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Clare

Hello and welcome. I'm Clare and you're listening to Microbe Talk, the podcast by the Microbiology Society. For this episode of Microbe Talk, I spoke to Judy Li, one of the authors of our latest microbial primer: Microbiome and Thermal Tolerance - A New Frontier in Climate Resilience? We talk about the relatively new field of study, including the possible mechanisms of microbes buffering organisms through temperature changes, exciting parts of this research, and where she sees it going in the future.

00:00:41:17 - 00:01:06:02

Judy

I'm Judy, I was born in China, and I did my PhD at Oxford, where I worked on the interaction between the host, a microbiome and the pathogen and the different temperature settings. And then I moved to UBC for my postdoc, and now I'm working on the microbiome. So polar bears. So in terms of to improve their polar bear conservation using their microbiomes.

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Clare

Excellent, excellent. And you're here to talk about your paper Microbiome and thermal tolerance - a new frontier in climate resilience? Yes. Would you be able to explain what your paper is?

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Judy

So this paper is a short microbial primer review where I introduce, how specifically and more associated microbiomes could, play a role in host physiology, health as well as the, the its potential role in conservation of wild animals. And, I sort of emphasize the current knowledge and, the future potential of microbiomes as a tool.

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Clare

That sounds so exciting. And I'm very happy and excited to delve into all of it. But before we do, I would just explain, what are microbiome as I guess, or the right person to ask?

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Judy

Yeah, sure. So the microbiomes, normally we refer to, the wide range of microorganisms that colonize on a host. The host can be an animal or a plant or like any multicellular organisms. So, currently, I think most scientists focus on the bacterial community within the microbiome by the microbiome actually could also include, like fungi or, even small protist or other organisms.

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Clare

So in your paper, you write about buffering vulnerable animals against, temperature fluctuations. This kind of idea of microbes buffering comes up quite a lot in your paper. Yeah. What does that mean?

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Judy

So currently, I think we only have certain empirical evidence of, for example, if you remove microbiomes from an animal, it could reduce its thermal tolerance. So it means that, for example, if an animal could tolerate 40 degree before without any fitness consequences, if it's microbiomes removed, maybe it could only tolerate 35 or even 40 degree the animal's physiological function not working.

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Judy

So in that case, the microbiomes could be a host plastic response to like improve the host tolerance to thermal extremes. I guess in that case it could be like a additional layer of protection.

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Clare

Yeah. And what kind of mechanisms are happening which enables this buffering.

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Judy

So, what we have known is it might not be very comprehensive, but some examples are like the microbiomes could secrete some metabolites and this metabolites could help, improve host physiological function. Or sometimes the microbiomes could regulate gene expression for the host. For example, like heat shock, protein expression and some of these pathways. So the microbiomes have the this ability to to help host regulate that something we don't know exactly how.

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Judy

But in corals, for example, the ocean warming conditions, some of the microbiomes would be selected. For example, this heat, more heat tolerant microbiomes would be selected. So the community, would be reshaped. And sometimes this reshaped, might be a community. If they were transplanted to another coral, it could help the host, to, like, protect them against a thermo stress.

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Judy

So I would say sometimes it's like, feel typically protective for the host. And the mechanism, the, like I said, about this gene regulation, but it's not something we know very wise, wildly or generally for all the organisms. I mean, it's not like the microbiomes want to help the host, but yeah, it's as a like consequences. We don't know why is it.

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Judy

But it's something we observed.

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Clare

So it's quite, a new sort of area. And the world is your oyster. You've got a lot in front of you, for this kind of area.

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Judy

Yeah. So currently, I think what we are trying to, like most scientists trying to understand is the general sort of response of microbiomes to this stresses like thermal extremes. And some have like goes deeper to, to to study how what are the underlying mechanisms using like genome sequencing. Or and and sequencing. But most studies are still working on what are the responses or other changes of microbiomes to these temperature extremes.

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Judy

And what are the potential role these sort of changes, in host health against thermal extremes. So yeah, it's quite I would say it's quite new or like emerging field.

