



Episode 51: Please Explain: Taxonomy

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VOICEOVER

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SHANE HUNTINGTON

Hello and welcome to Up Close coming to you from Melbourne University Australia. I'm Dr Shane Huntington. Taxonomy is the oldest branch of biology and the tools of the trade go back hundreds of years. It is interesting to note that even well into the 20th century taxonomists were trying to determine the differences between species between looking at physical and anatomical features. It wasn't until the discovery of DNA by Watson and Crick that the field of genetics started to play a significant role in this field. Today on Up Close we are joined by one of Australia's leaders in taxonomy, Dr Belinda Appleton from the Department of Genetics at the University of Melbourne, Australia. Welcome to Up Close, Belinda.

BELINDA APPLETON

Thank you.

SHANE HUNTINGTON

Now, first of all, what is taxonomy?

BELINDA APPLETON

Well, taxonomy is pretty much a science of categorising living things. We basically use a system, like you said, that's been developed for a long, long time. It's not only the DNA and genetics that we use but we still do use the morphology, the appearance of the organism, to classify living things. We try and give pretty much a simple practical method of putting things into an organised hierarchy, so a system of increasing complexity that allows us to get a handle on what we have in our living world.

SHANE HUNTINGTON

Now, what I'd like to do for a moment is just go back in time a bit, say 50 or 60 years, before we knew about DNA and so forth. What did taxonomy look like back then? how did we go about determining if, for example, we had two species instead of one?

BELINDA APPLETON

Well, back a couple of hundred years there were very many fewer species that had been identified, so it was relatively simple to see something new and give it a new name. However as time goes on, and more and more species have been identified, it gets to be harder and harder to actually delineate new species. It's not because they don't exist? new species are out there and we're still describing them? but the fact is that they recognise each other as species quite easily. It's just that we humans, looking at them from a different perspective, don't see the differences that they see.

SHANE HUNTINGTON

I guess the way we used to do taxonomy, there were certain techniques for determining when species were separated and you had two instead of one; essentially, what they look like externally? so colours, shapes, textures, all of those things wound together. What sort of difference would you need to pull two of them apart, for example, would colour be enough?

BELINDA APPLETON

Colour used to be enough. Colour was something that was used a lot. Even in bats, the group that I work on, just a difference in colour was enough to name a new species but that's generally frowned upon these days because we know there are clinal differences in colour. So, depending on where you are on the globe, you can have a difference in the colour just because of the environment an organism is in. Even down to skull characteristics, skeletal characteristics, external characteristics; pretty much any character that showed a discrete difference was something that could be used in taxonomy.

SHANE HUNTINGTON

Belinda, I am assuming that there is a big aspect of the way we determine when you have a new species that's related to reproduction. How does that work?

BELINDA APPLETON

That's right. One of the main species concepts is a biological species concept which pretty much states that if you have two groups and they cannot successfully reproduce then you've got two separate species? if they can reproduce then they're one and the same. Now, in a lot of cases that's fine and in a lot of cases it would be wonderful to know whether they could reproduce; but in a lot of systems where we're trying to determine whether we have a new species or not, we actually don't know whether they can reproduce or not. The other problem with that is that in some cases we're not looking at sexual reproduction? there are groups that exist that don't sexually reproduce. So we can have groups which are parthenogenic, which means that they will basically make copies of themselves without sexual

reproduction, and you have a line of animals that could constitute a separate species because they don't reproduce with anything else. There's lots of different ways that you can define a species, so species concepts are a really controversial area.

SHANE HUNTINGTON

We should use reproduction as part of that puzzle, not the whole thing?

BELINDA APPLETON

Yes.

SHANE HUNTINGTON

In fact, it's a good time to fast forward to what we do today. Tell us a bit about the sorts of tools we're using now and how they compare to those used a couple of hundred years ago, I guess beyond the visual inspection that we would still use.

