

Gondwanan Odysseys and Taxonomic Adventures

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Kip Will lecture from the *Looking for Life: Adventures and Misadventures in Species Exploration Symposium* presented as part of the *Darwin Distinguished Lecture Series*. This symposium series is sponsored by the Arizona State University International Institute for Species Exploration, College of Liberal Arts and Sciences, and the School of Life Sciences.

Transcript

Robert Krulwich: [0:01] Kip Will is next person from UC Berkeley. This one is called Gondwanan Odysseys and Taxonomic Adventures. Well, go ahead.

Kip Well: [0:09] So that I will not be outdone in being dramatic and romantic I found this particular comic online, and with apologies to the author of the site, put it to my own use for title page. Partly because I also knew that Joe's going to talk about small beetles - I work on large beetles. I haven't had resort to a large-bore rifle yet, but it does at least capture some of the feeling we have of excitement and adventure when we go into the field; which is real. You are getting a glimpse of that from the previous talks and you'll see that partly because of our background and because of the area, interests overlap, there's going to be some intersection - what has already been talked about and things that are in my talk. [0:49] Of course, it's not surprising at all that Joe had exactly the same quotation up for Darwin. This is a very famous one and if you collect a beetles this is tattooed somewhere on your body but Darwin really meant it. I mean he really did have this sort of feeling and he talked about it many times over the course of his life. I'm sure that when he was in southern Chile and he saw this beautiful beetle, his pulse raced and he was excited.

[1:14] So when I was asked to talk about some adventures in taxonomy and the work I do, so, sort of thinking historically which is normal for us, I thought of four people and of course one of them is Darwin. And this being this big event for Darwin this year, it is not surprising we all would think about it. Although some have been mentioned already; Vicky had some of these in the list. Henry Walter Bates spent 11 years in the Amazon primarily collecting insects. He collected almost 15,000 species while he was there. Over 14,000 of those were insects; more than 8,000 of them were undescribed.

[1:48] So here's a man who is at this sort of heroic level of collecting and then to come back -- he came back in 1859 to England -- to have this huge corpus of collected material and suddenly have the origin of the species to explain it. He must have been ecstatic. Of course, he wrote his *Adventure of a Naturalist in the Amazon*, which was introduced by Darwin, who basically fawned over the work. It was such a wonderful trip and a wonderful confirmation of the ideas in origin.

[2:20] The next name that comes up is, of course, Wallis, who has mentioned a bit earlier. His greatest collecting was done in the Malay Archipelago. He also wrote a wonderful book. In fact, of the three books, *The Voyage of the Beagle*, *The Naturalist in the River Amazons*, and *The Malay Archipelago*, this is the best reading. It has got a little bit of that Victorian purple prose about it. You have to be able to sort of quit the hunting and shooting of the orangutan into the context of the 19th century, but nevertheless it's really a great story.

[2:52] He collected over 125,000 specimens during his eight years there and halfway through you know the story of him coming down with malaria fever fits and coming up with his own version of natural selection. But then he turned around and took all of this data that he had and had his own wonderful ideas about bio-geography and contributed greatly to the building of our collections and is really a very notable person.

[3:14] So there is three, and then for me, personally, there is another name that always comes up and that's Phil Darlington, which some you will know and some of you won't. But I know him well because Darlington worked in the same groups of beetles that I do, traveled in many of the same places. Of course, he has a number of interesting stories, this one being one of them.

[3:33] When he was in the Papua New Guinea in the 40s he was collecting beetles and the ground beetles that we collect like wet sloppy places along rivers and streams. He was collecting along one of those out on sort of a slippery log, and he looked up and a crocodile was coming towards him. He stood up to sort of back pedal to get out of there but he slipped off the log and into the water. So, the story goes. He reached out to try to grab the jaws of the crocodile.