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Clare

Yeah. So it's exciting that we're starting to think about applications. I space now obviously we have equity firms and endosomes. Could you first explain the difference between these two and how they could potentially respond differently to temperature.

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Judy

Yeah. So active themis is, what we refer to as cold blooded animals. So for example, like amphibians or, fish.

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Judy

So they, they can't regulate their body temperature themselves so that their body temperature normally corresponds to the ambient temperature or the environmental temperature they are experiencing. They could, using some strategy to sort of regulate their body temperature, for example, you know, when it's like very sunny, the lizard could go to the shade to, to sort of dumb down its, body temperature and, but it's within like certain, I would say like a very narrow range.

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Judy

So they are very sensitive to temperature changes, but end of them, like human, we are warm blooded animals and, we can regulate our body temperature regardless of the, environment or temperature. I mean, if it's extreme cold or, like, hot, it will require us to, to, to have, like higher metabolic, metabolic cost, but at least our body temperature would retain in the very, like narrow range or like the stable range unlike the active.

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Judy

Yeah. So I would say end of them are more like robust. Yeah. To to temperature changes.

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Clare

Yeah. And do the microbes in the microbiomes of those different types of organisms interact differently when it comes to temperature fluctuations.

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Judy

So potentially, yes. Because imagine like microbiomes within the act of them. The microbiome actually, exposed to the same environment or temperature as the host are because the body temperature, is like influence influenced by the environment temperature. But for the end of them, especially for the microbiome, it's like way thing inside the host is actually in a very stable temperature regardless of the environmental temperature.

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Judy

So it's like it's not directly impacted by the temperature, but it's impacted by the host responses to the temperature. For example, if the host have like difference, metabolic pathway activated because of the thermal extremes, it may impact the microbiome in certain ways. Because we do see like in some papers, we see, when mice were exposed to temperature extremes, the microbiome changes as well.

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Judy

But to be honest, it's not like a direct influence of temperature because the microbiomes are in the mice gut and the gut temperature is quite stable.

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Clare

Yeah. And so what changes do you see the composition of the microbiome in temperature fluctuations. In those organisms.

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Judy

So I actually did. So the first day of my PhD, I did a meta analysis to assess, like what are the general responses or like the changes of microbiomes across a wide range of animals. Yeah. And so for the compositional change, I actually didn't found any like general or common pattern across all the animals because, the microbiomes like they are host associated and they are

quite specific to specific host, even for like the same species in the same population, each individual have like different microbiome.

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Judy

So it's very hard to assess like what are the specific changes or how are those changes that drive different host responses? I would say.

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Clare

So am I right in saying that that all changes? It's just difficult to associate a pattern to what those changes are. Yeah.

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Judy

So one tricky thing about microbial changes is that because microbiomes are quite like is a vast is a vast, community with like, those small bacteria and they're very sensitive to different changes. So this communities is always in dynamics. So, I would say even with, under the temperature changes, if the temperature is the only factor, it's hard to say, like the temperature is shaping the microbiomes because different hosts are shaping the microbiome as well.

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Judy

I, I used to use a different metric sort of to, to study, not exactly the compositional change of the microbial community, but to study how similar are the microbiomes within the population. So it's, it's a way to assess its stability. For example, in the population, if the individuals have very similar microbiomes, we would suppose that microbiomes are under, relatively stable state.

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Judy

But if it's variable across individuals, greatly, under temperature changes, we would suppose that is because temperature making the microbiome is more unstable. So host, unable to regulate the microbiomes to, to towards a very stable state. That's one way we sort of try to assess how microbial changes could be related to host house.

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Clare

A lot of it is quite observational, I would say, in terms of just like looking specifically at the microbiota.

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Judy

So for like for what I have done, we did use the elegance as a experimental system to study, how the microbiome could help the host against, like them extreme as well as pathogen invasion. But currently we're still not sure what other like mechanisms of microbiomes because individually there are so much variation. So it's really hard to disentangle.

