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CONVERSATION

In the field: an interview with Chris Wood

Chris Wood is an Adjunct Professor at the University of British Columbia (UBC) and an Emeritus Distinguished Professor at McMaster University, Canada, investigating physiology and aquatic toxicology. After completing his BSc and MSc in Zoology with Dave Randall at UBC and a PhD with Graham Shelton at University of East Anglia, UK, Wood worked as a post-doc with Brian McMahon at the University of Calgary before joining the Biology Department, McMaster University, Canada. Wood talks about his experiences on the legendary R/V *Alpha Helix* expedition to the Amazon in 1976, his development of the Tusker Chamber in Kenya and more recent adventures at the Bamfield Marine Sciences Center on Vancouver Island, Canada.

How did you become a scientist?

My high school counsellors thought I was quite good at math, so I went into a first-year math programme at UBC. But I also took zoology as an elective. The teacher was a very famous wildlife biologist, Ian McTaggart-Cowan – a giant of a man with a big booming voice, incredible enthusiasm – and he was the host of a nature TV show on the Canadian National Broadcasting Corporation. He completely turned my head. I changed my programme from math to zoology and that is why I do what I do today. I got a BSc in Zoology from UBC and I did my fourth-year honours project under Dave Randall, who has been my life-long mentor, and I stayed to do a Master's degree in his lab. Dave was always up for any adventure, so I did two field trips with him during that time. The most memorable was to a salmon run in northern British Columbia on the Bella Coola River, where we tried to measure cardiac output in the migrating salmon. I'm a fisherman, so I knew about fishing in rivers, but I'd never seen a salmon run; it's a spectacular sight. We wanted to put electromagnetic flow probes around the ventral aorta of the salmon to measure how much blood was being pumped. The surgery was very difficult under field conditions with the wind blowing and a lot of mosquitoes. Eventually, we got a flow probe working, but we didn't have a box to keep the fish in overnight, so we built an enclosure out of rocks in the river. The next morning, the salmon was gone, along with the flow probe. In those days flow probes were incredibly expensive, ~$1000 – probably the equivalent of $10,000 today. We spent 2 days walking the river hoping that the fish had died, looking at every carcass to try to find the flow probe, but we never did. It wasn't a very successful trip, but it was an eye opener for the sort of things that can happen in the field.

At what point did you realise that fieldwork would be an essential component of your research career?

During the first year of my faculty job at McMaster University, Canada, Dave Randall and Peter Hochachka organized an expedition to the Amazon on the R/V *Alpha Helix*, which was essentially a floating laboratory that could go virtually anywhere in the world. They packed it with their former and current graduate students and friends. They invited twice as many people as they had beds, so we had to 'hot bunk' and got a bed every second night. We spent 4 or 5 weeks working mainly on the Rio Negro and the Rio Solimões, the two major tributaries of the Amazon. It was an incredible experience seeing fish migrating through the grass to get back to the main river in the morning from pools that were drying up. We also saw many types of oxygen uptake modifications to every piece of the body – the gut, the skin, the buccal cavity, fins – by different fish. That really sold me on the idea of field work. When you can study animals in their natural environment, I think you learn a great deal.

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Can you take me through a day on the R/V *Alpha Helix* and what you learned from the experience?

I worked with Jim Cameron, a former post-doc of Dave Randall. We compared two closely related fish, one that was a water breather (*Hoplias malabaricus*) and one that was a partial air breather (*Hoplerythrinus unitaeniatus*). We were looking at the role of the kidney because we thought that it must be important in the evolution of air breathing. Other people were working on electric eels, pirarucu – also known as arapaima – on swamp eels, all sorts of different fish. Someone had to sit up on the main deck each night with a bag of money, because that's when the local fishermen came selling fish. We had a list of what we were supposed to buy and what not to buy. We'd keep the fish alive by pumping water into our

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Deploying the Tusker Chambers at South-West Hotsprings of Lake Magadi in 2013. Photo credit: Ora Johannsson

tanks, then we got to work in the morning in the very crowded conditions on the boat. The days were quite long, we probably worked until about 10 o'clock at night and then quit. The food was great. One of the important things on field trips is to have good food. The *Alpha Helix* had a really good kitchen, but the meals were at a certain time, so you had to plan your experiments around mealtimes. The cooks wouldn't tolerate late arrivers, but they would give you a sandwich to-go if you couldn't make the meal at the right time.