[3:59] He got one hand on the jaw but missed the other. The croc gets him, takes him under the water, rolls him around. He is fighting and struggling and he is not sure why but the crocodile released him. Then he crawls back and he's got some maimed arms and stuff but works his way back to the hospital. We know now that this was just good judgment on the part on the crocodile that Harvard professors taste bad. [laughter]

[4:20] But while he was in the hospital he penned a letter to his wife. There are two very different versions of this. The letter that he penned to his wife, compared against the Boston Globe's edition which says, "Harvard scientist fight crocodile with bare hands." His version to his wife was, "I'm convalescing in the hospital; had an incident with a crocodile." So for those of you that have spouses that don't travel in the field with you, you'll be here with a very much, sort of sympathize, with how that translation happens. [laughter]

[4:50] These are four people that come to mind right away for me when I think about traveling and collecting, building our collections and adventure. I've had the good fortune over the last -- better than a decade -- to put a lot of dots on the map, to go to lot of places of these naturalist went to, 15 or so different countries. We heard a lot of the difficulties and problems and diseases and dangers that you might encounter. I've had plenty of those. Most of them will be outlined in Joe's talk. These are the sort of you watch for, you do the best you can and you recover.

[5:24] But, by and large, because I'm going to talk about one of the bad ones, I want you to know that most of my trips have been very successful and really good adventures. I think that that's what one of the things that keeps me going back.

[5:36] Like Vicky was talking about, adventure really starts here in our collections on a number of different levels. I mean, it starts here for our life and we've already heard a couple of personal accounts of how collections have been important for that. It's not different in that sense for me although I was much later in life, maybe, than others. I had a false start career in the Army, which was a great place to learn field craft. But at some point I realized that it wasn't going to be satisfying and I needed to look for something else.

[6:05] I begin doing volunteer work at the Bishop Museum in Honolulu. I was stationed there in the Army at the time. I met each of the researchers in the collections there and they took time to

take me and tell me about their work, to show me the collections, and these people were having fun. I had been in the Army for almost eight years. It was OK but it was lacking in the fun department. [laughter]

[6:27] Yet what they were working on -- I mean, I started as a volunteer for a woman named Sabina Swift, sorting soil mites but it was fun. It was interesting and then I started pulling drawers in the Bishop Museum where they have 30 million specimens. It's one of these great insect collections. And I was floored - drawer after drawer of diversity. So for life adventure starts here.

[6:49] What I found is that that sort of start to adventure, that inspiration, doesn't disappear later. It just is more focused. So now my inspiration for what collecting trip am I going to go on, what taxonomic question am I going to tackle, it all starts here. It starts in the months, maybe years of taxonomic foreplay, if you will, where you go into the collection and you find a specimen. You look at these localities and you say, "Where is that?"

[7:15] You go to the map, but now you can go to Google Earth, which is a lot faster. You look at these localities and you look at their notebooks and how did they get there and what were the circumstances? Why did they only get one of these? Something very rare that you know is odd and you sort of build this level of excitement. Then you go to NSF with a big grant, and that excitement is somewhat diminished when they say no, but you keep trying. This part of the adventure, this inspiration is actually hugely important - to maintain the momentum, to go to these places and work hard to get these things.

[7:49] The particular group of insects I work on, like I said they are actually rather large beetles as beetles go, with a four millimeter or less beetle being astoundingly small in turastic kinds. The groups that Joe works on for us, that's a bit big. They are a worldwide group. The particular piece of the tree of life that I'm trying to contribute to right now has about 4,000 named species that's, I don't know, half or third of probably what's out there. All continents have them. They are often abundant. They are a big important predator in our ecological system.

[8:22] The best diversity is in the southern hemisphere on our Gondwanan continents. So, that's where most of my work has been. Now, they are not as ferocious as crocodile. I have been bitten like this a number of times, because, ounce for ounce, they try really hard. Everyone I know has always recovered with full capabilities of the tip of their finger after such attacks.

[8:46] This is a typical one. It's quite a large individual from New Zealand, one of the ones that the females burrow and provision for the larvae which is quite unusual.

[8:59] What I'm actually trying to do, just to give you a picture of, you know, I'm not just having fun in the field but there is a point to this, is to actually take this big worldwide group. The Florida 2,000 or so species that are out there and work at it in an integrative manner. We're using all kinds of data, molecular data, morphological data, behavioral data, chemical data, and work on it from the both from the top down and the bottom up.

[9:22] So building the higher level phylogenies and building and describing species. So that we can take this group from something that's kind of interesting, a bunch of specimens in a museum, to something that helps us actually explain phenomena across the planet.

