair of paired fins at the front. Now this paired things at the front, basically your arms, because they continue right through evolution and they become the fins in more robust fish and eventually the arms of early amphibians.

John Long ([10:06](#)):

So that's where arms first appeared a bit of an arms race placoderms though, or where legs first appeared paired pelvic fins. So not only did legs first appear in this ancient group, the placket terms are now extinct, but there are a group that also had very advanced brains that had jaws, the first fish, first vertebrates to have jaws and teeth. And they also had an inner ear with three semicircular canals instead of two. And that's what we have in our ear. So they're the beginning of these advanced characteristics that would carry right through evolution up to us humans.

John Long ([10:42](#)):

There are many different kinds of placoderms the ones that I'm going to talk about today include these ones at the top called Arthur dyes. These ones with very powerful jaws, crushing plates called kicked it aunts and another group called Antioch's with boning pectoral fins. But I'm not going to talk about them so much today, but the thing is, there's a great diversity of these early Jord Ahmed fishers on the planet. They rule the earth for 70 million years, the seas, the lakes, the rivers of the world. It, how many people in this audience before now I've heard of a plaque of derm, honestly, put your hand up. Yeah, just a few. Okay. But you know, you should remember placoderms they're the rulers of the planet for 70 million years. And yet nobody knows about them. It's my mission that everybody knows what a placard room is. Okay.

John Long ([11:29](#)):

Recently, a fabulous paper was published in nature. And I wrote an article about it for the conversation. And it showed that this, we found like a missing link placoderm colon tele nature's that had the body of a placoderm, but the lower jaw of a modern tetrapod having a multiple pairs of bones informing the lower jaw, including a Dendri. So we have a tree forming, a lower jaw and a maxilla forming her upper jaw. This was the first creature on the planet to have that combination, which is why it's so important. And if you look at the evolutionary line from placoderm to us, that's it. And so many of the features that define us now as human first appeared in placoderm rooms, that's why it's important to study them. So this is my fossil site, the place I go into the desert to collect fossils in the Kimberly up at Gogo, it's a fun place.

John Long ([12:19](#)):

It's very wild, lots of interesting snakes and animals and birds, but the really amazing thing of the fossils. So when we hit these limestone nodules, we find fossils like this, and that's what they look like when you actually find them. But when you put them in weak acid and dissolve the Rockaway, they turn into three-dimensional Jules, they look like they died yesterday. You can still open and close the mouths or move the arms. So there's not another site on the planet where preservation of fish this age is so extreme. So beautiful. So we made an unexpected discovery in November, 2007. I had my fish in the acid. I was slowly dissolving the Rockaway and I was very excited because I thought I had a new species of plaque at home. And for me, that's a very exciting day. We get to name it and we get to describe it.

John Long ([13:10](#)):

But something more exciting came out of this specimen. That's it? You can just see the bones beginning to poke out. And then a little bit later, I had the tail out and there's the front of the fish, which is this bone here. And then if we look, these are all the vertebrae from the tail. And if we look in this little area, I noticed a whole mess of tiny little bones, very delicate little bones. And at first we thought, this is probably the last meal, the stomach contents of this fish. But then we looked more carefully. We realized they were beautifully preserved. They weren't damaged. And they were very light, lightly formed bones, like embryonic bones. And eventually we realized that exactly what we had was an embryo. And the thing that nailed it, wasn't so much the fact that the bones were delicate, not crushed up.

John Long ([13:58](#)):

It was the fact that we had, you know, you've got the jaws there and various bones. We even made it in the Guinness book of records with this one, which is quite amazing. If I take away some of these arrows, this is the clincher. This is the thing that made the hairs on the back of our neck, go up where we found it. And we put it through a micro CT scanner and through a scanning electron microscope to get four morphological features that identified this as an umbilical structure, a mineralized placental structure, connecting an embryo, probably to a yolk SAC. So we discovered the oldest birth on the planet. We'd also discovered the oldest mother on the planet, which I nicknamed Josee after my old, my dear mother who died a couple of years after this. And the third thing we discovered, which didn't go on us for at least a week or two later was we discovered the origin of complex sex of copulation because this creature had an embryo inside it. And the only way you can do that is by having internal fertilization.

John Long ([15:01](#)):

Okay? So this is what the fish look like. We made a little computer reconstruction of it and I named it Marta peices mother fish at and bearer. I after sir David Attenborough, because he was the first person

to draw attention to Gogo is a very important site. And he was over here in Adelaide a few weeks ago, a month or so ago. And we got to show him some of these go-go fishes. And he was absolutely delighted to, to see some of these fishes. He's been up to go go back in 79. So he knows the site, but then we got thinking, surely there must be other examples with embryos. And we found this specimen, which I discovered in 1986 and published 10 years later. And it actually had not one,

Speaker 4 ([15:40](#)):

Not two but three, the

John Long ([15:43](#)):

Unborn embryos inside it. So a mother fossilized with triplets inside, that was very exciting. This is the first evidence that we had on tagine or growth change with age in these ancient fish

Speaker 4 ([15:56](#)):

Made a little movie.

