P1: Ngai pirrku mankulankula Ngai nari Kumatpi Marrutya Ngai wangkanthi marni naa pudni Kaurna yarta- ana Irdi yarta. Hello, it's Mickey O'Brien here, ambassador of the Gaurna people. And today we're on Gaurna country. And I'm known as the impatient one. So Ngadlu wangkanthi Naa marni naalitya Marni naa pudni parrku pirrku Warra mankunthi Kaurna yarta. So we can say hello to you and we also welcome you to this podcast, recorded on Gaurna country.

Q: Welcome to the South Australian Museum podcast. I'm your host, Meg Lloyd, and I'll take you through the curious and complex collections of the South Australian Museum.

P2: So just a general greeting, you've just walked up.

Q: You just stand up there and imagine that there's someone there.

P2: Hang on. I'm visualising. Okay, right. Hello, welcome to the South Australian Museum. How are you today? How can I help you?

Q: Where are the toilets?

P2: Certainly. The toilets are just straight down the wall. Turn left at the painting and right at the line, thank you. Hello, my name's Brett Sande. And I'm the visitor experience officer for the South Australian Museum. My job title, what do I do? I look after the front end, the visitors coming through. Give them the information they need to make the most of their visits. I also look after our fantastic front of house volunteer team including our museum host and front of house and I deal with any complaints and feedback that come through. What do I like most? My favourite artefact or thing, here, at the museum is actually right above us. It's Alice the Allosaurous. This was always my favourite as a

kid and today it's my desk ornament which, I think, is pretty cool. I literally work under a dinosaur.

Q: That was Brett Sande, visitor experience officer and the person you are most likely to see if you're coming through the front door. This episode is about something you're less likely to encounter in the museum but that goes on all the time, research. Specifically research in the palaeontology department. Who doesn't love dinosaurs? Disclaimer, this podcast contains no more references to dinosaurs. We're going much smaller and much older than dinosaurs. I spoke with Dr Mary-Anne Binnie and Dr Jim Gehling, two amazing palaeontologists who work at the South Australian Museum, about tiny fossils and early life forms.

P3: Hello, I'm Mary-Anne Binnie. I'm the collection manager in palaeontology but I really like to be known as the keeper of the fossils. I think that's a bit more romantic and it's exactly what I do. I take care of fossils in our collections. What is palaeontology — it's, essentially, the study of fossils. Some may ask, what are fossils? Well, these are the remains of animals, plants and other life forms that are preserved in sandstone or in sedimentary rocks. And even the traces or imprints of these organisms are also known as fossils as well. I work with vertebrate and invertebrate fossils and they can range in size from microscopic organisms, foraminifera to the larger mega-fauna, such as the Diprotodons, and the marine reptile such as Ichthyosaurs and Plesiosaurs. I'm afraid I don't have much time, now, to do my own research but in the past I worked on micro-fossil foraminifera. Foraminifera, or forams for short, are tiny single-cell organisms which are closely related to amoebas. They secrete shell-like tests of calcium carbonate or the tests can be made up of fine grains of sediment cemented together. Some are so beautiful and intricately formed, earlier researchers mistook them for miniature Nautiloids. Some forams are planktonic, drifting in the water current but most species are benthic and they live on the sea floor. They occur, mainly, in marine waters but they also live in brackish and in some

cases freshwater environments. In modern day environments there are strong correlations between the numerical distribution of foraminifera species and water depth. So fossil foraminifera are the same species, recovered from sediments several thousand years old, can be used to infer past sea level changes. I completed my postgraduate studies using forams as environmental proxies to reconstruct the sea level history of the gulf waters of South Australia over the last 10,000 years.

Q: There are so many different ways to use proxies in science. A proxy is simply a stand-in for something else. So in Mary-Anne's case the fossils embedded in a core of a sea floor are a proxy for past sea levels. In other cases a tree's rings are a proxy for the age of the tree but, also, possibly of environmental change.