[9:40] In fact, that's what Darwin and Wallace and Bates were doing when they were out collecting. Those were comparative data sets that they were making to come back and make a contribution by synthesizing across all of them. So our approach a little different, maybe a little more specific, but in some ways the goals are the same.

[9:56] So to pursue those, I've gotten to go to so many of these places, places that Darwin went, like Southern South America where he complained - if you look in the *Beagle* - that it was wet and the jungle was thick and difficult, and you would be literally walking up on the top of these piles of dead wood with meters between you and the actual ground, very difficult to collect.

[10:16] But in there, if you dig hard enough and you stay long enough, you get to the most remarkable beetles. Some of the things that I've found in here actually tie together all of these southern continents. They're well worth the effort.

[10:28] Like Bates I've had a chance to go to the New World Tropics and I put up these two guys and they're not pterostichines in our group, but they're very memorable to me. Because when I was a student before I had a chance to go on my first trip, these were in museums.

[10:43] And these were things that I fawned over and looked at and said, wow, look at this pterostichine. It's amazing. It's huge, and it's orange and black with these furry antennae. The first time I saw one in Ecuador, I saw it on the wing and I knew what it was. It's unmistakable. I took off at a full run through the jungle, because it was not going to get away. The beetle flying along, almost lazy.

[11:04] It was getting a little too high and out of net reach and I spied a dead leaning tree and sped straight up the trunk of that thing and took a swing at the pterostichine and it just shrugged me off with a little motion. Sort of like, what kind of predator are you?

[11:21] I missed it wildly and went head over heels plunging about ten feet through that dead tree to the ground where I again learned something about my own abilities and not to be too excited. In these sort of minor events the beetles begin to teach me something. You'll see many sorts of escapades if you read Wallace and Bates, of their adventures of trying to get things.

[11:41] Speaking of Bates, I had a chance to collect in Saba, literally collecting beetles from the footprints of elephants underneath the trees where there are orangutan. Into the last scraps of a remarkable forest in Ranamafan and other places in Madagascar.

[11:58] We're pitching a tent along the beautiful river to wake up in the morning to watch the lemurs, the early morning lemurs there and then to go out and collect again some of the most remarkable beetles, quite a wonderful adventure.

[12:10] Some really remote places all the way out on the Juan Fernandez Islands. This is a picture from the Mirador de Selkirk. Alejandro Selkirk was the man who was actually isolated there for a period of time on which the Robinson Crusoe story was based.

[12:27] So you can walk through the place where he stood so many days looking out into the ocean, hoping that a ship would come by. Then again, an island habitat like this, it's a taxonomic treasure that you can find by going and spending some time there.

[12:44] What I want to spend a little more time talking about is my relatively recent trip to New Caledonia. This actually will be two years ago next month that I went to New Caledonia. Wonderful place. Sort of to remind you where New Caledonia is, because people forget.

[13:00] Here we're looking at a map that shows Australia, everybody recognizes that, and New Zealand, Tasmania, New Guinea. Out here, this little sliver of land - this is New Caledonia. It lies along the Norfolk Ridge, this underwater structure in line with New Zealand. It's basically a little, cigar-shaped piece of land that has sort of a northwest to southeast tilt to it.

[13:25] It's remarkable in many ways. It's an isolated oceanic island which, of course, that always sets up for interesting biological and evolutionary conditions. But also because it is a piece of Gondwana that we think probably broke off somewhere in the 100-80 million years ago range, about the time New Zealand did. There's some debate about that. It took with it the Gondwanian inhabitants of the time and sailed out, in geological time, into the ocean.

[13:53] This had a somewhat traumatic life. It has been largely submerged. Sometimes it has had outflows that have deposited what's called ultra-basic or ultra-mafic soils on it. These soils are full of toxic substances like nickel and chrome, but very poor in nutrients. So, anything that can actually grow in these black areas on the island, which are these ultra-basic rocks, is something that has to put up with a chemically very difficult environment.

[14:24] In fact, this is a picture of a portion of this ultra-mafic habitat, which, the lights are not letting you see it so well. In here, there's about 90 percent or greater endemism of the plants. The plants are all very slow growing. They're stunted looking.