John Long ([15:58](#)):

We figured that if you find a dinosaur, it's easy to get press, but if you find a little fish this big with an embryo, you need to make a movie. So we put it on YouTube and it went viral and we're able to get the message out that this was actually the first fish, the first vertebrate on the planet to give birth to a live young. And the company really images in Melbourne did a great job. There is the little pup. That's what sharks younger call they called pups. And then the next step in the story was that we're looking at one small group of placoderms that had this embryo. Now we looked at the biggest group, they call the Aphrodite and these were the biggest mega predators on the planet. Some of them grew up to six meters, long armored fishers. And then recently we found that with a synchrotron particle accelerator, we could put a fish still in the rock through this powerful beam and analyze all the structures inside.

John Long ([16:51](#)):

We're able to find soft tissue, complete musculature. So that's, that's a muscle still attached to the bone inside the rock and there sheets of muscles there. So that was a big breakthrough. And it also vindicated the fact why we're getting umbilical structures preserved in some of these fish because of the very special chemical conditions of preservation. The next thing was that we looked through all the collections in Australia and in Europe until we found it, the British museum in London and example with another embryo in it. So we'd extended. The fact that embryos live birth and copulation were not just in one group of these placoid fishes, but they're in the biggest group of placoderms. And that was exciting. We found several examples with embryos in them. And this showed that these Aphrodites these biggest group of placoderms had internal fertilization and also showed that despite hundreds, if not thousands of specimens in museums around the world, we couldn't find evidence of males or females being. We couldn't find, for example, the classes that you find in sharks that determined the males from the females.

Speaker 4 ([17:55](#)):

So at Ray's this very complex

John Long ([17:57](#)):

And intricate scientific question,

Speaker 4 ([18:00](#)):

How the heck were they doing? It

John Long ([18:03](#)):

Really was the smoking gun. We had to find, how are they mating? So we went back and we looked at all the pelvic structures in these fossils, and we found all sorts of structures that came off the pelvic fin that might've been a class spur, but we didn't have the evidence of the class spur pelvic girdles. This bone called basic pterygium. Even some of these other fossils that aren't as nicely preserved as Gogo still had the same structure, forming the pelvic, the hind rear fin, possibly for a class spur, but, but not convincing. But finally, after doing these fanciful reconstructions of how these things might have made it after we'd done this, we found one in 2009, and that's the pelvic girdle where the fin comes off. And this is the element called the class for this long bony rod with little hooks and barbs on the end is exactly like a sharp class.

John Long ([18:55](#)):

But today, except the shark Casper is made of soft rubbery Cartilage. Whereas these early vertebrates had had bone real bone. Now you can't read that, but it says paleo porn productions presents down and dirty in the Devonian starring big cow class Burt and Pamela pelvic plates. This is X-rated. Now any of you that might be offended, please turn away. We're going to show you the first Palio porn movie, Joost starts off with a fossil innocent looking fossil. I might say that's the belly up, the ventral plates that the jaws up there. And then we're going to show you how it fits into the body of the fish. It's the male. He has classes at the back and here comes the

Speaker 4 ([19:41](#)):

Now at the time

John Long ([19:43](#)):

I thought the classes were articulated to the pelvic fin in such a way that they didn't have much flexibility with the class. But so there must have made it in like a 69 position. Now, as the female swims away, the male swims away, the females they're going call me and we leave the fate up to whatever happened. But the female got fossilized with the embryo is still insider. So she didn't have a long life. It's very tragic. This story recently, we've gone back. I was in London, not too long ago, only about a month ago. And we've just written another paper where we've found lots of evidence of classes in all these different fish. And the interesting thing is we found one go-go fish with the class we're actually poking out of its mouth. Don't ask me about that. We don't know how it got there.

John Long ([20:31](#)):

It's probably displaced after death, but dare I say it first fossil evidence of oral sex in the fossil record. But the most intrinsically interesting thing about this is that we always thought that vertebrates primitively had two pairs of limbs, you know, hind limbs, legs, and front limbs arms. We now know that from our new research, these classes were actually not connected. We actually got it wrong in our 2009 paper and good scientists. The first thing you admit is when you're wrong, you say we made a mistake and new evidence has come to light that these classes were not connected. So we now look like we have

three sets of limbs. And the third set of limb in these early vertebrates was purely for reproduction. That's really exciting. This is work we've just submitted. So it's not even published yet. And this is my revised mating position for these placard rooms.