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Judy

There's different like which variation corresponds to to sort of which host responses or host fitness, consequences or different factors. So I would say it's very hard about we are also doing some field work on, Canadian polar bears. So it's a more exciting project where we want to see, whether, not specifically to temperature, but whether the microbiome could be an indicator of polar bear house under climate change because their, their habitat is, degrading and ice melting or that stresses, polar bear populations.

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Clare

So where do you potentially see this research going in the future. What would you love to see.

00:13:41:03 - 00:14:12:18

Judy

Well, I would absolutely want to see, the microbiome as a practical tool, for like predicting, animal health or protect animal health, I mean, as a tool to protect, sort of improve animal conservation. It may still be a long way to go, but at least I think is quite promising. Now that we're could use microbiomes as an indicator to of of animal House.

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Judy

I mean, like in humans, we already have some indicator species to for some of the metabolic diseases of human being. So I think we would be able to use microbiomes as indicator

indicators of poor animal. House in the wild. While that would need more field work, more collaborations and more funding. Guess.

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Clare

And what excites you sort of the most? What's the coolest part of this research? I know you mentioned the polar bears, which is really cool. Is there any other bits that are particularly exciting for me?

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Judy

So another thing, not directly to temperature, but is related to climate change is that, climate change is also associated with, increased disease risk in some regions or for some animal populations. So, studying microbiomes, we could also see sort of studied the, the pathogen dynamics. So if the pathogens the bacteria by studying the microbiomes, we can actually track the dynamics of the certain past pathogen, and its association, to host health as well as the temperate, climate change.

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Judy

And if the, pathogens the virus for some, for most mammals, I think that's the case. We also would well go into the, sequencing. So we would also track the, the virus pathogen, dynamics as well as its association with microbiomes, because, microbiomes are also shown to protect host against a pathogen invasion, through, for example, like nice, competition or they sacrifice, metabolites which help kill the, the pathogen.

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Judy

So it's also a very interesting area.

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Clare

And apologies if this is, showing my lack of, scientific background, but you mentioned about, like, certain microbes. Yeah. Which are able to support the host in dealing with, extreme temperatures in the future. Would there possibly be a situation in which you're able to do something like microbiome transplants or something like that? Yeah. To be able to literally get an individual animal and make them less susceptible to high or low temperatures.



00:16:45:08 - 00:17:17:22

Judy

Yeah, absolutely. So, so to be honest, it's already I think it's already, like used in corals. So corals are the most least studied act of worms, in terms of their because they are susceptible to ocean warming and the bleaching of coral or coral really like harm the ecosystems. So because most studies on, corals, some people have already identified certain probiotics for corals.

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Judy

So you know this by transplanting this coral, the probiotics, they could protect the corals from, bleaching. So which is the that that's so it's quite promising. I mean, not for other organisms, but at least this technology, or this sort of way of, of using microbiomes as a conservation tool. I think it would be applicable in the future.

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Clare

That is really exciting. And I suppose there's a big step between protecting corals and protecting polar bears. There's probably quite a bit in between. And I suppose as well with climate change, there's so much like doom and gloom around it and temperatures rising and global warming and all this sort of stuff working out how microbiomes are affected by climate change.

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Clare

There's also such this positive side saying, look, we're protecting the coral reefs by giving them probiotics. That's really exciting.

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Judy

Yeah. It's also very good to let the public know how microbiomes could be important for for the for climate change.

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Clare

Yeah. Yeah. That's great. I have you on the podcast that we can discuss and go kind of into the depth of it. It is a really exciting new research that's been absolutely fabulous to to have you on and to pick your brain.

00:18:36:03 - 00:18:40:09

Judy

It's my pleasure. Thank you.

00:18:40:11 - 00:19:07:17

Clare

Thanks again to Judy for her valuable insights in the world of microbiomes and temperature. If you're interested in finding out more, you can read Judy's Microbial Primer, published in the journal *microbiology*, by clicking the link in the description. You've been listening to Microbe Talk. If you liked this episode, please leave a like or a comment wherever you're listening.