[14:39] In fact, the first time I drove into it, I wasn't sure I was whether I was looking at a natural habitat or someplace that had been devastated by people and was just trying to struggle back to growth. But it is, in fact, almost entirely endemic. Even invasives don't seem to get into it.

[14:55] The fauna and flora there are known. It's one of these listed hotspots, and one of the smallest hotspots, with a huge diversity of very interesting creatures. Modest numbers of birds; but things like the largest arboreal pigeons and flightless forest birds, fossils of rather strange looking turtles, a radiation of geckos, including some rather giant-sized geckos, as geckos go. All in New Caledonia.

[15:20] Plant-wise, it's actually pretty well known, while there's probably plenty more to find. But this is one of the groups that's been studied so we know something of its diversity there, with a huge diversity of gymnosperms, including 13 of the 19 species of Araucaria in the world. All in New Caledonia.

[15:37] This little plant here, which I guess is a little shrubby thing, Amborella, which is thought to be sister to all the flowering plants. So, botanically, it's a wonderful place.

[15:48] Entomologically, like so much of the world, it is rather modestly well known. The groups that are known, bigger showier things that have been collected, butterflies, some tiger beetles and things like that.

[16:00] But to actually get out into the nitty-gritty of the forest, to collect things that are out there in the difficult-to-get places, really, not much has been done since about 1880. That's the way the situation is for the group I went with.

[16:13] Here's just a few of these wonderful, big pterostichines from there. Not only are they interesting to collect and, I think, very attractive, but they are also part of a very interesting pattern. You'll have to search for the dots here, but these dots are on islands where large pterostichines are found.

[16:32] Large pterostichines don't do oceanic islands, oceanic in the sense of volcanic islands that have become emergent secondarily, or things that have been completely submerged and then re-emergent. The only place you find large pterostichines are continents and continental islands, Madagascar, Tasmania, New Zealand, New Guinea, and the smallest little piece, New Caledonia.

[16:53] So, for me, trying to work out these higher-level groups, particularly in Gondwana, these species are a huge attraction. Also, just to show Joe that I have some small beetles in my group, one of the most remarkable and smallest pterostichines in the world are from there. This is just under four millimeters, which is, like I said, fairly astoundingly tiny for my guys.

[17:17] This is a group that I'm actively revising, the phirinistae, very odd little guys with funny striations on the bottom that we don't know what they do with, leaving in the leaf litter in some of those deep, dark, dank corners of the forests.

[17:30] So, I went there to get these and other pterostichines, together with my colleagues from New Zealand, Thomas Buckley, Robert Hoare, and Rich Leschen.

[17:39] We went there. We were having a great time. Here we are, and we have our group collecting. The habitat there, especially in the upland, is this wonderful lush forest. It's really a pleasure to work in most of the time, a great diversity. And everything you find there are things that you've only seen in museums, if you've ever seen them at all.

[17:58] Well the reason I picked out this particular trip is not because it's a typical one, but because this is one that, in the end, turned out fine. But there is a bad period we're going to talk about here that is an interesting story. This is a trail to the Plateau Dogny that is a fairly, well-known hiking trail. It's a vigorous three-hour climb from about 100 meters to just over a thousand meters here.

[18:23] We've been there once before. I was going back because, just below the ridgeline here, maybe 50 or 100 meters down, is where I found these tiny, pterostichines. I needed to go back because I only had one at the time, and I needed some more. And so, we had done this trail once before, and I'll show you some of the way up. But I want you to note this area here is like a large catchment - that will become important later in this story.

[18:49] Most of the forest you work through, you see some human impact areas, and then you break into this wonderful forest. You keep climbing up, eventually, you get to the plateau, where it opens up, and you have wonderful views across New Caledonia. It's really a great place for hiking and views like this.

[19:03] The plateau itself is quite different in terms of the vegetation and insect fauna. Pterostichines largely drop out in the open; here they prefer a more closed forest. And most of the work, like I said, is about 100 or 50 meters down slope from this where it's scrubby and starts to get thick, and that's where I headed.

