Space on the Page Podcast
Mars Present: The Search for Microbial Life

>> David Baron: It’s the summer of 1996, the South Lawn of the White House.

>> President Bill Clinton: Good afternoon.

>> David Baron: President Clinton steps to a microphone to announce an astonishing discovery.

>> President Bill Clinton: Today --

>> David Baron: A piece of Mars that fell to Earth, a meteorite found in Antarctica, contains what some scientists believe may be fossilized microbes, evidence of past Martian life.

>> President Bill Clinton: If this discovery is confirmed, it will surely be one of the most stunning insights into our universe that science has ever uncovered.

>> David Baron: The discovery would not be confirmed, but this moment would mark a shift in scientists’ and the public’s view of Mars, that the red planet might be alive, home to microscopic life.

[ Music ]

I’m David Baron, and this is Space on the Page. It’s a podcast from the Kluge Center at the Library of Congress that explores outer space in literature, in science, and in the human imagination. I’m a writer, and I spent part of 2021 as the Baruch S. Blumberg NASA Library of Congress Chair in Astrobiology, Exploration, and Scientific Innovation. I’m working on a book about Mars, and in the first three episodes of this podcast, I’m talking to other authors of Mars books about our shifting view of the planet, past, present, and future. Last episode focused on the past. Today looks at the present, and my guest this time is a scientist who is herself intimately involved in the hunt for life on Mars.

>> Sarah Stewart Johnson: My name is Sarah Stewart Johnson, and I’m an Associate Professor at Georgetown University. I’m a planetary scientist and an astrobiologist, and the title of my book is called The Sirens of Mars: Searching for Life on Another World.

>> David Baron: I just absolutely adore your book. I mean, it is wonderfully lyrical and thoughtful and complex. It’s part science, part history, part memoir, and that’s actually where I want to start is with the memoir part. You grew up in Kentucky back in the 1980s and '90s, and I’m just curious, when you were a kid, was Mars part of your consciousness? And what did you know about it or think about it at that time?

>> Sarah Stewart Johnson: It came into my consciousness, primarily via my father, who was a bit of an amateur geologist and an amateur astronomer, and so he had this big pair of binoculars, and he loved to go out in the backyard and look at space, and I’d come along and he’d hold them steady for me, and I could look up in the sky, and he’d always subscribe to Astronomy magazine, and so he’d get that, those magazines and he’d pull them out and look at the star maps and look at the planets as they were apparent in different places in
the night sky, and so I think that’s kind of how it first entered my consciousness. I don’t really remember planetary science being a big part of my education in elementary or middle school, or even high school, for that matter, and it wasn’t until I was graduated. I went off to a summer camp and it was the summer of 1997 when Pathfinder landed on Mars, and that was a moment, a real watershed moment for me.

>> David Baron: Huh, at camp when that happened. I mean, do you --

>> Sarah Stewart Johnson: Yeah, Camp Wendigo.

>> David Baron: -- people were talking about it?

>> Sarah Stewart Johnson: No, I don’t know so much people were talking about it, but I read about it in this newspaper as we still got the Louisville Courier Journal, which was just a Kentucky paper and it came and I just remember seeing it at the dining hall and the main thing that had caught my interest was there was a professor, this this wonderful man named Ray Arvidson, who I ended up getting to know, but he was at the University. I was going off to college in Missouri, to [inaudible] --

>> David Baron: To Washington University.

>> Sarah Stewart Johnson: Yeah, to Washington University in St. Louis, and I saw his name, that he was part of this mission and I was reading about this quote that he had had in this article, and I just thought wow, I’m off to this university. I’m going to have to meet this man. And I did. I ended up signing up for a class as soon as I arrived with him and he ended up becoming a research mentor of mine over the years.

>> David Baron: Well, so in college, you really became acquainted with Mars, and what were your thoughts about life on Mars? Did Mars seem like a dead planet or potentially a living planet?

>> Sarah Stewart Johnson: I mean, I think I was hopeful. I mean, I guess that’s the same word I would use to describe my feelings at this moment too, two decades later.