P3: I analysed cores which were recovered from the sea using a ship-borne vibracorer. This is an electronically driven core tube which penetrates into the sea floor and extracts a core of sediment. Foraminifera have a long fossil record dating as far back as late early Ediacaran to early Cambrian, about 540 million years ago. Because these micro-fossils occurred globally and were abundant they're really useful for studying stratigraphy and are used in biostratrigraphy where fossils are used to give the relative ages of rocks. Especially planktonic foraminifera, which were used as markers in petroleum exploration. Recent studies, though, focus on the ecology of environments with a change from geology based interpretations to that of palaeoecology and paeloenvironments, which was what I worked on. Forams are also sensitive to ecological changes and are used in present day environmental monitoring such as marine pollution. So next time you're at a beach, scoop up a handful of sand and with the help of a hand lens or a magnifying glass, you're bound to see these wonderful little organisms in amongst the sand grains. Fossils are important because they provide clues of life on Earth and this enables scientists to reconstruct past environments and eco-systems which help us understand the

geology in our present climate and environment. Even specimens, in our collection, that was collected over 100 years ago are re-examined now, using the latest research technologies. And they're giving us a new story, a new light of information which we didn't have 100 years ago. So they're adding — they're building this knowledge of information and I think research can't be adequately undertaken without examining the specimens that we have in our collections. I think that's why I love geology because we're forever searching and exploring and forever learning. I'm a perpetual student. I don't think I will ever stop learning and discovering new things. It's exciting and I love it. I think — well, no, I don't think. I believe it plays a vital role in documenting Earth's history, our past and present. And our collection provides a valuable resource to all — not just researchers but to all who wish to examine, interpret and expand our current knowledge and understanding of life. It enables us to understand environmental changes and I think helps prepare us for a sustainable future. So it's, for me, it's a fascination. Knowing about how it came to be and learning about how rock formations developed. And it's learning the past of our history, our environment and of course, how we all started from the beginning. I love them all to be honest. They all hold some fascination, they're all special and unique. And they all have their own little story. I really don't know which — I just love them all. They're all very special. And perhaps I am a little biased when I say I love the fossils. But I also love all the other specimens that are in the museum, from the bugs to the big whale bones that are on display. They all give us some story and I just love them.

Q: **I spoke with Dr Jim Gehling. The recording, here, is a little patchy in parts and punctuated with background voices because Jim and I were walking through the First Life gallery in the museum. He was a recipient of the 2019 International Council of Museum's Lifetime Achievement Award. And has spent his career researching, teaching about and writing about fossils, particularly those in the Flinders Ranges. Jim has recently retired but like**

many of the scientists has returned to the South Australian Museum, as an honorary researcher so that he can continue his work.

P4: Hi, I'm Jim Gheling. I'm an Honorary at the South Australian Museum. But my field of interest is palaeontology or fossils and in particular fossils of the Ediacaran biota. So why were Ediacaran fossils so interesting? They were the first recorded objects in rocks that you could explain as being marine animals. And the notion of finding the first animals of any kind was the radical move. Ediacara represents the first clear evidence of things you could see with the naked eye that had to relate to all future animals including us. So well over 100 years ago people went looking for riches. They wanted gold but in lieu of gold they often dug up copper or lead or zinc. And that's what Ediacara was known for, it's silver-lead deposits. The Ediacaran rocks are actually sandstone slabs. The kind that you might use on a garden path and they have all sorts of beautiful textures on them. Textures which sometimes look like ripples that you'd find on the beach when the tide goes out. And sometimes they had dimples or wrinkles. All of that is not terribly interesting to most people but to some of the scientists it tells you quite a lot about the kind of environment that was involved. And the fact that they looked like ripples on a beach was a very important indicator to the man who initially discovered the fossils there and realised them. Reg Sprigg was a young geologist who was a graduate of Adelaide University, under the very famous Sir Douglas Mawson. Reg Sprigg was sent out after World War II to reinvestigate the minerals of South Australia. And one of the places he headed to was Ediacara. You can't think of a less likely place to go and look for fossils. Unlike the rest of Flinders Ranges it's a flat plateau. But he went there because there'd been rumours that there were strange imprints on these rocks. And those imprints were very curious and he wanted to know what they were. As this young geologist he found these fossils in 1946, published three papers and was shocked that people were really not interested. No one was interested in pieces of sandstone lying around on the desert floor. They didn't believe that you could have fossils in rocks that old