John Long ([21:21](#)):

Standard missionary position was the primitive condition and like sharks do it like that today because they have great flexibility with their classmates. You can age a shark by the density, dense calcifications on the class spur. So if you want to know how old a great white shark is, and you're clinically insane, you can swim up to it and feel it's class. And if it's, if it's class was rigid, ossified, it's reaching sexual maturity. So that's how these fisheries produced. But how did this act actually begin in the first place? Well, we can only look at the bizarre world of modern fish to get some idea. For example, some fish like Mandarin fish, which don't have classes, but they get close to each other. They hug each other. So there's very close contact between the female laying the eggs and the males putting sperm on them.

John Long ([22:10](#)):

That's probably how these placard rooms got together originally with holding each other close together. [inaudible] Contact was probably the beginning before internal fertilization began. But if you look at angler fish, they're very bizarre. The males attached to the female sometimes on the head and then they completely degenerate and just become a bag of sperm. They do nothing else, but satisfy the female at her will when she needs sperm, they become totally useless. So parasitic sex, if you like. But my, my favorite example, which is in my book is the common bronze catfish. Cory Doris, there's a paper published in a scientific journal, actually called sperm drinking in female catfish. And it's because the males are aligned. This is an actual meeting act here. The female aligns next to the clinical duct of the male. So she can take the sperm into her mouth and circulate it through a duct directly to the ovaries. What's the advantage of this? Well, these things live in fast moving streams. So you try to mate externally in a fast moving stream, it's less successful in being able to contain the eggs and sperm in it in a controlled environment.

Speaker 4 ([23:20](#)):

But what's the link to us

John Long ([23:22](#)):

From placards to humans in terms of sex? Well, I was very excited when I saw this paper in a biology journal, showing that the way class was developing sharks uses exactly the same genes, the patterning genes, Hawks genes that develops in humans, the urogenital plate from which genital organs, both male and female are developed and also the limbs. So there's this ancient connection that goes right back to the beginning of the vertebral body plan, that bills genital organs from an offshoot of limbs, which is exactly what we found in our plaque of derms. So it's a very exciting discovery, but I'm going to leave you with, this is a rather complex sort of map of how we got from fish to humans. There's been loss of sexual organs at many times in evolution. For example, many amphibians don't have a penis at all. Some do like Sicilians, many reptiles.

John Long ([24:15](#)):

Don't have a penis that you are. Tara doesn't have one, but snakes have too many lizards have too many birds. Don't have a penis cause they've lost it for flight. But the early primitive birds still have a penis emus, ostriches ducks, especially if you wonder why my book's called hung like an Argentine duck. It's

because of this. The other time like duck Oxy year over Tata has a 42 centimeter penis for an average size duck. It's the largest male sexual organ relative to body size of any animal on the planet. Now, just to finish up a little bit about sex and evolution, again, of course, Darwin who formulated the theory of evolution with this book in 1859, also wrote some fabulous books after that, the descent of man and relation and selection in relation to sex in 1871, where he actually put forward the theory that it's the males that are the dominant ones in terms of sexual selection.

John Long ([25:11](#)):

And that this was founded on things like peacocks with their wonderful tales, the way that antlers developing many types of antelopes and deer. So the males can fight it out for the females and baboons with wonderful facial displays, but it implied the female had a totally passive role that was all about the males to battling it out for the best females. That's so far from the truth now because there's a whole new area of biology that's kicked in recently, that's all about sperm competition, where the females control the quality of sperm that they want for their eggs. So for example, with dragon flies, the males can actually scrape out the sperm from the previous meeting and deposit their sperm. And then the female can actually choose, which may it is the strongest or fitters that she might think will be best for her offspring. Same with ghost crabs.

John Long ([26:04](#)):

Many, many animals do this in zebra Finch, very common bird here in Australia. Last male precedents, for example, the first male might've made it nine times with this female, but the second mal comes in and makes once and has more than 50% of the offspring that's called last-mile precedence. Again, it's a way of the female controlling the quality of the sperm she wants rather than the male copulating being the crucial act in mammals. We see very bizarre things like the Gootie and many of the rodents, which I call the Swiss army style penis that has all sorts of hooks, bobs and things because when males copulate, they also deposit a plug of meekness to lock the sperm in. So the next mile comes along and has to drill and cart and pull out that plug and then deposit his sperm. So it becomes a bit of an arms race.

John Long ([26:56](#)):

Yes, the most unusual thing I discovered in doing my research for the book was very recently published research on the hyena. Did you know, for example, all hyenas have often been in ancient literature thought of as true hermaphrodites because they couldn't tell which of the females from the males, because the females have a very enlarged what's called a phallic closer clutter it's that could be as large as the male penis, but the most amazing thing about it is that when they give birth, they don't give birth through the vagina. They give birth through the clutters and tears the is apart, but then it heals up again and they have further pups. But this is, this is just an ex bizarre example of how reproductive strategies in animals evolved in very strange and unpredictable ways. I've got many, many more examples of it in my book, but I'm just keeping it short for today.

