Biomineralogy with Robert Ulrich
Ologies Podcast
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Oh heeey, it's your younger stepbrother who somehow is old enough to have a sleeve tattoo, and you don't even know when that happened, Alie Ward, back with *Ologies*. Another ology you never knew about, probably, with a charming person you wish you knew earlier. Trust me. So, shells. Hard stuff. Living chemistry.

This episode was almost called 'Conchology', but it's about so much more, as it turns out, than just some swirly seashells. And this guest's Instagram handle is @Biomineralogist, so when that happens, you go with Biomineralogy. So, conchology, or shell collecting, that's going to wait for another time, another person. Also, Biomineralogy, technically -*a*logy, and I'm not accepting any emails about it. It is what it is.

This ologist got his Bachelor's in Chemistry from Virginia Tech and is now completing his PhD at UCLA, studying geochemistry. And we met one fateful summer, the one before covid, at a backyard barbecue at, none other than Raquel Nuno's – your favorite Moon expert and Selenologist – house. And this guest told me, just offhand, that he studied shells, and I was like, "Mark my words! I'm going to drag you on *Ologies*, my new friend!"

So, being at a barbecue and finding out that the person eating a veggie burger next to you studies the microscopic properties of shell structure to figure out what's going on with the impending apocalypse, is what this show is all about! But before we dive into this episode, thank you Patrons for supporting the show. I am doing my first-ever live show – for everyone, not just Patrons – on May 18th, next week. Tickets are on sale. They're at the link in the show notes. They're $12 general or $9 for Patrons, who can submit questions for returning Volcanologist Jess Phoenix. She's back, and we'll get her reaction to her episode. Again, link in the show notes.

Also, thank you for leaving reviews. And to prove I read yours, here's a brand-new one from Rose141618, who wrote:

> *Ologies has changed my life - Seriously*
>
> *Dear Alie, I hope you read my review out loud. Just one request - can you explain the PodDad joke? Thanks and love from a new listener and patron - A mama from Boston.*

Rose141618, we've got a lot of puns. There's a lot of well-meaning life advice. And just a big Dad vibe, so that's all. That's all it is. PodDad. Thank you for the review, kiddo, and you're welcome!

All right, Biomineralogy. From words meaning 'alive ore'. Biomineralogy is the study of biominerals, which are inorganic elements, such as calcium, iron, potassium, sodium, or zinc, and they're essential to the nutrition of humans, and plants, and animals, and critters.

This ologist, again, getting his PhD at UCLA while writing a book called *The Hard Parts of Life*, about bones, and teeth, and shells, and reefs. And we reunited to chat all about those things, plus the brickwork of iridescent shells, the oceans, tiny pieces of alive artwork, shells versus exoskeletons, lobster lifespans, animals that glue other dead animal skeletons to their own skeletons, snail drama, fiddle leaf care, fashion versus function, spiraling, and more, with advocate, scholar, total sweetie, geochemist, writer, and Biomineralogist, the soon-to-be Dr. Rob Ulrich.

Rob: Rob Ulrich. They or he pronouns.

Alie: Cool. And you are a biomineralogist, or a conchologist [hard "ch"] or conchologist [soft "ch"]? Tell me.

Rob: Yeah. I would say I'm either of those. Conchologist [soft "ch"] is probably more accurate to what I am now, but I feel like my goal is to branch out to be a more general biomineralogist.

Alie: I'd never heard Biomineralogist until I met you at a summer pool party, seasons and seasons ago.

Rob: Oh my god, yeah.

Alie: I've been so excited about this for so long! [*laughs*] Ah!

So tell me a little bit about you. Did you grow up seaside? Were you landlocked in Nebraska? How did you end up studying things by the sea? And does it even involve things by the sea? Are there inland things as well that are biomineralogy related?

Rob: Yeah! So, biominerals are any minerals that are formed by living things. That includes, like, our bones, or there are even little biominerals inside the leaves of a lot of species of plants that act as, essentially, disco balls that help scatter light more efficiently throughout the leaves, which is really cool.

Alie: Ooh!

Rob: Yeah. But no, unfortunately, I did not grow up by the beach. I grew up in Northern Virginia, kind of just, like, in the middle of the woods. And I feel like it was just, kind of… I never really had the goal of ending up where I am. I think it just, kind of, happened. And I feel like I owe a lot of my direction into Earth science or geosciences in general just, to… I don't know, I had a crush on a boy, so I followed him. [*laughs*]

Alie: [*laughs*] Did you follow him to Los Angeles?

Rob: No. Oh my goodness. This was just me, like… I was probably still in denial that I was gay at this point, and I was just like, "No, he's just a really good friend." [*laughs*] So I was like, "Yeah, I totally want to try to go to the same college." So we both ended up at Virginia Tech. And initially I was in chemical engineering, but then I realized that wasn't what I wanted to do, because chemical engineering's a lot more, like, application, and process-based, and trying to make processes more efficient. And I found that I was a lot more fascinated with basic science, like trying to figure things out, how do things work.

So I switched from chemical engineering to just chemistry, but I was still in this mindset… because my parents wanted to make sure that I got a good job coming out of college, right? So I was still trying to stay on this path to go into, like, the energy sector; go into, like, petroleum, and oil, and energy.

Aside: Rob asked some mentors how to pivot from the petroleum industry and chemical engineering, and many folks suggested that he try out the geosciences and geology, which was a great fit, and also romantically convenient, because it turns out he was focusing on *chemistry* indeed.

Rob: And that also happened to be what the boy was majoring in.

Alie: Ooh! Did you guys ever get together?

Rob: No. He was… Not was. He is straight. I just considered him a really good friend; he considered me a really good friend. And then in my second semester of college I had finally had a chance to, like, explore things on my own, and then I was like, "Oh… Yeah. I'm gay." [*laughs*]

Alie: Surprise! [*laughs*]

Aside: Cut to now: Rob is out of the closet, thriving. And after moving to LA for grad school and looking for community, he founded Queer and Trans in STEM to bring together LGBTQIA+ and other intersecting identities into science, technology, engineering, and math. And the group meets on Mondays at 9-10pm Pacific, through Zoom because otherwise, he says:

Rob: It's really hard to make friends. [*laughs*] So, I was trying to go really out of my way. I was driving to West Hollywood, like, every weekend and joined the gay kickball league because there wasn't… At least in my department, there weren't a lot of people that I knew were, like, queer or gay. I was thinking about it, and I was like, "I shouldn't have to drive all the way, halfway across town to meet queer people when I moved to Los Angeles, right?"