BELINDA APPLETON

Well, we now have lots more statistical models and tests that we can use to define the differences between species. But, in the morphology, we're still looking for discrete differences between groups instead of just a gradation of change between those characters ? so we're looking for discontinuities or discrete differences between groups. We also now use the DNA. Because DNA has been passed on from generation to generation to generation, everything living now is somehow connected back in the past. So we can look at the similarities in the sequences of the DNA and we can compare those to look at how closely related or how differently related those groups are.

SHANE HUNTINGTON

This brings up the interesting question of how different in DNA do two separate groups have to be before we classify them as two different species? How many base pairs or how many different areas of coding in a DNA have to be distinct before we would make that choice?

BELINDA APPLETON

This is another area that's quite controversial. If you're looking at a particular group, that particular group might have a certain level of DNA variation that you might say constitutes a species ? you might say, okay, 10 per cent might be a species ? but that doesn't mean that that's applicable to another group of organisms. In the group that I look at, I'm looking at that ? we find that sort of anything around the 2 per cent sequence divergence mark is just the same thing; anything over 10 percent is probably definitely a separate species; anything in between 2 and 10 percent ? and that's a lot ? is an area that needs more work. We actually have a group here in Victoria, Australia where we're looking at a group which has only about 3 per cent sequence divergence in a few areas of the DNA code that we're looking at, but because of all the other information that we have, including morphology and parasites and things, then it actually looks like it's reproductively isolated and, in my books, separate species.

SHANE HUNTINGTON

I know that we've only sequenced completely the genome of a few animals in the world, so you only use a portion of the overall sequence to do the classification?

BELINDA APPLETON

That's right, yeah. We use just certain sections that are sort of ubiquitously used around the world for comparisons.

SHANE HUNTINGTON

You're listening to Melbourne University Up Close. I'm Dr Shane Huntington and we're speaking with Belinda Appleton about taxonomy. This is an incredibly important field but most people wouldn't see it as one of the first areas you would jump into as a student or an undergrad. How did you get involved in this particular area?

BELINDA APPLETON

Well, I've always been interested in evolution and, more and more, taxonomy is playing a role in looking at how things are connected by evolution. The first research that I conducted was to look at a group of bats here in Victoria, Australia, where we were looking at the ecology the bat and one of the important things we wanted to know was whether the bat we were looking at was actually one species or more than one species. The reason for that is because if you've got two different species and they've previously been unrecognised, then you can be looking at radically different life histories and radically different ecological niches without even knowing that that's there. So the first thing I did was to work out whether I had one species or two.

SHANE HUNTINGTON

Belinda, you must spend a fair amount of time in the field. What sort of work do you do there and what's it like?

BELINDA APPLETON

Basically I'm an outdoors person, so I love being outside, I like being in isolated areas and like working with the people in those isolated areas. But it can be really hard work; it can be long days of driving to get to where you're going and very long nights actually doing the work. It's not as glamorous as you think ? you've got to lug heavy gear everywhere and it's hot and cold and you might be working in close proximity with only a few people for a long time. Being a bit crazy helps.

SHANE HUNTINGTON

Sounds a bit like being an astronaut, I suppose. Tell us a bit about the actual process. You mentioned trapping the bats, but presumably you need to anaesthetise them in some way. Do you photograph them, do you measure them ? how does that actually work, the examination of the bat?

BELINDA APPLETON

It depends on the type of work that you're doing. One of my students at the moment is collecting her samples for a genetic study and she is trapping the bats. We don't

anaesthetise them but we put them into cloth bags so that they go to sleep. Once they're quiet and they've gone to sleep, we'll take one out at a time and do some measurements, take a small sample of hair and then the bats are released. But everything that we do has to have an ethics approval.

SHANE HUNTINGTON

I was just going to say it sounds a bit terrifying the idea of them in the cloth bag, but I assume they go asleep through comfort?

BELINDA APPLETON

Yeah, they do.

SHANE HUNTINGTON

They actually enjoy being in there and the environment is safe?

BELINDA APPLETON

Well, bats particularly are good because whenever they have a chance they lower their body temperature and conserve energy. So if they have an opportunity to go to sleep, they take that opportunity generally, as long as you don't put too many bats in a bag.