John Long ([27:49](#)):

Okay. And I'm going to finish up with, what does this inform us in terms of politics and policy about modern life for us humans, how can nature inform policy and political decisions, but it all comes back to what is natural behavior. And dare I say that, which is observed in nature. What could be simpler than that? Would you all agree? That's natural behavior. Good. Look at these penguins here. And these koalas fabulous book was published recently by a professor at Monash elder. [inaudible] A good friend of mine, animal homosexuality, a 570 page textbook. We now have over 1500 species of animals that



have observed using homosexual behavior of one kind or another. Some forms even have lifelong bond relationships. Those penguins I just showed you were both male, very famous example, Roy and Silo at the New York zoo who are male males who adopted an egg and then raise the female tango as their own tango grew up to then have a lesbian relationship with another penguin.

John Long ([29:01](#)):

This is true, but seriously folks, if we look at what's happening around the world, the persecution of people who are homosexual in Iran, according to the Berman foundation, there are records of at least 107 executions in the last 15 or so 20 years. And we all know what happens in Uganda and Saudi Arabia. You can get lashings or executions for being homosexual. So, and really people of the extreme religious right in America often claim that homosexuality is unnatural behavior and they should all be punished and so on. But nature defines what is natural and homosexuality is therefore defined as a natural behavior. What is its purpose? Well, according to Aldo's book and he wrote an extract for my book, basically, it's to strengthen kin bonds within a larger population, strengthens the population and the fitness of a population and makes reproductive success even greater for that population. So there you go. I like to finish up with this, the picture of the lesbian koalas from Queensland that was publicized a few years ago, quite a few scientific papers

Speaker 4 ([30:07](#)):

Are written about them as well. Finally,

John Long ([30:11](#)):

In some vertebrates they can do without males altogether. So all about penises in males, the females have a great story as well. Vertebrates as high as lizards can exhibit parthenogenesis, which is giving birth to a clone of the male of the female without males being involved at all. So with these combo dragons that were held in captivity well away from males suddenly gave birth to live young and they were healthy offspring. They weren't cloned. They were able, they were clones of the mother, but they're able to reproduce, continue reproduction into the next generation. So right up the evolution from fish, old groups right up to reptiles can have this behavior of parthenogenesis. So us males should be very wary that we might be redundant before we know it.

Speaker 4 ([30:57](#)):

Thank you.

Speaker 5 ([31:10](#)):

[Inaudible]

Laura Crutch ([31:11](#)):

Hello again, that was contested. If you do have any questions, please find your way to the microphone here in the middle. And while you're thinking, I'm going to ask a couple of questions. The first one I get, I have to say, does it always make sense? You know, there's so much bizarreness out there and is there always an evolutionary,

John Long ([31:31](#)):

There is a reason. Yeah. I mean, in the invertebrate world, a very nasty arthropod sex. It's a whole chapter of my book. Bedbugs are one of the worst homosexual, traumatic rape and the traumatic rape with females as well. What are they doing? They have an DGS, which is a penis likes structuring the males, which has raised a sharp, like a sword. And they Pierce either the female or the male. They don't care to deposit the sperm in there. Now, if it's in a male, then it can go to directly to displace the sperm of that male for next reproduction. If it's in a female, it finds its way to the ovaries. So it has an advantage. Yeah. The first question.

Speaker 6 ([32:11](#)):

Hi, I'm actually interesting. I'm a little bit concerned about the, the mass of the need for the penis. Sorry, the need for a pain. Yeah, just a little bit only. Some of the studies have been around the, the, the, the robustness of the Y chromosome and where will we be in the future? So my question relates to the, the, the, the lizard. Yup. And is that the only one or the other examples where Genesis, both sexes can still coexist and have relationships and yet parthenogenesis is the primary primary method of pre-production? Well,

John Long ([32:54](#)):

It's not the primary method, but it happens. I mean, all through vertebral evolution and with modern vertebrates today, sexual reproduction is that is a dominant one. Pathogenesis is a rare case, but it just shows it's possible as you go lower down the tree, it's more common. So for example, many sharks in captivity and aquaria have shown pathogenesis hammerheads, and bonnethead head sharks much more common down the bottom of the tree than at the top. I use the Camano dragon because it's the most advanced vertebra to show pathogenesis. We still don't have it in, in any mammal, for example, or any bird, but, but you're right about the use of a penis, because we look at birds, which are the, one of the most abundant species on the planet. There's 10,000 species of birds, 90, 95 or 96% of them don't have a penis because they primitively had it. But once they began to fly, they suddenly re altered their whole physiology and the need for penis wasn't as important as the need for lightening, the whole skeleton and so on. And they got by just by having client contact. In fact, darts can do it in a 10th of second in flight bang. Let's see. That's pretty advanced sex if you asked me without a penis. Yeah.