Alie: That's the most… You know you're an Angelino when you're like, "I should not have to go from Westwood to West Hollywood at 4pm!" You're a true Angelino! [*laughs*]

Rob: It shouldn't even be a problem! It's only like, what, four miles?! [*laughs*]

Alie: It's like three hours in LA distance. [*laughs*]

Rob: Exactly!

Alie: So you were like, "Screw this!"

Rob: Yeah. I was like, "Screw this." I went to one of the events that is held by the UCLA LGBTQ Resource Center, and I walked in there, and I was like, "There's nothing here for queer or trans people in science and engineering." And I, kind of like, stormed out of there really frustrated. So then I just reached out to the director, and I was like, "Hey, I'm really interested in forming this. How do I go about doing this? I don't really know how to do anything around here yet. I just moved here."

They were extremely helpful, and they were like, "Oh yeah, actually there are a few people who have bounced this idea around. Let me connect you." So, born somewhat out of just, like, me needing and wanting friends, we all got together and built this together.

Alie: That's amazing! And just think of how many people are now not having to battle traffic in LA to play kickball to meet friends.

Rob: Exactly. We can all just, like, play video games online.

Alie: [*laughs*] And what about getting into biomineralogy? Did you want to enter into it, kind of, through geosciences, or through human bones? What was it that really hooked you?

Rob: I feel like I was trying to stay away from it at first because I feel like when I was in chemistry I was always really fascinated by, like, crystals and crystal growth in itself. And then when I was looking around for research opportunities, I ended up working for my faculty advisor eventually. And I was working with her PhD student at the time, Sebastian Mergelsberg, and the first project that they had me helping out with was this project on lobsters. I was like, "I don't know *any* biology." I still haven't taken a biology class since freshman year of high school.

And so I was just like, "This is super out of my element." But that was my first introduction to it, and I realized that crystals are cool, but living things making their own crystals is even cooler. [*laughs*]

Alie: Do lobsters just keep molting, and growing, and molting, and growing? Is that why they were studying them?

Rob: Um… Yes. Yeah, they were trying to figure out whether or not the chemical composition of the lobster shell is, like, the same throughout the entire shell, or if it changes at different points of the lobster. We found that, yes it does change across the lobster with, like, the claws actually being more enriched in certain elements compared to other parts of the lobster. And we drew connections from the differences in the chemical composition to the function of each part of the lobster. The shells have to be harder so they're more enriched in these certain elements; at the tail it needs to be more flexible so it's more enriched in these different elements.

Alie: Ah!

Aside: Please see various papers, including the 2019 *Frontiers in Earth Science* publication, "Composition Systematics in the Exoskeleton of the American Lobster, *Homarus americanus* and Implications for Malacostraca." Malacostraca, sidenote, refers to the 40,000 or so shelly boys, including crabs, and lobsters, and shrimp, and woodlice, and many other beautiful and bizarre little beasts with exoskeletons.

But this lobster paper Rob worked on found that magnesium, phosphorous, and calcium concentrations in lobster exoskeletons are not uniform. There are different shell compositions for the pinchy parts versus the flexy butts.

Alie: And what exactly would you say… As a biomineralogist, what would you say the field mostly involves? Are there biomineralogists that study totally different animals and structures? And how does one even get into that field?

Rob: Yeah, I feel like it's a really small field, at least my exposure to it. There's a handful of people that study things that create… things that live in the oceans and create, like, calcium carbonate shells. And then there are medical fields where they're trying to mimic biology for, like, bone regeneration, tissue regeneration.

I remember when I was researching for one of my fellowship application proposals, I kept coming across a lot of papers by, like, dentists looking at healing teeth. And I was like, "This is really cool."

Aside: One of the more compelling ones I found was titled, "Calcium silicate coating derived from Portland cement as treatment for hypersensitive dentine."

Now, Portland cement, you ask? Is it locally harvested, organic concrete? No ma'am. It's a fine powder made by baking limestone and clay stuff and then adding gypsum. And it's so much worse for the environment than I realized previously. But apparently, in dental nanotechnology circles, they're using derivatives to strengthen teeth? I don't know.

I don't know what it's all about, but yes, we're going to need an odontology episode about teeth, like, yesterday. Also, gnathology is the study of chewing! So… Sorry, I'm never stopping this podcast. I can't.

Alie: When I first met you, I remember you telling me that you are looking at shells and trying to figure out how the acidification of the ocean is going to affect them. Is that a big part of it?

Rob: I use the chemistry of shells to better understand shells, if that makes any sense. [*laughs*]

Alie: Yeah. And so, tell me a little bit about what your work is like. Are you, like, scraping shells with an X-Acto knife and tossing them into a spectrometry contraption? What's a day in the life like for you?

Rob: Yeah, most of my lab work so far has been taking powders of shells… So, someone else has, thankfully, already cultured a lot of the samples that I'm working with right now. They've already been scraped off – I guess they use a drill – drilled off and then put into vials for me, and then I just need to weigh them out and prepare them to be put into the mass spectrometer. And then I put them in the mass spectrometer, or whatever other technique we're using to analyze it.

But more recently, for newer projects that I'm working on, I seem to be moving towards working with algae, and specifically coccolithophores, which are these tiny little things that make these beautiful calcium carbonate plates. They're really gorgeous, if no one's ever seen one.

Aside: Sidenote, I have seen one, because I had to google it. And first off, coccolithophores are these musically named, single-celled phytoplankton that live in the upper layers of the sea. And they're so cool. They make themselves a little house out of what looks like a bunch of starched, lacey doilies, or paper plates layered over a beach ball; just these round things with scales all over them. And at their largest, they're the size of the width of a strand of hair. And then when they multiply, or die, their shed scales are helpful for sequestering carbon. And it builds up to 1.4 billion kilos of calcite in the ocean every year.

And you're like, "Calcite? What's that, Dad?" Well, it's a great question that I asked Google for us. Calcite is a form of calcium carbonate, and calcium carbonate is a carbon and three oxygens. It's the same stuff that's in eggshells, and pearls, and seashells. But there are different types of calcium carbonate.

Calcite is calcium carbonate that's in a really stable structure, but there's another form called aragonite, which has a different crystal lattice shape from a molecular standpoint. And calcium carbonate is also a supplement for bone health and is in the Tums that you chew on when you're burping up chili dogs and you need an antacid because carbonates are pretty strong bases.

Now, this information will prove useful in the episode. Do trust. But yes, very cool chemistry happening to make strong shells out of thin air, and water, and other minerals.