and unfortunately, the people who should have supported him were also worried about upsetting people in England or America who were the gurus of science. So it took quite a long time for the rest of the scientific population to realise Ediacaran fossils. Professor Martin Glaessner, an Austrian, who was an expert on micro-fossils, was brought to Australia with the idea of revamping our understanding of fossils. But he didn't do anything on Ediacaran fossils that Sprigg had found until this find by two amateurs. One was a school teacher, (? Hans Minchin) [00:13:17], who turned out, in his retirement, to be the first information officer at the South Australian Museum. So he was fascinated by this story about these weird fossils that Sprigg had found. And he and an amateur from Whyalla, Ben Flounders, went to Ediacara in 1956, '57 and discovered some very tiny Ediacaran fossils. Not just round blobs that people assumed were jelly fish but they found little fossils which seemed to have segmented bodies and heads and really looked like primitive animals. And that changed the whole scene. Out of those finds we get Spriggina which is, today, the state fossil of South Australia. It's really the first thing on Earth that has a body which appears to be made of divisions and it has a distinctive head. And head usually means there was some kind of a brain there. However limited that might have been, that's what we get with Spriggina Floundersi. And the discovery of that and a little fossil called Tribrachidium with three arms and another one that looked like a tiny kite, Parvancorina, changed everything And from then on, the professor of palaeontology at Adelaide University, Martin Glaessner worked on this for the whole of his career, along with his protege, Mary Wade. So from — for the last 60-odd years people have been searching specific places in the Flinders Ranges and finding these fossils in very distinctive layers that we can trace. From Devils Peak, just north of Port Augusta, all the way up, almost as far as Arkaroola in the very north-eastern Flinders Ranges. So that's where the Ediacaran fossils come from. What they are, how they came to be at this time and what their descendants look like are the big questions that I and my colleagues have been interested in for many decades. The Ediacaran fossils pop up around about 580 million years ago. The

very oldest ones that we know of are actually in the eastern part of Canada, in Newfoundland. There, we have, volcanic layers with those very simple mega-fossils that you could see with the naked eye. Unlike the microbes which just made domes on the sea floor, it took to the Ediacaran period, named after these fossils, for us to see fossils that were clearly individual animals, and in some cases, plants that were living on the sea floor. And that's what the rest of the Ediacaran gallery is.

Q: The First Life gallery is on the third floor of the museum. The walls of the gallery display numerous ancient fossils and casts, most of them on open display so that they can be touched.

P4: These are samples of sandstone which have imprints on them and in most cases the imprints are on a bottom of a layer of sand. So if I go over here to this slab which has been glued together, it came from the original site of Ediacara. And it's a first official excavation which was ever done there.

Q: In the centre of the room, set at a diagonal angle and around four metres long is the [00:17:04] (? shale) wall. It's set in a metal frame and inside the frame is the sea floor, collected from the Flinders Ranges. On one side, the side seen upon entry to the gallery, the wall looks like preserved red brown earth shaped in to ripples. On the other side is the underside of the sea floor, where the fossils of Ediacaran biota that lived over 500 million years ago, have been preserved.