Speaker 6 ([34:04](#)):

If I could just ask them, you have no known as behind me. The the, are there any views on where species can go if the DNA wasn't required, I can understand the penis dropping off, but what about the DNA? That's the draw. That's weird.

John Long ([34:25](#)):

Yeah. Yeah, no, I don't think DNA is essential for life because sexual reproductive reproduction is about sharing a genetic pool. So each individual offspring and generation is unique. Genetically creatures that clone each other, like hydras and certain sort of lower invertebrates, they just make a clone of each other. But then the whole population is genetically the same and they're prone to be wiped out if there was a disease or something. So the origin of sex goes back because it made us genetically more fitter as a population to withstand unexpected traumas in life, whether they be diseases or changes of environment or whatever. Great.

Laura Crutch ([35:04](#)):

In the beginning you were talking about yourself as a child and becoming a paleontologist. And I was wondering, given, reading this book, there's so much biology in it. I just wanted for you and the research you do, kind of where those two things met because you've sort of ended up with all the dead things. And I've got all the living things.

John Long ([35:23](#)):

I do a lot of different avenues of research that informed the paleontology that I'm focused on. For example, we're looking at the problem of we've pretty well solved the origin of sex. Now we're looking at a problem of the origin of breathing. When did air breathing of all invertebrates, and we've got some stunning new evidence from Gogo in terms of Gill, arches that are being modified for a, for a breathing, but I haven't published that yet, but in order to do this work, we've also done a lot of physiology on living fish with the Scripps Institution of Oceanography in California, where we've looked at air breathing in modern fish and the carbon dioxide oxygen ratios, and so on. We're about to publish that in nature communications very soon. So we have to do a lot of research on living organisms to be absolutely sure we're making the right interpretation.

Laura Crutch ([36:06](#)):

Fantastic learning one questions. So given you are dealing with the living and the dead, I wondered if you feel worried about extinction now, because we sort of talk about the fact that we are entering possibly ecological collapse. And I just wonder what that looks like when you're

John Long ([36:24](#)):

Here. I have no doubt from all the articles that have been published in learning peer review journals that we are going through the major six mass extinction right now, part of it is a natural, just a normal spread of humanity growing to such large populations. You know, a million years ago, there was 20 or 30,000 humans on the planet. Now there's 7 billion and that's got to displace a lot of other animals just by virtue of us occupying so much territory on the planet. I do worry about it. And also climate change, which is a really major problem. We all must face up to many species will go extinct. And I don't think we can stop that, but we can preserve and do our best to, to, to value what we've got here in terms of biodiversity. Not only because it's intrinsically important, but it's very valuable to society by diversity is where many of the great cures and the pharmaceuticals of the future will be coming from.

John Long ([37:14](#)):

Once we've done the study on those organisms, do you think we'll be able to save things? I think we can. I mean, some of the things will evolve with changes, but changes are happening far faster than background geological time. I did a graph once looking at temperature changes now and compare them to the last ice ages. The temperatures are increasing now something like 10 times faster rate than they did in the ice ages. So that's, I'd say this were pretty dramatic, quick changes, but animals evolved. Many things went extinct by the way with the ice ages, but others evolved, but accelerate that times 10. And I just can't see the way animals can keep up with that sort of rate of change. How about us? Well, we're humans, we'd be on devolution to some extent in the sense that, you know, with modern medicine and pharmaceuticals and things, we can keep people alive to, to good ages, well past reproductive capabilities. So I have great faith in humanity that we will survive, but what's gonna happen to the rest of the planet. Is that is the problem. It turns out where the cockroaches and other questions. Yep.

Speaker 7 ([38:18](#)):

I'm just curious you brought up homosexuality, actually. I'm just wondering if that you think that's from evolution because surely one day someone couldn't have just woken up and gone, Hey, I'm homosexual or I'm just born that way.

John Long ([38:31](#)):

Well, according to the scientific papers, which are all about homosexuality and kin bonding and this book, which is a wonderful read, I haven't read the whole thing, but I certainly picked elbow's brain when I wrote my section on it. The fact that it occurs widespread in nature means it's a kind of behavior that a small percentage of the population in all of those populations shows. So all I'm saying is that if you observe it in nature, it's part of a natural behavior. I'm not casting any judgment

Laura Crutch ([39:00](#)):

To just follow on from that. One of the things I was thinking about in the book is how prescriptive our own sex lives have become for so long, you know, for hundreds of years. And I'm kind of wondering if you ever think there was a time we did look at nature and see things as natural, or if the church just beat us to the punch.