>> David Baron: Well, but I know, but in your book, you write about the changing view scientists and the public have had of Mars over the decades, over the centuries, really, but am I -- so in my last interview, I spoke with author William Sheehan, and we were talking about views of Mars in the decades before you were born, and particularly going back 100 years or a little more than 100 years ago, when there was this idea, promoted most vividly by Percival Lowell, the American astronomer, that Mars was very much a living planet, in fact, home to cities and irrigation canals and a highly technological civilization, an idea that was kind of embraced and got people excited back at the turn of the last century, but was just definitively wiped out in 1965, when the Mariner IV spacecraft flew by Mars, and saw what seemed like just a dead, moon-like planet, and yet, by the time you came along, by the time you were born, it seemed we were back to looking at Mars as potentially a living place again, of a very different sort, and I’m curious how that transformation happened from Mars as a living planet to a dead planet, back again to maybe a living planet.
Sarah Stewart Johnson: Yeah, I think you’ve described it precisely right. It was almost you think at the beginning of the space age, you know, we started off with this just incredible expectations for what we might find. The surface had never been glimpsed before. We have Mariner IV, you know, just streaking across, taking these 22 photographs. They come back to Earth, and it was, I think, the moment that all those craters, that pockmarked surface, just as dead as the lifeless Moon showed up, you know, in those people’s minds and, you know, on those computer screens, those early, early, early computers. I think it was just such a letdown, but then it sort of starts building up and up and up, and I think we’ve just been on that sort of upward slope, but the more data that we get, the more exciting it is.

David Baron: So why is it that by the ’90s, there was this idea that maybe Mars isn’t or wasn’t lifeless?

Sarah Stewart Johnson: Well, so we had a lot of evidence coming back not from the first flybys, but the subsequent flybys, and then the orbital missions that went in into orbit around Mars that it wasn’t just this lifeless, little cold, dead, cratered surface. You know, we were able to see evidence in the geology of river valleys that have been carved by water. We understood that Mars had a past that was very different from its current state. You know, around the time life was getting started here on Earth, Mars and Earth were very similar types of places with much thicker atmospheres, at least periodically, and warmer conditions such that liquid water could exist on the surface, and we see evidence for water not just in those geologic features like those riverbeds, but also in minerals that can only be formed in the presence of water, and so we start to see this picture that Mars has some of these fundamental ingredients, and that Mars may have taken a different planetary path, but that doesn’t necessarily mean that life didn’t start on Mars, or that life couldn’t even still be there today, perhaps deep in the subsurface, and so I think that’s part of the reason that there is this excitement in the ’90s. Even at that point, we were starting to see the data coming in, recognizing that this was a much different planet.

David Baron: Well, and then there was a specific moment in the ’90s that really ramped things up, and that was when there was this piece of Mars, this rock from Mars that was picked up in Antarctica. It was a -- and it came to earth as a meteorite.

Sarah Stewart Johnson: Oh, such a huge moment. You know, there was Bill Clinton in the Rose Garden, saying, we may have found life on Mars. There’s this rock from Mars. It was just this -- it was this media frenzy. Like there are just articles all over the world talking about this incredible potential discovery, these lines of evidence that seem to point in this direction of possible little tiny fossils in this rock. And I also remember, the aftermath where lots of other scientists went in, and there was just much more controversy about what those signals actually were, and if there could be other ways that some of those lines of evidence could have originated.

David Baron: Right. So I guess today, most people in the field do not think that the meteorite showed evidence of life, but the fact that people thought it was possible, I think, must have said a lot about the change of attitude toward Mars to think that it was a place that that could have had fossil life, and may still have life.
Sarah Stewart Johnson: Yes, I think it was just this moment that revitalized the ideas, and astrobiology got a lot of people really excited about going back to Mars, finding more samples, you know, doing more experiments, getting more data.

David Baron: Well, and then at the same time, there was this transformation in our very ideas about life on Earth as well, that changed our view of whether life could exist on Mars, correct?

Sarah Stewart Johnson: Indeed, and it was one of these sort of -- it was interesting because after the Viking missions in the 1970s, you know, there were no successful missions to Mars for two decades, and it was this period that you would think would be really fallow, and in many ways it was. I just think about all those poor graduate students who trained up on those missions, and then they just had no more data to work on for two decades, but you know, some of those enterprising young folks turn their attention back to Earth, and they started exploring different places, you know, on our own biosphere to understand so much more about the limits of life, about the possibilities in really extreme environments, places that bear relevant similarities to the surface of Mars, and we just had all these biological discoveries, all these new understanding about the tree of life, all the different possibilities life on our own planet could take, and these places like the dry valleys of Antarctica, which we weren’t really sure would be habitable, we realized actually were quite habitable and had a very diverse thriving microbial community that just wasn’t necessarily evident because it wouldn’t grow. These microbes wouldn’t grow in petri dishes in laboratory settings, that it was a fundamental understanding we didn’t have. You know, now we know that 99% of our biological diversity here on our planet won’t just grow in a laboratory setting, but you can detect it if you have new tools, like the ability to go in and sequence its DNA without actually growing something you can see under a microscope.