SHANE HUNTINGTON

Some of this work is being done in Madagascar. Tell us what's special about that location ? are the bats different there, are they unique?

BELINDA APPLETON

Well, there's a group of bats in Madagascar that are supposed to be the same group as what I worked on during my PhD here in Australia; they're supposed to be one species that is found in Australia, Europe, Asia and Africa. I found that difficult to believe, so I did some work and got some samples. Then a colleague from the Field Museum in Chicago got in contact with me and asked if I'd be interested in doing a study on Madagascar. He works for the Field Museum but he lives in Madagascar, so he had a good collection of samples and we've just been working on those together over the last three years. It's an interesting study and I've been lucky to be able to be involved with such a good collection of samples.

SHANE HUNTINGTON

Now, a question I know our listeners will want me to ask is how many species of bat have you actually discovered personally?

BELINDA APPLETON

Well, in the last couple of years we've named probably about eight species in Madagascar ? some of those publications are still to come out, probably another similar number in Africa and there's quite a few unidentified species here in Australia.

SHANE HUNTINGTON

Belinda, when you discover a species I'm assuming you get to name it?

BELINDA APPLETON

That's right.

SHANE HUNTINGTON

How do you go about naming these species?

BELINDA APPLETON

Well, it's always difficult. When you find your first species it's exciting and you can think up a really cool name. Then when you find your tenth ones it's like, well, okay, what am I going to think of this time? But there's lots of things you can do; you can use the name of somebody ? not generally after yourself anymore, though that was a trend for a while.

SHANE HUNTINGTON

No Appleton bat?

BELINDA APPLETON

No, it's not the done thing.

SHANE HUNTINGTON

Yeah.

BELINDA APPLETON

But you can also use the geographic area, so one of the bats we named first was a subspecies of *Miniopterus bassanii*. *Miniopterus bassanii* was named because it came from the Bassian volcanic plains here in Victoria, Australia. The other thing that you can do is to look at the morphological character that particularly separates the group. There was a group of bats that was named *fraterculus*, which was in Africa and Madagascar. Our research in Madagascar showed that the *fraterculus* in Madagascar wasn't the same as Africa and so it needed a new name - *fraterculus* means little brother, so we named the Malagasy form *soroculus* which means little sister.

SHANE HUNTINGTON

When we look at all these new species and we hear about all these new species being discovered all the time, I get the sense that this can somewhat mask the fact that many species are disappearing. What is the role of the taxonomist in determining this but also in getting the message out there that it's not all good news, in fact, it's primarily bad news?

BELINDA APPLETON

Well, that's right. I know that recently it's been estimated that in the next 100 years in Southeast Asia we should expect to lose about 40 per cent of the biodiversity in the region because of deforestation and so forth. That's really concerning ? it's a massive amount of biodiversity, but then you consider that that's only the biodiversity

that we know exists today. If, in fact, a species that you think has gone actually comprised ten species then we're vastly underestimating the biodiversity loss that we should be expecting over the next 100 years. Some of the things that we're looking at is looking at trying to accurately identify the number of species that are present so that we can give them better conversation management.

SHANE HUNTINGTON

Belinda, I hope today we've given our listeners the impression, which I think is certainly true, that taxonomy is no longer something you find in museums but is an integrated part of the way we are now looking at our environment, our effects on it, what we get from it and what we need to do. Thank you very much for being out guest today on Up Close. Relevant links, a full transcript and more information on this episode can be found at our website at upclose.unimelb.edu.au. We also invite you to leave your comments on this or any other episode of Up Close. Simply click on the 'add new comment' link at the bottom of the screen. Melbourne University Up Close is brought to you by the Marketing and Communications Division in association with Asia Institute of the University of Melbourne, Australia. Our producers for this episode were Kelvin Param and Eric van Bemmell, audio recording by Craig McArthur, theme music by Sergio Ercole. Melbourne University Up Close is created by Eric van Bemmell and Kelvin Param. I'm Dr Shane Huntington. Until next time, goodbye.

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