Rob: So, I maintain our cultures by just going to the lab, feeding them every once in a while by putting them in some new seawater media, and then doing some experiments with that. Then I also have another project that I'm really excited about where we're, hopefully, going to be planting different types of fiddle leaf trees. So maybe I'll get to work in a greenhouse soon.

Alie: Ooh! And fiddle leaf trees, those are the ones that people have in their house but they kill a lot, right?

Rob: Yes! [*laughs*]

Alie: [*laughs*] Okay. I can't believe I get to actually ask someone about this, but why are they hard to keep alive? Because I see them in beautiful Instagram interior design photos, and I say, "How long will it take me to kill them?"

Rob: [*laughs*] I feel like people probably overwater them. It feels like it's either that they pay too much attention to it or they pay too little attention to it. But unfortunately, I'm not too much

of a plant scientist, I just am able to keep plants alive somehow. I always just tell people to, like, stick your finger in the dirt, and if it's dry, it probably needs to be watered.

Alie: Very scientific, Doctor. [*laughs*]

Aside: Sidenote: I tried to look up some fiddle leaf tips because I knew some of you out there are struggling, and apparently they like a lot of bright, indirect light, and you should dust the leaves often. And yes, stick your little finger in the dirt and water it if it's dry. That's what you do, says a scientist. Also, Costco was selling these otherwise-pretty-pricey plants for, like, $20 recently, in case you need to replace one you've killed while your roommate's been away. Your secret's safe with me.

Alie: Okay, now when it comes to shells, let's say you're dealing with shells in the lab, are they really different across different animals? Are a lot of them, like, calcium carbonate, and others are calcium silicate…? I am making up words because I don't know what they're made of.

Rob: [*laughs*] Yeah, the most predominant biomineral is made up of calcium carbonate, and then I would say, maybe, the second most common are calcium phosphate, which would be like bones and teeth. And then maybe the third would be silicate minerals. And then at the end you probably have… The more complicated ones, they have iron in them and they're made by bacteria.

Alie: Oooh! And when it comes to shells… This is a very basic question, but I don't understand how something that's, like, a slimy little flaccid little tongue is making something that's harder than my bones, maybe. Where is it coming from? Where are they getting this calcium? Where… Are they secreting it? How are these shells even made?

Rob: Yeah, so bivalves, they secrete their shells from this organ they have called the mantle. The organ has… It's lined with these epithelial cells that are what secrete the mineral that eventually becomes the shell. But what it has to do is take all of the parts that it needs from the seawater first. So, through some process of, essentially, absorption, it's pulling in little tiny pockets of seawater into itself, and as that pocket is traveling through the organ, its different enzymes and transporters are changing the chemistry of the water in that pocket to make it favorable for it to form a mineral.

Aside: Rob says that crystalline structures form out of these minerals, plus a mix of some acidic proteins from the animal, to make these biomineral structures of varying hardness and uses. Ta-da!

Rob: And then it turns into its final form.

Alie: And is it hard as soon as it comes out, or is it, like, plaster of Paris? And how can something that's in the sea dry? I don't get any of it! It's so exciting.

Rob: [*laughs*] I wouldn't say it's necessarily hard, because what they're finding more and more evidence for is, like, this intermediate mineral phase called amorphous calcium carbonate. It's sort of counterintuitive because you don't think of minerals as being amorphous because one of the definitions of a mineral is it has a crystalline structure. It's this, like, amorphous mineral that seems to be what gets deposited, and then that's what eventually transforms.

It seems like it doesn't want the water, like, as a part of it. So when it is released from the pocket that was keeping it stable, then it sort of dehydrates and pushes the water out because it wants to be this more stable form of the mineral.

Alie: Okay, so spirals. Is that a common thing with a lot of shells? Why are some, like, two little clappy plates like a clam or a mussel, and others are, like, this incredible, beautiful, Fibonacci spiral?

Rob: Yeah, so the shape has to do a lot with the function of it. So the things like the nautiloids and stuff, they have this spiral shape that, within it, has these different chambers that allow it to change the animal's buoyancy so it can move up and down the water column. And bivalves, like the different clams, and mussels, and oysters, their shape is very determined by how they live. Do they live attached to a rock? Do they live on the surface of the sediment? Do they live buried under the sediment? How buried are they? Partially, or fully?

And I think the spirally shapes, like snails and things like that, I think it's mainly for protection as well as their sexual organs are the same shape, so they need it like that.

Alie: Oh! So when you're looking at a spiral, you're looking, maybe, at their bathing suit area's shape? That's exciting.

Rob: [*laughs*] Exactly. Yeah, and most of the gastropods, they're chiral, so they'll swirl in this clockwise pattern because it matches the shape of their reproductive organs. That's why they can only mate with things of the same handedness, or the same rotation. And that's why the sad, like, Jeremy the Snail, left-handed snails, they can't reproduce.

Alie: And so that is just part of sexual selection where they tend to be like, "Well, couldn't find anyone so I guess I'm just… out of the game." Is that how that goes??

Rob: Yeah, it's really sad. It's surprising how new this research is that actually identified the gene that controls it. It came out, like, last year where they actually identified the gene. And they noticed that, like, "Things that lack this gene are the ones that spiral counterclockwise." So it's just a mutation, and it's sad.

Alie: Aww, Jeremy!

Aside: I looked it up, and this lefthanded, or sinistral, snail could not get it on with any other snail unless it too was a beautiful, backwards mutant. And in a tribute to horny souls everywhere, the world found him two other lefty snails to fall in love with. All three were put in a love nest enclosure. And the two others mated with each other and made tons of babies while Jeremy watched from the sidelines before he died in 2017.

But don't cry yet. Researchers realized that he did mate before his demise. He produced 56 babies, all of 'em righties, who have a better chance at love and making more snail babies.

Alie: Okay, you figure a tiny snail, tiny snail becomes a bigger snail, becomes a bigger snail… Are they adding to the shell on the big end, or on the little end? Can it just keep growing like rock candy in supersaturated sugar water? Where are they adding to it?

Rob: Yeah, they're adding to it at the little end. That's the point at which things are growing outward.

Aside: So the snails hatch from an egg, and they have a protoconch, which is like a colorless little shell that hardens with more calcium, which they have to get from eating their eggshell! Kind of like snacking on the placenta that you just slid out of. It's resourceful!

Now, as a snail grows, the teeny-tiny baby whorl stays in the center and it keeps making more new shell at the aperture, or the opening end, which hardens and crystalizes as it grows.

Alie: Okay, and crystals. You love crystals, obviously. It kind of drew you in.

Rob: Mm-hmm. Very LA.