We came away from the field trip with an understanding that the kidney was important in many aspects of evolution, not just the evolution of air breathing, so we met some of our goals. I also learned to improvise on the fly. When you're working in the field, you have a general plan, but nothing ever works as you thought it was going to, so you have to be very flexible; you have to be able to pivot very quickly. That's one good reason for taking students on field trips, to learn that every experimental plan has to be flexible – even in the main lab when things are not working, but especially on field trips. You also have to look at your data as it's coming in. The only way you know if things are working is if you can actually see the data and analyse it as you go. Blindly collecting data is not a good idea on a field trip or, indeed, on any project.

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Which is the best season to visit the Amazon?

When we're collecting in the wild and working on a boat it's always best around October, November, December; the dry season, when the water levels are lowest. The fish are more plentiful and the water level is receding so it's often easy to collect fish. Our key collaboration is with Adalberto (Dal) Val and Vera Val at the Instituto Nacional de Pesquisas da Amazônia (INPA) in Manaus, Brazil. I met Dal and Vera when they were post-doctoral fellows with Dave Randall and Peter Hochachka, respectively, at UBC. Before we get down there, INPA hires native fishermen who go out and catch the fish that we need. Most of the fish are in the lab by the time we arrive. Sometimes we go out for 1 or 2 day field trips, but most of the time we work in Dal and Vera's lab. In addition, they have organized at least four or five boat trips to study fish up the Rio Negro. People flew into Manaus then we loaded our equipment onto the boat and went to a field site in the jungle. It was fantastic being so close to the fish and their natural habitat, meeting local people and working with Brazilian and international scientists.

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What environmental changes have you noticed in the Amazon over your career?

Not good ones. When I first went to Manaus on the *Alpha Helix* in 1976 it was a city of 300,000 people. Now it's a city of over 2 million. It's unrecognisable. There's also been a lot of road building, which opens up corridors for clear-cutting. There has been a lot of degradation and pollution going into the river as well as logging and farming. Since the government change a few years ago, the Amazon has been opened for exploitation. The pace of change has increased dramatically. The government has removed environmental protections, as well as protections for the indigenous peoples, and has drastically reduced the funding for science while increasing the assistance to industry. These are issues that Dal Val has been fighting.

Can you tell us how you heard about Lake Magadi and why it grasped your imagination?

I was the external examiner for one of Dave's PhD students, George Iwama. After the exam, Dave, Pat Wright and I went to see the movie 'Out of Africa' and that inspired us to find an excuse to go and work in Africa. About a week later, Dave found a paper about a fish that lived in Lake Magadi, Kenya, that could tolerate pH as high as 10. At that time, we were interested in how fish could excrete ammonia across the gills, which didn't seem possible against a pH of 10 for a variety of physico-chemical reasons. Dave said, 'I think this could be our vehicle to go to Africa'. He went on a self-funded visit to scope out the possibilities and then we wrote a bunch of grant applications to fund the expedition. We went in late 1987 and the team included myself, Dave Randall, Steve Perry, Pat Wright and Harold Bergman.

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What happened when you arrived in Kenya?

Our host at the University of Nairobi was Geoffrey Maloiy, one of the authors of the original *Nature* paper, but it was a difficult time. Back in those days, Kenya was not a democracy and Maloiy was in the opposition party, which was kind of being suppressed by President Daniel arap Moi. At the last moment, orders were sent by the government that we shouldn't go, but we were already en route. When we arrived, Maloiy said he couldn't have anything to do with us and all of our equipment was seized by customs. The authorities told us that we could stay and go on holiday, but we couldn't do anything else. We spent about 3 weeks doing 'holiday stuff' – we went on safari, out to the coast for a weekend – but were running out of money, so we decided to bite the bullet. We drove up to Lake Magadi to talk to the Magadi Soda Company, which

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was mining the lake for trona (a sodium carbonate precipitate that floats on the surface) for glassmaking. They said that we were welcome to set up experiments on the outdoor balcony of their chemistry lab. We went back to Nairobi and bought everything that we would need from aquarium shops and pharmacies: syringes, tubing, air stones, air pumps, buckets and chemicals to do simple ammonia and urea assays. We also got some curtains from the wife of the Magadi Soda Company manager to make nets and we caught the fish with them by wading in the water, which hurt because the pH is so high. If you had sores, it opened them up right away. It's amazing that fish can live in that water, it's like living in bleach.