John Long ([39:20](#)):

Very good question. That's sort of getting out of my depth in terms of natural the relationship of sex and animals and evolution, but I see where you're coming from. Ah, yeah, no, no. There are examples in the book, all sorts of bizarre what we consider, you know, different, different sexual behaviors. I mean, fruit bats in Malaysia use as a way of increasing their sexual drive. Necrophilia is common in garter snakes in north America. Males posing as females. Semales do that in order to warm up in the sun. And there's all sorts of behaviors that we think are associated only with human sexual behavior that you do find in the animal kingdom. And I've, I think I've done a good job to document it in the book, including the auto-fill eating goat, which is one of my favorites. But anyway, I've got to read the book it's all in there and

Speaker 4 ([40:12](#)):

There's some pretty startling. We don't have any

John Long ([40:14](#)):

Comments outside. I must add. Cause it's, it's out of print, but no, it's not out of print, but they don't have any copies around, but it is available as an ebook. So you're welcome to get it or order it in with your local bookshop because I know Ellen, sorry, HarperCollins. I've got lots of stock of it at the moment. Sorry. It is

Speaker 6 ([40:32](#)):

A hugely readable. Good. Okay. Given a lot of the, I guess the, the end of your talk on some of the conversations since then, I'm just wondering if you've ever had some really interesting conversations with church ladies, particularly fundamentalist

Speaker 4 ([40:49](#)):

Leaders, I've battled creationists

John Long ([40:51](#)):

In on the debate floor not about sex, but about, about evolution. They always win because they stop stack the decks before the scientists get in there. So I don't debate them anymore because it's always on their terms. But in when I was younger and more naive, I used to love to challenge like that. Now you can't debate or have an argument with people that don't use this system of normal logic. I mean, if, you know, I mean, I don't mean, I don't mean religious people. I respect anyone who's religious. I mean, fundamentalist religious people who don't believe in evolution because we can put all the evidence in the world on the table and they still will say, well, we don't believe the earth is more than 6,000 years old when we can date it with half a dozen different radiometric method methods with great precision. And this is like chemistry. It's not debatable. We know it works. There's absolutely nothing flawed with the way the method works, but they just don't accept it. So I don't debate with people who won't accept the basic premise of logical science,

Speaker 4 ([41:48](#)):

But there's no point. Yep. Great. Thank

Laura Crutch ([41:50](#)):

You. Do you think we're having a bit of a hard time though? Right now it feels like science and the church are really struggling and especially because I come from the states and you've been in the states, you know, science, I think is getting a bit of a short shift in terms of the media and coverage and climate change. Deniers seem to a lot more,

John Long ([42:08](#)):

But that's a good time. Brilliant question, Laura. I've just lived three years in Los Angeles and there's a much higher level of fundamentalism in Y widespread in the community. There, people that don't believe in evolution or all climate change and white trust sites. I think it's an erosion of the trust in science in the old days, 50 years ago, people politicians turned to scientists for advice and took their advice because it was what was right now. They get the advice from the scientists and ignore it. So no wonder we're on a trajectory for disaster, when scientists are telling you that this is what's happening, and this is what we must do to stop it. And if we don't stop it, this is the outcome. I did this in a children's book about climate change, where I presented the evidence very clearly. And then I painted two scenarios of what the world will be like in 2080, if we do nothing now, or if we start mitigating greenhouse gases. And it's very clear what the world's going to look like in 2080 based on all the evidence and predictions. Sorry,

Speaker 7 ([43:07](#)):

Just wondering, is there any evidence that the things that you're examining, whether there was any pleasure relating to sex or was it purely procreation because we could now have pleasurable sex. Yeah.

John Long ([43:20](#)):

Yeah. That's a very good question. And I don't think there's any actual evidence for it. In my fossils. We're looking to find one with a green [inaudible]

Speaker 4 ([43:31](#)):

In some eyes

John Long ([43:31](#)):

Based on living organisms today is that they wouldn't have done it unless it was fun. Let's face it. Why would a fish for no reason, swim up to another fish and stick an intimate part of its anatomy inside that fish, unless it was having a good time. So sharks do it and they enjoy it. So I presume my packet rooms have the same approach.

Laura Crutch ([43:52](#)):

And also you do talk about masturbation in the book and I was kind of a man. I knew, I think I knew about Bonobos, but I certainly didn't know about the barnyard fund that was going on. I just kind of wonder,

John Long ([44:06](#)):

Well, barnyard animals, especially like horses, goats, and sheep are well-documented in terms of their sexual nuances. Shall we say? The case of the auto flying goat goes back to a veterinary manual of the 1830s in Scotland. So I took a quote out of it, but there are many, I found in the literature, many, many cases of bizarre behavior in barnyard animals, simply because people are around them and they can, they can watch them, you know, behaving this

Laura Crutch ([44:31](#)):

Way. That's a presumably they would be having fun. You have to give up really hello. People laugh

Speaker 6 ([44:38](#)):

At our pandas at the zoo because they only have sex for a short time, four days of a period of one year. What could be the evolutionary advantage of that? Oh, that's