Alie: I know! [*laughs*] I like the idea that if you have, like, a crusty snail shell on your altar, that's kind of a crystal.

Rob: Yeah. Smash it up a bit, look at it under a really strong microscope, you'll see the crystals. [*laughs*]

Alie: How are the crystals forming? Because we know that an ice cube is a crystal, right? A snowflake is also a crystal, six sided. What is it about calcium carbonate or these other minerals that allow it to make that crystalline structure?

Rob: Yeah, it's what's available. It's based on what they have around them; it's what they can make most easily. When they are putting these chemicals into the space, they're really… They're not, like, intentionally doing it. We don't think about ourselves making our bones, but there is something there guiding the crystals into being formed, and more impressively, formed into these wild, beautiful shapes that we see.

Alie: And I mean… Okay, favorite shells. Do you have some that stick in your mind? Are you, like, a shell person as it is? Are you a person who's like, "Ah! I keep some on my bookshelf!"? Or are you strictly, like, "When it's powdered and under a microscope, *then* I care."? Or do you marvel over them?

Rob: I marvel over them, but when I moved… Since I was moving across the country I had to leave my rock and mineral collection with my parents at their house. I was like, "Oh no!" So I, sadly, don't have any. But yeah, I think I'm always going to be fascinated by things that nature can create, especially with how beautiful shells can be. It's kind of like, almost for no… They do it for function, and then it just happens to be beautiful. My old research advisors used to always say that nature was the best engineer.

Alie: Aww! I mean, when I think about biomimicry and how much we borrow from nature, I always think, you know, we're on iPhone 11 or 12 or something, but for every animal they've had so many iterations. Every generation is an iteration, and they've had millions and millions and millions of years, so imagine an iPhone 35 Million. It's going to be a great iPhone! Like, it's going to be advanced. So of course they've figured it out based on, like, what works best.

Can I ask you one million Patreon questions?

Rob: You can ask me whatever you want.

Alie: Okay.

Aside: You hear that? Whatever I frickin' want! Which is what you want, Patrons who submitted questions. But first, we donate to a charity of the biomineralogist's choosing, and this week it's directed toward the Center for Diverse Leadership in Science. And CDLS at UCLA was founded by Professor Aradhna Tripati and is an initiative to bring people from diverse backgrounds into science.

A donation to them was made possible by these Ward-approved show sponsors.

[*Ad Break*]

All right. We have a *shell* of a lot of questions to get through. Let's do it.

Alie: Okay, a lot of people, Leah Darpel, Courtney R, Anne Blondin, Monica, Beatriz Bevilacqua, Lisa Ma, Zoe Jane, Paige Liberski, Flora Duff, Carissa Perry, Felix Wolfe, Kelsey Story, Becky Roberson, Aleah, Sarah Sexton– I know these are a lot of names – Ann McHenry, Rebecca

Swerida, and Ellen Durnal, all of those people… It's a lot of people – and I read them all because it is important – want to know, Kelsey Story's words, she said: Is it rude to collect shells (empty ones, obviously) or am I robbing a little sea friend of a potential home? And Carissa Perry said: Love my shell collection but can probably be convinced to quit the habit if it's *no bueno*. And Sarah Sexton has a million shells from when she lived in Hawaii, and she doesn't want to get rid of 'em, but what should she do with them?

What is the deal when you are collecting shells? Are you ruining life for the sea?

Rob: [*laughs*] I guess, in short, yeah. Anything where you're removing a material from the natural ecosystem probably isn't the best for the environment. I'm pretty sure that hermit crabs are already, like, very… It's not their market for homes, so removing more potential homes for them is probably not the best. But they're also not the only people who use old shells. There are other organisms that use old shells to, like, weigh themselves down or even use them for protection.

There are some really cute pictures of sea urchins that actually put some old bivalve shells on and they kind of look like little tiny hats. I think there was an image circulating Twitter of these sea urchins wearing tiny little cowboy hats and they're *really* cute. [*laughs*]

Aside: Did I look it up? Of course. Did it deliver? Also, of course.

So, Reddit user VanillaBean5813 has an aquarium, and after seeing their urchins pick up shells or bits of coral and damaging the coral doing it, they decided to 3D print them some hats to use instead! So you can see the links on my website if you need to look up a spiky, alive Koosh ball wearing a witch hat, which you do.

And apparently, scientists think they do that because it makes them feel protected. And they also, according to VanillaBean5813 on Reddit, they move them just to the side. They cock 'em to an angle in order to poop, which happens out of the top of their head. They poop out of the top of their head. Please tell everyone you know.

Alie: Now, I was going to ask about hermies. Emily asked: Is it true that hermit crabs all line up to trade shells when they need a larger one? Felix Wolfe had this question too. I don't know if you've seen the David Attenborough clip, but it is the cutest thing I've ever seen in my life.

Rob: Yeah. I feel like… Yeah, they have a video of it, right?

Aside: So, we happened to discuss this recently in the Nephrology episode about kidneys because one kidney donation might help ten other people meet their match, rather than their maker. So yes, David Attenborough narrated it beautifully; I think about it way too much. I think people should do it with houses, maybe. I'm just sayin'.

Alie: A lot of people wanted to know… I don't even know if I'm going to read their names, to be honest, because it's like 75 people, wanted to know, like Bridget White says: First Patreon question. Why do the insides of shells tend to have a beautiful, shiny gas rainbow and the outsides are just good for camouflaging? Also Ann McHenry, first-time question-asker wanted to know: Mother of pearl, what's the deal? Why is the inside of an oyster like a fairy wing? Is it an accident? Does it serve a purpose, and do they know how beautiful they are?

Rob: I would hope so. I would hope they have some sort of reflection where they look in whatever they can use as a mirror and are like, "Yes, you *are* beautiful. You are gorgeous. You are powerful." [*laughs*] But that's probably not the case. But yeah, so mother of pearl, or nacre, it's beautiful because of how the light refracts. Because it's usually made up of… They're, like,

prismatic tablets almost, and the way that they're stacked bends the light in the way that makes it look like this weird rainbow.

And it does have a purpose. So, its mechanical properties are very strong, and are very good, and very resistant to wear and tear. And it's especially useful because it's ductile. They can put it into odd shapes that are the insides of these shells.

Aside: So ductile, sidenote, means that it can be formed into shapes without losing its strength. And kind of like an iridescent Lego set, mother of pearl has a brick-and-mortar structure to it; the bricks being aragonite, which is another form of calcium carbonate. And the mortar, what is it? Thanks for asking. Well, it's elasticy biopolymers, kind of like a silky glue that holds the aragonite together. The mollusks that secrete it in their mantle tissue are just always turning it over to help capture and get rid of parasites, and debris, and gunk and stuff.