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We also needed respirometers, so we put the fish and Lake Magadi water in 500 ml Tusker beer bottles – a fine Kenyan beer. Of course, we had to empty the bottles somehow, but that wasn't a problem, and they became the infamous 'Tusker Chambers' from our 1994 JEB paper. Each upright bottle nicely accommodated a 5 g fish. Then, we put a rubber bung in the top through which there was a needle attached by tubing to an air pump, which kept the fish alive when we were measuring whatever it was producing or consuming. To measure oxygen consumption, we just sealed the bottle to stop the aeration for a short period of time, However, we didn't have a spectrophotometer to read the various chemical assays. Luckily, all of the assays were colorimetric – produced colour changes – so we did all the assays 'eyeball-o-metrically'. We made up a lot of concentration standards, so we could see the colours they produced during an assay, and we then judged the colours of our experimental samples against this standard range of colours to determine the concentration of urea, etc., in the samples. If there was a dispute, Dave Randall made the decision, although it turned out that he is colourblind! He told us after a couple of days, but still it worked pretty well. We found out that the Lake Magadi tilapia don't excrete ammonia, they excrete only urea and they still remain the only fully ureotelic fish.

How has the situation in Kenya changed since that first visit?

We now take all our supplies and equipment as passenger-accompanied baggage, we don't ship it, which avoids most of the hassles with customs. Most recently, in 2013, we had to get permits from many different organisations and government departments. We spent maybe $15,000 on permits before we arrived and more when we were there. Also, there were a lot of wars going on in South Sudan, Somalia, Ethiopia, Eritrea – areas north of Kenya – so there was a flood of refugees in the Rift Valley where Magadi is located and a lot of bandits. It was very dangerous. Also, the Magadi Soda Company was not able to give us accommodation at the lake, so we rented a house about 70 km away. Because bandits only attack at night, we had to make sure that we got up at 5 am, drove the 70 km to the lab, did our experiments and then left by about 5 pm, so that we could get home before dark. But it was really difficult to get people to finish on time, because we all had different experiments going on. I was the team leader, so it was very stressful. Our driver would get increasingly nervous as we put off the time to leave, but fortunately nothing bad happened, even though we got home sometimes when it was dark.

Tell us about UBC's Bamfield Marine Sciences Centre and your current field research there

Getting to Bamfield is always an adventure. We load up a truck in UBC and we put it on a ferry that takes us across to Vancouver Island. Then, we drive for a couple of hours before joining the logging road, which is always an adventure. It's a gravel and dirt road where you encounter very large logging trucks coming around corners at high speed. They have the right of way because it's a private road. Many times you blow out tyres or you have mechanical problems. The worst is when our truck breaks down half-way along the Bamfield road because then you have to arrange for someone to come and tow you. Bamfield is very isolated. Once you get there it's a really good basic lab with standard stuff like distilled water, ovens and hot plates. If you want to do anything fancy, you bring your own equipment, but it has a good support team with a helpful research coordinator and a full store room, which we're welcome to browse. The staff also help us to catch fish and they have internet now. Currently, I'm working on a variety of projects including the physiology of feeding in sculpins with Bernd Pelster, metal effects on marine invertebrates with Camila Martins and gill transport mechanisms in sharks with Gudrun De Boeck.

How do you address language and cultural differences when you're working in international locations?

I don't see language as a big problem. English has become more prevalent over the years, so you can get by, especially with translation apps on your phone. However, having a local person who you trust as your driver or communicator is important, because of local customs and culture. In Kenya, we've had the same drivers for many years, George Muthee and his son Dishon. Sometimes when we were talking to someone, I'd ask George, 'What does he really mean?' and he'd say, 'Oh Chris, it means that you're going to have to pay him', or, 'He means that he needs to talk to his wife before he can let you on their land'. It's so important to have a local person to help, we just wouldn't understand things like that without George and Dishon.

If you were advising an early career researcher planning their first field trip, what would you recommend?

First, I'd tell them to make sure they have a local scientific host – they are invaluable in sorting out problems. We have been so lucky in having the Vals in the Amazon and various Chairs of the Department of Veterinary Anatomy at the University of Nairobi in Kenya as our hosts over many years. Second, I'd tell them to make lists of everything that they might need. If in doubt, if you think it may not be available where you are going, bring it with you. The third thing is, don't have fixed ideas, go with an open mind and if something is not working, be prepared to pivot and switch. You cannot be dogmatic, because every field trip has its own challenges; the animals may not be available, the weather may change, there may be rules you didn't know about. You just have to be able to cope, to be very flexible. The last thing is, be prepared to work very long hours, you need to bring a high energy level to field work. Working in the field is not nine to five.

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Chris Wood was interviewed by Kathryn Knight. The interview has been edited and condensed with the interviewee's approval.