David Baron: Right. So we found that life can exist in incredibly harsh places, dry, cold, dark, underground, acidic environments, and one of the interesting dichotomies that you explore in your book is really how fragile life is, and yet at the same time, how resilient it can be.

Sarah Stewart Johnson: That’s a theme that I just keep returning to. I just find it so compelling, and so beautiful, and so profound, that you know, here’s this force, you know, this living force. It’s us, and it’s all these other forms of life, and it seems, they could be so easily snuffed out, but at the same time, you can go inside a core of a nuclear reactor, and you can still see these organisms hanging on against all odds, surviving, and I just -- I don’t know. There’s something about that, that I found very poignant. In some ways, it’s kind of how the book even came about. Like I would be working on datasets. I’d go to conferences and seminars. I’d be thinking about all of these issues, and there were so many things about the whole endeavor that would just never find expression on the pages of scientific journals, and I just started jotting down all of these thoughts, you know, sometimes kind of metaphorical thoughts about, you know, what does this mean? And it just would -- there were just all these things that just seemed to touch on not just the science, but sort of the human part of this whole journey, like what it is to look out into the deep night and try to find another point to not be alone, and all of these things, you know, even just about
survival of organisms in these just most unlikely of places, and I would jot them down in
the back of my notebook, and slowly those were the sorts of things, that stuff that was left
over from the stuff that would go into a scientific journal, those extra thoughts that I just
felt needed some way to find expression, so that’s actually how the book came about, in
many ways.

>> David Baron: Well, you must -- clearly, you interact with students on a regular basis. I
imagine, particularly since your book came out, you’ve had lots of opportunities to interact
with the public around Mars and the search for life, and now when you're talking about
microbes, you’re not talking about finding elephants or, you know, turtles, or birds on Mars.
You're probably talking about -- right? -- microscopic beings or fossilized small things. Do
you get the sense that the public is excited about microbes on Mars? I mean, it’s not quite
like what Percival Lowell was talking about with intelligent Martians.

>> Sarah Stewart Johnson: Yeah, no, it’s not quite the massive civilizations with benevolent
oligarchs, you know, controlling the planetwide water distribution. Now, you know, we
have a very different vision now for what life on Mars may be like and the form it would
take, and in some ways, you may say, well, it’s really diminished, you know? We were
originally looking for kind of intelligent civilization, and then it was, you know, vegetation,
and now it’s just this kind of sheen of a little bit of microbes and maybe microbes that are
simple and just holding on, but I hope that that’s one of the key takeaways from my book is
it’s just even if it's the smallest, the smallest little microbe, the smallest breath in the
deepest night, the smallest thing, it’s extraordinary because it’s we have this one data point
for life. All the life we have on Earth is exactly the same, you know, the DNA-based, carbon-
based. We’re all related. We can all be traced back to the same last common ancestor. But if
we had a different form of life, especially from a different genesis, even if it was just, you
know, a tiny, tiny microbe, just understanding how we could have a separate origin, and
especially if we made that discovery just here in our own backyard here in the solar
system, I mean, it would just be so suggestive that the whole universe could be just a
hatchery for life. You know, if lightning could strike twice, just here right at home, it just
would really have, I think, huge implications for what we might hope to find around other
stars.

>> David Baron: Right. And you use the word hope. You write in the book that I mean,
you’re you don’t come to this question without, I guess, you might say, without a bias. I
mean, you would like to find life on Mars. You hope that there is life or was life on Mars.

>> Sarah Stewart Johnson: I do, and I think it’s okay to say that and still be a card-carrying
scientist. You know, I think that we all come with our own biases and our own ideas into
the scientific discipline, and of course, you have to, you know, be as rigorous as you
possibly can with the data, but I think that that passion, you know, that drive is what
pushes science forward, you know? I don’t think you get a big advances with dispassionate
people. I think the idea that people that are really excited about possible discoveries are the
people that are going to stay up all night working on them and go to the ends of the earth to
try to find answers. I mean, I look at all of these other Mars scientists, my predecessors, and
the risk professionally, personally that they would take on in this quest, and I don’t know. I
find it very inspirational.
David Baron: Well, at this point, do you have any question that Mars is habitable? I don’t mean inhabited but habitable.

Sarah Stewart Johnson: We can certainly say that Mars was habitable in its past. It’s one of the major conclusions of the Curiosity rover mission that NASA sent that landed in 2012. You know, Curiosity has found definitive evidence, like not only that there was water there, that there was even circumneutral water, sort of sweet water as you can think of it, not just the incredibly acidic water that earlier missions like the Opportunity rover discovered. The discovery of -- Curiosity rover has also discovered all the essential elements that we need for life as we know it here on our planet, as well as organic molecules. This has been a long quest for scientists on Mars, these building blocks of life, so certainly habitable in its past. Habitable today? Perhaps. Perhaps, you know, down in its surface, subsurface, perhaps, but it’s one of these questions that we’re still trying to answer.