Under a microscope, the inside of an abalone or mussel shell looks like a brick building. And the stacked aragonite platelets are close to the size of a wave of light, so irregularities on the surface scatter light, makin' it look like a jazzy little rainbow. All of that chemistry, structure, strength, beauty, and your cousin just uses an abalone shell as an ashtray. Hmm. Do as you will.

Alie: So it's function first and then it's fashion.

Rob: Yeah, it's function and then fashion. Very much like my closet.

Alie: [*laughs*]

Rob: And the more surprising bit, even though it looks completely different to the outside of the shell, at the base level it's all made up of the same stuff. It's all calcium carbonate. It's just in a different crystal structure, or it's, like, arranged in a different orientation.

Alie: Oh! I had no idea. Sarah Kulig wants to know: Is Marcel the Shell the cutest example of a fictional shell creature? [*clip of Marcel the Shell: "Guess what I use to tie my skis to my car? …A hair. Guess what my skis are. …Toenails from a man."*]

Rob: Uh, I think so, yeah. That's a throwback. I haven't thought about Marcel the Shell in… I don't even know how long. [*laughs*]

Alie: Can I tell you something? I watched Marcel the Shell three days ago!

Rob: What! That show's, like, at least 10 years old. [*laughs*]

Alie: I know, but I just remembered how she was like, [*silly Marcel voice*] "You know what I ski on? A man's toenail," and I had to listen to it again. It always gets me right in the heart.

Ellen Skelton wants to know: What is the most ridiculous shell that you have seen? Like, one that you look at and think, "Why in evolutionary history did this squishy thing feel the need to create this elaborate thing?"

Rob: Well, there's this one xenophora, it's called the carrier shell. It doesn't make sense. It's just like, "Why did the shell of this snail decide at some point in its history that it was going to pick up and meld with other shells as it grows?" So, it just looks like this spiral that has other random shells sticking out of it.

Alie: Oh? And it just, kind of, picks it up as it goes? Like a lint roller?

Rob: It just picks it up. [*laughs*]

Alie: Dang! I mean, good for it. It's like the guy at the party that sees half-empty beers and is like, "Sure man. Why not."

Rob: Oh, ew.

Aside: So, I'd never heard of these, but xenophora's etymology means 'bearing foreigners' because they pick up objects like pebbles and other shells, sometimes bottlecaps, and they cement them to themselves for camouflage. Or in deeper waters, scientists think it might help them from getting sucked into the sticky mud, to have a bigger footprint.

But the objects they choose? Ah! They can be so beautifully curated. I was reading one museum exhibit about it that began, "It is not known to what extent an artistic sensibility plays a part in this behavior." Which, I bet a lot of mollusks right now are like, "Um, pardon me? This is handcrafted. And by handcrafted, I mean I made it with my slimy body. But that's not the point."

This next question is about [*computer pronunciation*] operculum.

Alie: A few people, Sarah Sutcliffe and Shireen Shipman, both wanted to know… op-hair-coo-lums… [*struggling to pronounce*] opPERculums? OpAIRiculums?

Rob: It's one of those words I've never read out loud. [*laughs*]

Alie: I've never seen it before! But: They're so cool. How do they grow as well as the shell?

What is… Is it a lid? What are they?

Rob: Yeah, they are lids, or like trap doors. They're made of the same stuff as the shell, and they're just one of the ways that the organisms living inside of the shell can protect themselves from predators because it's like a little trap door that they can retract and close themselves into. [*AOL guy: "Goodbye."*] And they're… yeah, they're just little lids for these little shell pots.

Alie: [*babytalking*] That's so cute.

A lot of people wanted to know: Can you hear the ocean in shells? What makes them sound like the ocean? Elizabeth Ross says: I heard that the sound is created by blood moving in our own ears being echoed by the shell. Do people ask this of you when you tell them you study shells?

Rob: I feel like nobody ever asks me anything about that. I would *love* more questions about shells, all the time. And I really want to say yes because it sounds very magical. But the answer is, no, unfortunately. And it's also not necessarily you hearing your own blood either. It's just that shells… And this is the reason why they've also been used for instruments in the past. It's just that shells are so efficient and effective at amplifying sound, that whenever you put your ear up to the shell it's really just amplifying the sound of the ambient noise and, like, air moving around.

Aside: So, flimflam busted. The noise that you hear from shells has a name. It's called 'seashell resonance'. But that ambient amplification would also work with, like, an empty Starbucks cup. So, I'm sorry to have just broken your heart, curious land mermaids, including Christa Charter, Rachel Moore, Elizabeth Ross, Kate Rampy, Kelly Windsor, Teagen Andrews, Megan Younce, Olivia Meyer, and DeLene Oppelt.

But on the notes of myths and thrumming blood in your ears:

Alie: Remnant Muse posted: How do you feel about the acid bath lyrics "The sound of the ocean is dead. It's just the echo of blood in your head."? But that makes me want to know, along with a

lot of other people, in terms of acid baths, tell me a little bit about the ocean and what is happening to shells these days.

Aside: Ellen Skelton, Becky the Sassy Seagrass Scientist, Monica, Julie Dupre, Ryan Gwin, Sarah Sutcliffe, Seth Suchy, Zach Strickland, first-time question-askers Olivia Zanzonico, Natalie Rhoades, LettersFromEleanorRigby, and Jennifer Stone all had similar questions which I will read in Juliebear's words: Sorry to ask the depressing question, but are we noticing a change in marine shells due to global warming and ocean acidification?

What a necessary bummer.

Rob: Yeah, as most of your listeners probably know, the ocean is becoming more acidic and the temperature of the ocean is increasing. So this, predictably, makes it a lot harder for living things that precipitate minerals to make their minerals. It affects animals in different ways because they all live in different ways. So, it's not necessarily as direct as, like, "Oh, the shells are dissolving." It's more along the lines of, "This is stressing out these living things," and it's making it harder for them to precipitate the minerals in the first place. So, they have to… if they even can, direct more energy into that process. That's what is killing these things.

Alie: What types of shellfish or mollusks are having the hardest time right now? [*"It's… pretty rough."*]

Rob: Hmm… I feel like it's any organism that doesn't have as much control over its internal chemistry. Like, some organisms control more strongly than others the composition of that fluid pocket that's traveling through the shell-making organ. So, if it's something that has a very high level of control over that, corals or lobsters, they tend to have a bit more resistance when it comes to being faced with these stressors.