[19:23] Interestingly enough, on the way up, I encountered this particular beetle. This is Abacomorphus - one of these nice big pterostichines - out in the middle of the day, scurrying across the trail. Now big pterostichines, out during the day, scurrying across the trail is not common. These are nocturnal things that typically get under logs, or in logs, and are very difficult to find.

[19:44] And I looked at it, collected it, and I thought to myself, "Gee, I've seen that somewhere before. Where have I seen it?" I saw it in Madagascar. That happened in this other genus, Eurcarimiphus, a distant relative that looks a little similar. They would come out every afternoon when it was about to have a torrential rain. They would run to higher ground and then climb.

[20:10] The beetle is telling me something. But I was focused on those little phirinistae, and I just carried on my merry way. It was in the afternoon, and I usually collect at night, and alone. That's my typical M.O., and that's fine. The rest of my partners there were off doing their own thing, and they didn't expect that I was going to be back until late. I had my own car, no big deal.

[20:31] Here we are. We headed up the trail. And I get up in here, and we start to get a little sprinkle. I think, "This is going to be a miserable day." I don't think too much of it, and work for a little while. And then, we start to get a little thunder, and it starts to pick up. And I'm like, "Well this is going to spoil the collecting," and I start to work down. And if you've worked on any of these islands, you realize that the mud is incredibly greasy, slippery, and it gets wet. It's tough.

[20:56] So I'm working my way down. It's a bumpy ride, but I'm getting down. The rain keeps picking up harder and harder. This is a benign view of the stream - the stream that was very small and easy to cross on the way up. On my way down, I went into it, and it had become a much larger and much angrier stream.

[21:16] But it was late in the afternoon, and I was grumpy because the collecting hadn't been good because of the rain. I had wasted all this time going up, and fighting in the rain going down. I looked at the stream, and I said, "I can cross that."

[21:32] I buckled in my gear, had everything there with me that I needed, and started to cross. I got about three-quarters of the way actually. In fact, I was pretty sure another step, and I would be safely on the other side. Then my foot slipped. And for any of you that have been in water, in a tide, or a current, you will suddenly realize how puny we really are.

[21:54] I'm a fairly robust guy. I've done a lot of fieldwork. I was nothing. That stream took me down several cascades, beating me off of rocks and logs, and then, plunging me into a pool with a current. I would spin under, pop up, get about a third of a lung of air, spin under, and pop up.

[22:13] This was rather abusive, and I wasn't very happy about it. I fought really hard and finally got myself out of that current to the side, but I couldn't make the shore. And so, I got another series of cascade treatments. This time, when I hit the pool, it shoved me under a rock.

[22:30] So, there I was, under the rock. I'm scuba trained so being under the water, in and of itself, is not something that elicits panic. Everything was quiet. It's amazing, actually. I know it must have been incredibly noisy roaring of water but as far as my recollection is time dilated. It got extremely quiet. I was holding my breath and thinking now, "How long and what am I going

to do? This is not going to... I can't sustain this forever." Actually, amazing the number of thoughts that go through your head.

[22:59] So, finally somewhere back in there in the more primitive section of my brain where all that training from coaches, instructors and drill sergeants lies said, "Hey stupid, unbuckle the rucksack." [laughs] And I proceeded to fight my way to undo the straps. Somehow got out of my backpack, out of my collecting vest and everything. All of that stuff went and low and behold, I popped out on the other side of the rock and air never tasted sweeter.

[23:25] Well, the river was taking me on another set of treatments down through the cascades when I spied a log jammed between two rocks and was able to grab a hold of it. And with the water rushing over me, very carefully worked my way over to the bank, got up on the bank and passed out. When I woke up it was dark, it was night. I felt a little used. But I knew that I was still close to the water. If it continued to rain, you know, I got to get away from it. And I didn't know exactly where I was but I knew back upstream was the trail. So I thought, "All right, stand up and start working your way back up the stream."

[24:01] I stood up, I took one step. Blinding white light, I was on the ground again. After several attempts of this, I realized that the ground was an actually pretty good place to be. And I figured I'd better just wait for a little daylight, then I would probably be better. So, periodically during the night I would wake up and at this point I didn't know what was going on, but I would just vomit violently. I would sort of crawl out of that one. And I'd survived one of the longest nights that I've ever had. And I spent a lot of nights out in the field. Until I got to some pre-dawn light.