P4: One of the things that we learn about Ediacaran fossils is that they come in many different sizes and shapes. And some of these shapes are so weird there is nothing, today, that looks anything like them. But every now and then you get something which is familiar and these small bits of white sandstone came from the south-eastern part of the Flinders Ranges, an area called the Chase Range and I was measuring the geology, not looking for fossils, particularly,

but doing the sedimentology of the rocks and one day I climbed up a cliff an found a fragment on scree slope, that means where the rocks have fallen out and are skidding down the hill. I picked one up and I found there were little indents on the bottom of these layers with a five-fold star in the middle. And so if you make a rubber cast of one of those you see, it's like a little disc with five grooves. Now, today, the only things on Earth that have five-fold shapes are starfish. So we call them echinoderms. Some of them move around and they're a bit elongated but others just sit there and they filter food out of the sea water. They have been around since the Cambrian. We still don't know if these genuinely were echinoderms. But it turns out modelling of these in a digital word has demonstrated they're probably capable of pulling out small particles of food just like starfish do today. And so, ostensibly, they are likely to be the earliest ancestors of things like starfish that you see washed up on beaches. And we have evidence that some of these Ediacarans could move. Because if you look at these little boot lace-like grooves, that's an image of what was on the sea floor. So this is the traces of tiny little creatures, too small to be preserved but they left a trail. So again, if you go over to your back path in winter, you'll see where snails crawl over a surface, eating the algae, eating the bacteria and they leave a trail. This is not somebody's back doorstep, this is a sea floor but tiny creatures, too small to be preserved, were leaving traces. That shows us they were actually moving animals at the time, however tiny they were. I'm one of many people who've looked for Ediacaran fossils in South Australia and my long-since retired colleague, Richard Jenkins, worked at Nilpena, which is now a quite famous[00:20:14] (? site). He was one of the first people to work there. The fossils at Nilpena were discovered by the current owners which has now been made over as a conservation park because it's so famous for the excavations that I and my colleague, Mary Droser and all of my our assistants and students have made over the last 20 years. What we were never able to find was this rather unique, quite an ugly looking fossil because it's made up of blocks of rock, with bits flaking off but that's life. These were lying at the surface, probably, for thousands of years after being unearthed by natural

process. This is Dickinsonia rex is — means, just a very big Dickinsonia. We see quite a large one, alongside. But this one, unfolded, would have been a metre long and it's no more than five millimetres thing because we can actually see the edges of the chambers it was made of. That's the biggest fossil that ever existed in the Ediacaran and no one knows what it does. And two years ago we've re-found the site. And last year an enormous specimen was found in the same beds and it looks like there's much more to be found in that same horizon. So particular layers of rock turn out to be very rich and very productive but you have to spend many days excavating and putting them together again. So these are the weirdest fossils. They have no bones. They have no legs and they might, in many cases, not even have a head but we know they move because they leave traces. They leave footprints behind, in some cases the same shape is reproduced many times and then you find a cast of the actual animal which left those traces so we know they moved. But they're so weird that most of my colleagues who work on fossils from Kangaroo Island, which have shells, say well, we don't know that these were animals or not. They may have been a failed experiment in the history of life. But there's enough evidence in the tiny things from the Ediacaran biota that the true ancestors are still out there, some of which we found — many of which we've not yet realised which probably gave rise to trilobites, worms, all sorts of sea creatures and we've given you a little bit of a look at some of those.

Q: **South Australia has some of the best examples of the oldest animal life on Earth. And if you're in the museum you can walk right up to the sedimentary rock and touch the real thing. Put your hand on the imprints of some living thing that made its way across the sea floor 500 million years ago. Jim's right. They are weird fossils. Strange and unfamiliar forms but they're part of a story of life on Earth, possibly from the opening chapter. And it's exciting to think about what secrets they hold and what scientists may find out from them in the future. Thank you for listening to the South Australian Museum podcast hosted by me, Meg Lloyd and recorded on Gaurna country. Original**

theme music by Peter Saunders, audio production by Jake Holmes. This podcast has been made possible by the support of National Science Week. Visit their website, www.scienceweek.net.au for amazing science events happening all over Australia. Thank you to all the SAM staff who trusted me to record their stories. For more information about our museum please visit our website, www.samuseum.sa.gov.au or get in touch by e-mailing programs@samuseum.sa.gov.au. Ngaityalya Nakutha. Thank you. See you later.

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