However, things that have less control, like certain species of algae, certain species of mollusks, they can't really do anything about it because they can't adapt quickly enough.

Alie: Because they're a little bit less complex of an organism maybe?

Rob: Yeah. I think that's one way of putting it.

Alie: Daisy Goldstein Cross wants to know: Please talk about chalk. Also opals.

Are opals shell-like?

Rob: You could argue that they look kind of like nacre, but they're not. They are not shells.

Alie: Good to know.

Rob: They are amorphous silica minerals that form more like via sedimentation.

Alie: Oh!! I did not know that. I understand that they are less hardy as a gem. Like, they're more prone to flaking than some other gems.

Rob: Yeah, probably because it's amorphous. It's not as hard.

Alie: Okay, and what about chalk? Chalk is a lot of dead animals?

Rob: Yes, chalk is a lot of dead coccolithophores, actually. So, it's the old skeletons of tons and tons of these algae that have sunk to the bottom of an ocean and piled up very high.

Alie: Wow. Do you think if you're a vegan, using chalk should be not something you do? Are they plants, or are they animals?

Rob: They are plants. They are a species of algae.

Alie: Okay, got it. So, they're not dead animals. They're dead plants. That's interesting.

Aside: Listen, I heard skeletons, I thought of bags of flesh, okay? My bad.

Alie: A few people, Edward Rice, Sakura Rivas, and Alex Walker all wanted to know about coquina. Can you talk about how shells become coquina? And Edward Rice says: I'm living just south of St. Augustine and there are whole buildings made out of this stuff that were built in the 1600s. How did those tiny shells end up becoming rock?

So, have you heard of this?

Rob: I definitely remember it from class. [*laughs*] I've never imagined it being able to be something that could make up entire buildings. Those buildings must be beautiful.

Aside: Coquina is the material composed of shells all stuck together by the calcium carbonate that dissolved over time and then re-stuck. And I had never seen this, but I just gazed at pictures and it looks kind of like a Rice Krispy Treat made with Frosted Flakes, only it's shells.

Rob: But it must be very similar to chalk in a way, where it's all these organisms that have precipitated shells and they've died, so these shells have sunk to the bottom of the ocean and created this layer of sediment that's just crushed-up old shells, but they haven't been pulverized enough to where they're super sandy. It's still very obviously, like, crushed-up shells glued together by other forms of calcium carbonate like limestone.

Alie: Ooh! I've never even seen it.

Rob: It's beautiful.

Alie: And Sarah Maas, first-time question-asker, such a good question: How are shells different from exoskeletons? And do crabs have shells, or do they have exoskeletons?

Rob: Yeah, so I think it completely depends on the exoskeleton that you're talking about. I would argue that probably all shells are exoskeletons but not all exoskeletons are shells.

But yes, crabs do have an exoskeleton, and yes it is a shell. I guess this also goes back to the lobster question, where it's like, these arthropods are crustaceans, they're molting, and at least in the case of the lobster, every time it molts it's shedding its old shell. But in that process of shedding its old shell, it actually recycles a lot of the mineral in that old shell. It resorbs it, which is really cool. So, depending on the species of lobster or even the location, it can recycle from 20% up to, like, 90% of that old shell, which is really cool.

Alie: That *is* cool. I had no idea. I thought they were just like, "Okay. Bye now. That was so expensive," just leaving an Audi by the side of the road. That's good to know. I feel less bad for them.

Speaking of feeling bad, Sarah Kulig and Monica both had a similar question. Sarah says: I feel like this is unlikely, but I can't help but wonder. Is there evidence of microplastics somehow now appearing in shells or affecting shell development? [*dreading the answer*] Ehhh… [*"This can't be good."*]

Rob: Um… Hm. I don't know if they've found them, like, within the shell itself. I know that the organisms are… they're getting into the soft parts of the organisms, like the shellfish we're eating and stuff, but I don't know about them actually getting into the shells themselves. I did read an article at one point that was looking at the effects of microplastics on hermit crabs and they found that when hermit crabs are exposed to microplastics it screws with their cognitive abilities and it makes it harder for them to be able to choose a new shell.

Alie: [*super sad*] Aww… I don't like that very much at all.

Aside: Please see the April 2020 paper, "Microplastics disrupt hermit crab shell selection." And then go whimper into your hands.

Rob: It's sad.

Alie: I wanted to pet one softly on the head. No, it does not want that.

Kelly Dredge had a great question: Can the chemical composition of shells be utilized to identify where they were developed globally? Like, can we look at a shell and know it was created in Australia because of its chemistry?

Rob: Maybe not that specifically. That's a really great question, and that's very aligned with what some other people in my lab do. I don't know if we'd be able to pinpoint, like, where on the globe exactly, but we would definitely get a lot of information of the type of environment that it grew in.

Alie: Along those lines, Juliebear wants to know… and I'm going to read it as it's written. It goes: H-have we found flushed manmade drugs in shells? :(

Rob: Not that I know of.

Alie: They're not, like, jacked on steroids or on birth control pills?

Rob: Maybe they have their own substances that they like to use.

Alie: Perhaps! Just party shells.

Vince Alasha asks: Why are Florida beaches covered in shells? So many cuts in my feet!!!!

Rob: Yeah, it's actually the shape of Florida and the surrounding bits of land or islands that causes that to happen. A lot of the islands run parallel to Florida, so they're aligned with the water currents running around Florida itself. However, beaches like Sanibel, it's actually perpendicular, so it sort of catches all of the shells that come out of that current. That's why it has so many more shells than a lot of other beaches.

Alie: Oh, okay. So do you think if you were to find a shell from someplace in Florida and there were a lot of them, it would be okay to take home? Or is it still, like, "Nnh, leave 'em on the beach"?

Rob: I think, to be safe, leave them on the beach. But I'm sure if you take *one*, it's fine. Definitely not if they're alive, but if they're fully formed and together, you probably should leave them.

Alie: Okay. Sikwani Dana asks: What determines the color of a shell? Like, what makes it white or purple? And does the same color have a different cause in different species? Like beautiful purple mollusk shells and stuff, any idea what causes it?

Rob: That's a really good question. So, a lot of shells have this… The final, outermost layer is this organic covering, sort of like a skin almost, and that's what carries the pigment or whatever makes the pigment. Usually what determines the color is similar to the shape, where it's about function and trying to camouflage with its surroundings. I know that some species of bivalves are actually able to change their color with the environment where others can't.

Alie: What! Let's say a certain kind of mussel shell is usually purple on the inside, if there's a purple seashell out of the Bahamas, is it the same thing that's making the same color?