[24:33] And I finally could get up, walk back to the trail. Walked, fell, crawled my way back down the three kilometers to the trail head. Where at that time my compatriots, realizing that I usually don't spend the whole night out, had assembled a search team and they were coming to get me. So, that actually was a bit hard on me.

[24:52] So, what does it take to get six months of that special parking? Which, trust me, you don't want. Aside from the mild concussion on my head and a few stitches inside of my mouth, I had received enough of a beating that most of my body was bruised. Which has this nasty effect of releasing tons of proteins into the bloodstream. Which, I discovered, is something that can trigger your selfish kidneys to decide they're going to quit working.

[25:20] So, I had all of those things going on. I had torn off my left hamstring and partially torn the right hamstring. And ground the lining out of my right hip, mostly in the process of getting out of there. All rather unpleasant but things that you recover from when you get into the hospital and they get you hooked up with the right machinery and good chemicals.

[25:41] And, in fact, the reason I'm standing here on two legs is because of the excellent surgeons and doctors in Noumea. If I had been one of those 19th century naturalists, you can be sure that either I wouldn't be here or I would be the peg leg entomologist because of the other little treat that I got from the stream.

[26:00] And that was this streptococcus or the so-called flesh eating bacterium that got into my skinned up shins. You know, I had plenty of bruises and cuts and the shins, much of the flesh had been ground off and the whole thing. But all of these things actually are things, you know, you grow that stuff back. It's OK. But this stuff puts crocodiles to shame, let me tell you. It's not truly flesh eating. It causes your body to overproduce products that actually begin to cause it to attack

itself and you're basically liquefying yourself and the only way to get ahead of it is rather serious debridement. So, four trips into the surgery arena to remove a portion of my leg to get ahead of this with some very skilled surgeons. Got ahead of it finally and we were able to get it under control.

[26:46] Now, my career as a pantyhose model is over. But you'll see, I'm standing here and that's good. In the end... We don't have letters so, instead of writing to my wife, which I wish I could have because I could have said, "Dear Chung Hee, I had a little incident with a bacterium and I'm in the hospital." But, that not being the case, of course, we have phones, right? So, they come into the intensive care and they shove a cell phone at me with my wife in the United States, thousands of kilometers away from me. I got enough morphine in me, I'm not even sure what I said, trying to reassure her. She wasn't very reassuring. So, I couldn't quite glaze over it the way that Darlington did. And she stoically waited, not really knowing what was going on because I couldn't tell her all the details and there's a long drawn out story.

[27:34] But I survived it, with the help of those doctors and nurses and a lot of great medications. In the end, we only got to do about half of the island. Nevertheless, these specimens - probably some of the most expensive specimens given what they had to pay for my work related injury - include 24 new species of phirinistae and three new genera of pterostichines, which have proven to be absolutely essential to linking together these major lineages in Gondwana.

[28:06] So, you know, I didn't really expect to pay a price like that. It's not something that we want to do, but in the end at least I'm here. Things worked well and we have some actually really good data. The other half of the island waits for me to return, which eventually, I'll get there.

[28:20] I've already been back to the field and the thrill is not gone, it's not diminished. I'm a little slower and I check those streams a little more carefully. But nevertheless, that sort of desire to be in the field to discover and find these things is not at all diminished. And then it comes back here. So, all of the specimens from this trip and all my other trips feed back into these collections. And some of them I'll work on in my lifetime, some I may not get to.

[28:46] They'll all be in these collections. And for generations to come, those students of systematics of beetles will come to those collections. They're going to see these specimens from these strange places and they're going to read back in the notebooks and they're going to see the stories. And just like I've found that the adventure begins here. When I'm looking at the old specimens, I'm looking forward to the day when those specimens are there and other generations define them and be equally motivated to go to the field. Thank you.

[29:14] [applause]

Announcer: [29:18] This lecture is part of the Arizona State University, Darwin Quest. And is sponsored by the Institute for Species Exploration, the College of Liberal Arts and Sciences, the School of Life Sciences and is a production of Grass Roots Studio.