David Baron: So we are speaking right now. It’s the autumn of 2021, and the Perseverance rover is exploring an area called Jezero Crater, collecting samples that are meant eventually to come back to Earth for analysis, and why is it important to bring those samples back? We have such sophisticated robots up there right now with high resolution cameras and chemistry experiments. What is it about bringing those samples back? What would you do with them in your lab that we can’t do with a robot on Mars?

Sarah Stewart Johnson: Oh, there’s so many things. Like these rovers that we send up to Mars, you know, they have a handful of instruments, six, seven, usually not more than a dozen. Even our most sophisticated spacecraft that we’ve, you know, sent off into different planetary targets, and there are so many different ways we can look at these samples, and there’s so many different experiments that we’ll want to do when we have them back, and so technologically, we’re lagging behind with what we send, and we’ll always be limited by the fact that, you know, even if you had samples and you took them to the best laboratory on the whole planet, it would still just be one laboratory, and you want to be able to look at them with other instruments and other laboratories, and I think that that’s what is so exciting about sample return. And also, once we have these samples, we’ll have them forever, and so being able to, you know, as our own instruments, improve, our technologies, you know, we’ve seen that with the Apollo samples [inaudible].

David Baron: Right. The moon rocks, yeah. The moon rocks collected about 50 years ago are still worth studying.

Sarah Stewart Johnson: And still good, amazing, tremendous discoveries kind of coming out of analyses of those samples, and so I think that that’s going to be really neat and I’m very hopeful we get those samples back soon.

David Baron: When is the soonest we will see them?

Sarah Stewart Johnson: So the early 2030s is right now the timeline.

David Baron: You know, one of the lessons we have from the whole episode of Percival Lowell and the canals of Mars is to be careful not to project onto a subject, whether it’s another planet or some other scientific subject, your own desires, and have that cloud what
you see. Is that a concern? Is that something to keep in mind? I mean, the meteorite that was found in Antarctica and at first was touted as showing signs of life that now we think probably we’re not signs of life, is there always a danger of getting a little too excited as a -- generally, as a scientific community, and maybe a public, about projecting onto Mars what we want to be there, as opposed to what really is there?

>> Sarah Stewart Johnson: I think that’s certainly a danger, and we’ve seen that time and again, sort of through history, and I think that some of it too, is just coming from we tend to see what we know, you know? We make so many inferences based on analogy, and the thing about Mars is time and again, we’ve been bowled over by what an indescribably foreign world it is, You know, it looks like a place that we recognize. You know, it looks like the deserts that we have here on our own planet. It looks like, you know, you could scrape your knee there. You think you know it, you think you understand it, and then it’s just truly alien. And, you know, how do you contend with the truly alien? We wrestle with that all of the time, and I think that we have to be very careful, especially around life, and it’s one of the big kind of focuses or one of the big things I’m focusing on in my own research is not just looking for life as we know it, this sort of terrestrial life, the carbon-based, DNA-based all pinned on the same phylogenetic tree of life that we have here on Earth, but really trying to expand our horizons and think about well, how would you detect life as we don’t know it? You know, what if that life doesn’t share a common biochemistry? What if it’s a totally different molecular framework upon which that life, a separate origin of life, is built? And so it’s actually a big project that I’m working on right now with a bunch of wonderful collaborators from different universities all over the country, and including all over the world, just trying to figure out how we go about this incredibly hard question. I mean, it’s almost like imagining a color that we’ve never seen before, but there are ways we can get traction. You know, we can go after things like chemical complexity above a certain threshold. We can look at isolation and compartments, different elemental and isotopic fractionation, chemical disequilibrium from the environment. We can look for things like evidence of energy transfer, you know, especially if we’re thinking about worlds where we might have extant life. There was this famous physiologist that won this Nobel Prize ages ago. He said life is nothing but an electron looking for a place to rest, and so trying to take these ideas and figure out how tools and techniques can be transformed into the next generation of instruments is something that is making me very excited these days.

>> David Baron: Huh. So what is your best guess as to when we will know if there is or was life on Mars?