Rob: Yes. It's probably the same thing going on. And it's also interesting that it's so much more function over genetics that it really depends a lot more on the local environment of the shell rather than it being closely related to other species of shell.

Alie: Wow. And is that partly because that's what it's pulling out of the environment to make it?

Rob: Yeah, it's partially, probably, like what it's pulling out of the environment but also just what it needs. We're probably wearing a lot more shorts and t-shirts in LA than, like, up in Washington.

Alie: True!

Aside: Sidenote: These lilac-to-violet marbly colored shells of the Northeast coast quahog clams are used to make what some Indigenous nations call wampum beads, strung together in various patterns with these creamy, white-shelled beads of the whelk snail. And this species of clam is called *Mercenaria mercenaria*, and those words, essentially, mean commerce. But wampum beads and belts had much more significance than currency for many Indigenous cultures. And I was just reading that it wasn't until colonization that their value became monetary to settlers. So, there's gorgeous beadwork and a rich history in wampum beads and it's worth going down labyrinths of rabbit holes to learn more.

But yes, those purple striations in the shell are regional and they're created by different minerals in the mud. So color me plum surprised. Biomineralogy, my friends, in a nutshell. In a clamshell.

Alie: Erin Morris, first-time-ever question-asker says: The little holes you see in shells, are they from worms burrowing into them while they're alive? What are those?

Rob: They're not from worms but they are from these carnivorous snails. Usually it's this type of whelk, I think it's called the dog whelk. And what it does is it goes up to these clams and it uses its "tongue", which is more of a drill. And it drills into these shells to try to get to the soft, tasty, gooey deliciousness that's inside the shell. So once it makes that hole, it turns its inside into goo that it can slurp up like a soda.

Alie: Augh! What a dick! What a dick! Just piercing it like a Capri Sun.

Rob: [*laughs*]

Aside: Of course it's okay, snail. You gotta eat. I understand. You're not a dick. I was projecting.

Alie: Okay, Molly Johnson has a style question, seconded by Erin Ryan. Molly asks: Why are dusty shells a thing in suburban beach-themed bathrooms, and how do we make people stop putting them there and just enjoy them on the beach? And Erin Ryan says: I second this question and its precise wording. Thoughts on dusty bathroom shells?

Rob: What do they mean by dusty?

Alie: You know, you've got a bowl of shells. It's been there for a year. You know?

Rob: Yeah, I don't know. I don't know what's up with that. I guess it's people trying to… You know, you're trying to transport yourself to where you want to be, so they put the shells in the bathroom.

Alie: It's very true. I'm going to see if I can trace it back to, like, a 2004 Martha Stewart edition of beach homes.

Jude Kenny has an important scientific question. Wants to know: Can I use a conch to summon animals to do my bidding?

Rob: I wish. That would be great.

Alie: They would be doing some of your lab work, I'm sure, were that true.

Rob: Yeah, I would buy one of those little microphones that people use to interview their cats and I would go down there and interview them. That would make my life so much easier. I'd just be like, "How *do* you do this?" [*laughs*]

Alie: Have you ever blown into a conch?

Rob: No, I haven't.

Alie: It's pretty transformative. I have to say.

Rob: Is it easy? Is it just, like, a trumpet? Do you have to do anything?

Alie: Yeah, it's like a trumpet. And it really does make you feel that there's, just, elk that are going to start filtering down, and a racoon's going to peep its head out and be like, "My Queen?" Maybe one day you'll get to "WHOOO." It's very exciting.

Rob: I just want to feel powerful. Maybe I'll try to find a conch shell before my defense. [*laughs*]

Alie: [*laughs*] You should!

Any myths that you really want to bust about shells?

Rob: Myths… Not that I can really think of. Oh! Pearls! Pearls are very interesting. I always thought that pearls were this, like, self-defense mechanism that different bivalves had to, like, protect themselves against foreign particles, like sand or something entering into the inner sanctum of the shell.

What I've come to eventually learn, now in the fourth year of my PhD, is that it's not… Like, yes, that's sometimes the case that there's a grain of sand or sometimes a parasite that is at the core of the pearl. But what it really is, it's usually… It happens when part of the epithelial cells that actually secrete the shell, they get moved or misplaced inside, and so then they start making this shell. It doesn't have the things really guiding it anymore, so the pearls are really just these inside-out shells that have the nacre, shiny beautiful outside. But the inside is more similar to the outer shell.

Alie: So, it's just a mistake, and anyone who's been seeding pearls to try to make more pearls… Is that just not effective?

Rob: It probably helps because it provides a site of, like, nucleation for crystal growth. So I would probably argue that maybe seeding them does help, but it's not the main reason that natural pearls form.

Alie: Wow. Have you ever gone down any of those rabbit holes watching people who open pearl mussels at home and do haul videos?

Rob: I really should, but seeing people shell stuff makes me really anxious. Like, oh my god, oysters? Oh no. I'm never eating oysters. If the texture wasn't enough, I'm… Ugh! Shelling them scares me. I do not want to stab my hand. The only way I want to see an oyster is, like, deep-fried on top of a deviled egg.

Alie: Me too! I like them canned and smoked. They look like toad turds but I prefer them that way. But when they're raw and slippery, I'm kind of like… if the table orders them, I'll have one to be polite, but then I'm always the most generous person that's like, "No, no. *You* have the last five." [*laughs*]

Rob: "It's for you. I got this *for you*."

Aside: Also, can I tell you that I just read an article about a man who got a bacterial infection from cracking open oysters, and got an open wound on his hand, and almost died. But good news, he survived, but the newspaper article detailing his article chose the headline, "Aw Shucks: How Oysters Gave One Man a Rare Bacterial Infection." Wow.

On the topic of things that are the worst:

Alie: Okay, questions. Things about your job that suuuuck. Worst than oysters. What is the worst part about being a biomineralogist/ "conk"-ologist/conchologist?

Rob: In my opinion, the least fun thing is, probably for me… I think it's the lab work itself. I don't think I'm made for sitting in the lab for hours. I very much enjoy… at least I enjoy more, the side of science where I've gotten the data and, like, I'm at the point of trying to figure out what it means, and writing about it, and reading about it, and sharing that. I don't know if I actually like doing the stuff leading up to that as much.

Aside: So some people like collecting the food. Some like cooking it up. Different scientists like different parts of the process.

Alie: What about the thing that you love the most about it?

Rob: The friends we've made along the way.

Alie: Aww!!