John Long ([44:50](#)):

A very good point. But other animals that make once and then die, like the desert yurts, there's some of the anti kind of species, but works for them. It's probably got to do with mating is a very vulnerable time for them in their environment or something like that. I really don't know. The pandas are a great example, but why they only do it for four days a year. It must be a specific time where the body fats levels are up large enough to mate implies that the female then has to go through massive physiological changes to really young. And that means a change in their normal behavior with feeding every day and so on. I really don't know much about pandas to be honest, but I think it must be some sort of reason that relates to necessarily levels of buildup for the female to then nourish the young or something like that. But there's always a reason. And it's usually when the scientists study it and they find out have to correlate and measure certain variables. Like it might be body fat, or it might be dyed. It might be changing seasons, or it might be just that they're vulnerable to certain predators as a certain time of year. And so they make when it's safest to give birth and they don't have these predators around. So it could be one of those reasons.

Laura Crutch ([46:06](#)):

One of the ones that I found most fascinating with the drafts, and you can explain how drafts make, cause it's quite fascinating the differences with the men. But I guess the thing I kept coming back to in the book is how long does it take, you know, how many drafts faint before you can explain that

John Long ([46:25](#)):

[Inaudible], they have a very long neck and when you have a very long neck, you need really high blood pressure to pump the blood up to the top of the head. And I talk about this in the context in the book about sauropod dinosaurs, the largest animals that lived on the planet, some of these were like 50 meters long and had really, really long necks with little heads on the top. And the thing is that when you're mating, they run a risk of blackout at orgasm because they're not getting enough blood to the brain. And historically orgasm, the French quarter, lipid mall, the little death because people sometimes faint and in these animals, it's really a matter of juggling the act of mating versus Abigail blackout at the end of it kind of thing. So they have to tread very carefully.

Laura Crutch ([47:07](#)):

And do you think that would have also been true of dinosaurs?

John Long ([47:10](#)):

Absolutely. They will. Certainly the earth would have shaken for them. That's for sure. But we don't know. I mean, the evidence from dinosaurs is that we've got things like fuse, tail vertebrae, where we think dinosaurs might've been able to move the Taylor side. So the males could get inflating. I just simply think that they would have had massively long penises because they're, so that that's the only way they can do it. Like armadillos. They have very long penises about a third, the length of the body of the animal, because they're the armor. They can't get close enough to do it properly.

Laura Crutch ([47:40](#)):

The other thing I found quite fascinating is everything that becomes load bearing, which in dinosaurs is kind of particularly fascinating that they have to be able to take the weight

John Long ([47:50](#)):

Like rhinos, mating or elephants. You know, the mail still puts weight on back of the females back. So they have to be physiologically and skeletally strong in that area. And that's where you'd look in terms of the evidence from the fossils. You look at those bones and see if they built up. But to date, I don't know of any published scientific paper that has actually reinforced that they were, you can't, you still can't tell the males from the females and the dinosaur skeletons. There's no actual sexual dimorphism being proven.

Laura Crutch ([48:19](#)):

Isn't that wild. But does that mean they're all the same size? Yeah. Killer does not.

John Long ([48:25](#)):

Well, as we know, we don't know because we can't determine which of the males or females apart from those very few specimens of have eggs inside them, which were no definite females.

Laura Crutch ([48:34](#)):

God it's wild, isn't it it's anybody else? One of the things going on from the Panda question is, I mean, there is, there must be some mysteries like that in some of the animals that you're looking at in, you know, how can it possibly be a benefit?

John Long ([48:52](#)):

Yeah, well, exactly. It all comes down to genetic fitness and it's the same reason why some animals like the anti kindness can make like crazy for 24 hours and then the males die, like their immune system shot. Why is that an advantage? Because in that crazy mating period, they actually get at works and the females have offspring and rather than there's different strategies in reproduction, there's K and R strategies. You can have lots and lots of offspring, but a few of them make it alive to reproduce as adults. Or you can just have one or two, but put a lot of care into them. So they're guaranteed to make it. And animal strategies divided between those two approaches basically. Yeah. A question.

Speaker 6 ([49:36](#)):

Yes. I'm just wondering on you said evolutionary advantage of homosexuality's strong Kings. So is that consistent? Does that show that only species that traveling like large groups that's where it's more prevalent? No, no.

John Long ([49:50](#)):

It's more looking at a population as a whole large population. This is Aldo's, he's written various scientific papers about it, looking at both animals, well, animals, mainly not humans and basically a small population of homosexuals in a bigger population can strengthen and protect that overall population or integrate with that population in such a ways of increases the fitness and ability to reproduce it, the whole population, even though they're not reproducing directly. So that, that's how it works. It's sort of like a proven mathematical sort of study that a certain number of homosexuals in a group like that, or a larger population will increase the reproductive ability of the population more than if that group wasn't present. So that's basically how it works. Yeah. And are there

Speaker 6 ([50:45](#)):

Any other advantages evolutionary speaking?