>> Sarah Stewart Johnson: Hmm, that’s a good question. You know, so I think that getting those samples back, we’re going to learn a tremendous amount about the planet. Whether or not we find definitive evidence of ancient life in the samples or not, like I think it’s going to be a massive leap forward in our understanding of just how Mars is put together, of its history, of its geology. You know, all kinds of things, I think, are going to come from that. You know, it may be one of these things that, you know, a discovery would just sort of -- just hit us in the face, you know? We might find a smoking gun in one of those samples, something that we can say definitively is there. You know, it may also be -- and especially if there’s a separate genesis, a different type of life that we need to really revisit this idea of, okay, it’ll be an immediate, you know, yes or a no. It’s a possibility, but maybe we need to
think more along a spectrum of certainty. You know, maybe we need lots of different data
sets coming together to build certainty, and be a little bit more okay with the ambiguity,
especially at the beginning, but I think -- I know this probably sounds a little bit in
contradiction to what I was saying earlier, I want to be sure. But I think that building that
certainty is going to be a process that could potentially take time and take a lot of different
scientific instruments, a lot of different collaborators coming together, especially in the
case of ancient life, which is, of course more difficult than extant life.

>> David Baron: Right. So it sounds like the 2030s is when we might be getting a glimpse,
when those samples come back that Perseverance is collecting right now, and if we open up
one of those rocks, and we find a little clam in it, which I -- I'm not saying you expect that,
or if we find fossil microbes that might do it, but if we don't find that, it could be a longer
process of piecing together either a yes or a no.

>> Sarah Stewart Johnson: I think that's true. You know, some of the places that I'm most
excited to see aren't the samples like right at the surface, you know? The surface of Mars,
it's this incredibly hostile environment. It's bathed in high-energy radiation. It does make it
a little harder for molecules to stay together, but if you get down into the subsurface, it's
much more protected, and we're going to do a little bit of drilling, so the Rosalind Franklin
rover, the European rover, that's going to launch in 2022, like we'll have an opportunity to
get two meters down below the surface and do some really cool experiments with rocks
from that depth. We'll also potentially have these bigger drilling rigs that we could send up
and we could access other terrains that I think could be really exciting. I just know if I were
a little microbe on Mars, that's the place I'd want to be, down in the subsurface where I
wasn't getting bombarded with radiation. Unless somehow I had evolved a way to sort of
find, harvest energy from that radiation, I would probably want to stay away from it.

>> David Baron: Well, just getting back to your book, which weaves together so many
themes about life and death, and you giving birth and thinking about that, in terms of you
being a vessel for life, like our spacecraft going to other planets, and I mean, it really all
does come together, I think, in very -- you can get very philosophical very quickly when it
comes to this science. In your lifetime, if at some point, while you're here on Earth, you
discover that we are not alone, that there is life on Mars, what would it mean for you, and
for your time that you spent here on the planet?

>> Sarah Stewart Johnson: You know, David, I would find that just incredibly meaningful,
and I think there's this possibility that we look at our universe, you know, and there's this
abiotic before, and then we come, and there's an abiotic after. Like we know that species
come and they go, and that eventually our planet will disappear, our solar system will no
longer exist, you know? Those are incredibly large timescales, but I don't know. There's
something that feels very meaningful to me that life might not just be this flash in the pan,
that it's just us, that there's this bigger system, that there's more types of life. That life, who
knows? -- maybe it's just a consequence of energetic systems, but there's something about
that first point, that discovery, that latching on to something beyond ourselves that, to me,
feels kind of like a sort of immortality, that feels -- I just think it would feel very, very
meaningful to me, both as a scientist and just as a human being.
David Baron: So even if -- even though people die, and planets die, life itself may be eternal or at least exist as long as the universe exists.

Sarah Stewart Johnson: Yeah, I think I would find tremendous solace in knowing that.

David Baron: And maybe Mars will provide an answer.

Sarah Stewart Johnson: Oh, that's my hope.

David Baron: Well, Sarah Stewart Johnson, it has just been a pleasure to talk to you. I really appreciate your time, and I sure hope that your search turns out to be -- well, I guess it'll be successful whatever it finds if it finds something definitive, but I hope you find something, something living or that once was alive on Mars.

Sarah Stewart Johnson: Ah, thank you, David. I so enjoyed the conversation.

David Baron: Sarah Stewart Johnson’s book is called The Sirens of Mars: Searching for Life on Another World. In the next episode, we'll push ahead from looking at what gets people excited about Mars today, to the public’s visions of Mars in the future. My guest will be David Whitehouse, author of Space 2069: After Apollo: Back to the Moon, to Mars, and Beyond. This is Space on the Page, a podcast from the Kluge Center at the Library of Congress. Our original music was composed and performed by Andrew Breiner. I’m David Baron. See you next time.