Rob: But seriously, I think the thing I enjoy the most about, just like life and working in general, is being able to mentor more junior students. I work with a lot of undergraduates, and being able to work with them is such a great experience. I love getting to teach them how to do lab stuff and then have them do the lab stuff. That's rewarding for me, they get experience, they can write about it in their personal statements, they can collect a paycheck. [*laughs*] It's a win-win for everyone.

But it's also just so rewarding to then… It's rewarding and sad because they eventually graduate, or they move to another lab to get more experience, and then they stop working with me and I'm sad. But it's very fun to see them grow and blossom into students or scholars.

Alie: Is there anything you wish you knew, you know, growing up, or any advice you would give to someone who maybe has yet to go through that kind of journey of discovering what they're into? Either personally or professionally?

Rob: I would say… I wish I knew what things to, like, look for; what things to look up. I grew up in a religious household, and then I also went to a, like, religious private school from kindergarten to eighth grade. So I feel like, growing up, I was very sheltered in many, many ways because I also didn't live in a neighborhood where I was seeing kids outside of school.

So even when I finally eventually came out when I was in college, an undergrad, I was like, "Okay, I'm gay…" but then I still didn't know anything about, like, LGBTQ history, or rights, or anything like that. And I didn't start being able to explore that until I moved to Los Angeles and started meeting a lot more queer and trans people who are a lot more knowledgeable in those things. And I can also attribute a lot of that to my partner, who's a lot more in tune and teaches me a lot.

Alie: So, find your friends.

Rob: Yeah, find your friends. Talk to people. Yeah, for jobs… Oh my gosh, I think the best advice I've ever gotten from, like, a career center is, yeah, just ask people about their jobs. Ask to talk to

them about their jobs. People love to feel helpful and you'll learn a lot about, like, what that job actually entails.

Alie: I mean, I can tell you, asking people about their jobs is not as hard as it looks. It's very easy to ask people about what they like, and I think it's great to reach out to people, especially if you think you might be interested in the field.

Rob: The worst thing is that they don't respond. No one's going to respond to you and be like, "How *dare* you?" [*laughs*]

Alie: "How dare you like the field I'm in!"

Rob: "How dare you appreciate me!" [*laughs*]

Alie: [*laughs*] "Gah!" Well, *I* appreciate you so much.

Rob: I appreciate you too. I still remember when… I was really mad at you when we met because I was like… You walked in, you were like… I was like, "Here's this smart, funny, gorgeous individual walking in." I'm laying down on this blanket playing with a kid. It was Raquel's kid. I was playing with his pump-up rocket. And you introduced yourself to me and I was like, "The *gall* of this woman to think I don't know who she is." [*laughs*]

Alie: [*laughs*] I had no idea you would know!

Rob: I remember distinctly being like, "I binged every episode."

Alie: That's amazing. I can't believe… I still can't believe anyone listens to it because I'm just… you know, I'm sitting here recording it next to my derpy dog. It never occurs to me that there are people on the other side that actually would want to listen to it. I feel like people do it out of guilt or something.

I was so excited. You've been on my list of index cards as an interview I've wanted to do for so long. I keep an index card deck of ones I want to get to. I'm so glad that we finally reconnected because I'm like, "Muahaha!"

Rob: I feel like it's been… The real purpose of me going through grad school and getting my PhD is just preparing for this moment.

Alie: [*laughs*] I hope this was easier than your quals.

Rob: It was definitely less stressful and more fun. [*laughs*]

So, don't *clam* up; ask *shella* smart people basic, or acidic, questions, because they are charming and informative, and now you are friends.

You can learn more about Rob Ulrich at RobertNUlrich.com. You can follow him @RobertNUlrich on Twitter, or Queer & Trans in STEM. Also of course on Instagram @Biomineralogist. He's got the handle! He's got the chops.

We also have our first-ever live show. There is a link in the show notes. It stars the return of Volcanologist Jess Phoenix to debunk more myths and go over more questions that we didn't get to. This happens on May 18th. It's at 5pm Pacific. Tickets are $12 for General or $9 for Patrons. There's a discount code posted at Patreon.com/Ologies. Patrons, you can get $3 off by joining for $1. Look at that. Boom. So, do attend. This may be the only virtual live show I ever do. I'm not sure how it's going to go. I don't know if I'm going to keep doing them, but I thought I'd give at least one a shot. So

tune in; you can see if it's brilliant or if it's a disaster. So that's May 18th. Tickets are available at the link in the show notes.

We are on the internet @Ologies on Twitter and Instagram. I'm @AlieWard on both. Thank you to Erin Talbert for adminning the *Ologies* Podcast Facebook Group, full of nice people. Shannon Feltus and Boni Dutch of the comedy podcast *You Are That* are sisters, they help out with Facebook and also handle merch at OlogiesMerch.com. T-shirts, masks, totes, mugs. It's all there. Emily White of The Wordary does our transcripts so wonderfully. Caleb Patton bleeps the episodes. And transcripts and bleeped episodes are up on the website at AlieWard.com/Ologies-Extras, for $0 to anyone who wants or could use them. Noel Dilworth is a scheduler extraordinaire. Susan Hale helps manage the ship and makes quizzes for you on Instagram.

And the man and legend, and hunk, Jarrett Sleeper puts together the show alongside long-time *Ologies* editor and a *shell* of a guy, Steven Ray Morris, who hosts *The Purrrcast* and *See Jurassic Right*. Nick Thorburn wrote and performed the theme music. He's in a band called Islands; it is a very good band.

If you listen to the end, you get a tiny dessert bonbon in the form of me confessing something, and this week I will tell you that… Uh. I'm a pretty bad bowler, but I've had some good games, which just means I break 100 here and there. And my trick to getting, like, spare, after strike, after spare, is usually right before I toss the ball, I visualize it just connecting, slamming!

And this one time I was out bowling with some people I didn't know very well but who were all, like, comedy writers on this big show and I was really self-conscious. And I started Knocking. Down. Pins. And they were all impressed like, "You're a really good bowler." And I told them, "Well, I use this trick of visualizing it first, and then it really just connects." And one of them was like, "So it's like *The Secret?* You use The Secret to bowl?" And I was like, "No… it's more about confi… just being confident." And then the next one I threw hit, like, one pin, and then a few gutter balls followed, and my whole game sucked.

And I think about that night a lot, about how they're all probably still, like, "Remember that girl who says that she uses *The Secret* to bowl and then she sucked at bowling?" And I remember thinking I should've never told them that I tried to rely on cosmic good vibes and visualization to bowl better. I don't even like bowling that much!
Anyway, May 18th, Live Show. Ticket link in the show notes. Come hang out.

Until then, berbye.

Transcribed by Emily White at TheWordary.com

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