John Long ([50:47](#)):

No. No, but elder's book, you should read it. And there's a section in my book that Aldo wrote and I just quoted him word for word about it because it's not my area of research. So I thought I'd defer to the expert. Yep. Thanks.

Laura Crutch ([50:59](#)):

And would that be biological or would it be cultural?

John Long ([51:02](#)):

That's fine. Well, I don't know about cultural because that's out of my area, but what I was looking at was the biological distribution of it through nature. Yep. Well, it's quite fascinating. It's very good bit that bit of the book.

Laura Crutch ([51:16](#)):

Do we have any more questions if you wouldn't mind just coming to the mic cause we won't be able to hear you and as you walk along, so what was your first fossil when you were at that nine-year-old boy?

John Long ([51:28](#)):



Seven year old, a little crustacean that lived at the bottom of the sea 400 million years ago. And did you find it? I did. I hit a rock and there

Laura Crutch ([51:37](#)):

It was. And this was in country Victoria in Victoria around Lilydale, which is, and that was a

John Long ([51:43](#)):

No it's with a friend and his dad who collected fossils. So he was able to tell me, I didn't know what it was. He started to tell me it was a trailer bite after that. I just started collecting fossils as a hobby and decided then and there I wanted to be a paleontologist. Did you ever do the dinosaur phase? Yeah. Yeah. I've been collecting and studying dinosaurs for awhile. I've named a dinosaur from west Australia, which I called [inaudible], which means the wizard of Oz. Oh, sorry, the question.

Speaker 6 ([52:12](#)):

Okay. well this is the good side of the point, but I was just wondering what's do you know what the geological reason is for the extraordinarily high quality of the preservation fossils at Gogo?

John Long ([52:23](#)):

Brilliant question. Yes. It was only published about six months ago in the journal geology by patronized chick, from Curtin university, whom I work very closely with. And basically there was a scenic layer rich in hydrogen sulfide within the environment. And as things fell through this layer and it became very anoxic at the bottom and the collapse of these armor plates around these placket rooms made micro environments. That was very special chemically. And the decomposition of adipose tissue, fatty tissue created a sort of alkaline environment that then helped preserve a lot of these soft tissues. So the soft tissues aren't preserved as themselves, they're mineralized into another form, but our unpublished work that we're about to publish next year. It's mindblowing, we've got livers, we've got the complete gut and elementary canal in these packet homes. We've got evidence of hearts and some of them you know, we published the muscles as part one, but next year, we're going to publish a bigger paper showing the full range of soft tissue that we've got.

Laura Crutch ([53:26](#)):

So does it mean, does it mean you can figure out where the fossils are before you get to them and does it mean, you know, where the fossils of the future are going to be?

John Long ([53:35](#)):

Yeah, you can do that because all you need to do is look at a geological map and know how to read it because that's, if you want to find a dinosaur, you look at a map and you go to for Cretaceous or Jurassic or Triassic rocks that are the right kind of environment like river or lake sediments. You know, if you want to find a trial by it, you're looking, say Cambrian and Ordovician or Devonian or Carboniferous or Permian rocks that were laid down under the sea. And then in a certain environment, you might find a trial, a bite. So there's lots of unexplored parts of the world, especially Australia. And if you want to find a particular fossil, you've just got to go there and spend a lot of time looking and hitting rocks.

Laura Crutch ([54:11](#)):

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If no one else has the last question I will ask, you know, I mean, one of the great troubles with paleontology was the enthusiastic amateur at the end of the 19th at the beginning of 20th century. And I wonder if that's still an issue that there are amateurs out there picking up stuff and toting it home.

John Long ([54:28](#)):

Well, we all did it. I was an amateur collector when I got my very first job at the west Australian museum, I donated my whole collection to them. So they've got all my fossils now. Now there's nothing wrong with amateurs, collecting fossils. Many of them work with museums and with palaeontologists, if they find something that's new to science, they're often very excited to give it to the museum because that means they often get the species named after them. But there are commercial dealers that sometimes do the wrong thing and they export fossils illegally without permits. So that's another issue. I was heavily involved working with the federal police back a few years ago with illegal fossils and, and to try and seize fossils. I wrote a book called the dinosaur dealers on it.

Laura Crutch ([55:07](#)):

I'll rereading that one next, I find that stuff fascinating. I'm afraid our session time has come to an end. I am going to tell you that there is outside by the cafe. There is a bookstore. And while this book isn't here, there are lots of other books and John's very happy to sign and let's see if there's anything else I'm supposed to do. Nope, that's it. Have a coffee and get the book. And first and foremost, please St. John for what was

Intro ([55:41](#)):

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