

# 19

## Thinking Bigger



An *Atelopus spumarius* stands up to get a better view. In general, our perspective on the conservation of Amazonian frogs is little better than that of this tiny creature.

In 2000, we decided to install a trail system to give access to the more remote parts of Reserva Ducke<sup>53, 76</sup>, and as a result we found a piece of land on the northeast corner of the reserve that we could buy and save a bit of forest. A stream, IgarapéTinga flows out of the reserve at that point and through our land, and its clear cool water provided a playground for our daughter and her friends when she was growing up. However, it was not only the kids who enjoyed the stream. We found frogs with beautiful green reticulations on their backs that hopped around the stream during the day. In 20 years of camping on the other side of the reserve, we had never seen one.

The species was *Atelopus spumarius*, and Albertina's students showed that it occurred only in the eastern watershed of the reserve<sup>77</sup>. Frogs of the genus *Atelopus* are bufonids, and the *Atelopus* radiation produced an astounding variety of mostly brightly colored species in the Andean highlands, stretching from Central America to Bolivia. Although, very beautiful in comparison to most other frogs, I joked that the species in Reserva Ducke was the ugly duckling of the *Atelopus* World.

I had seen an *Atelopus ignescens* in the Ecuadorian Andes in 1986. It looked like a clockwork toy as it slowly walked across the carpet of sphagnum moss, its dark black color contrasting with the bright green of the soggy mat. When I turned it over, I saw that its undersides were bright orange and I assumed that its startling colors and slow movements meant that it was too poisonous for any predator to eat. However, its defenses were only against vertebrate predators, and useless against a particularly virulent micro-organism. A chytrid fungus devastated the species, the last individual was seen in 1988, and it is presumed extinct.



In 2016, Albertina, Jeni, Adam Stow and I climbed to the top of Mount Roraima in southern Venezuela. The table-top mountain is said to be the inspiration of Sir Arthur Conan Doyle's book, *The Lost World*. To keep the number of visitors down and support local porters, you need to do a two-day trek through the Gran Sabana to reach the base of the mountain, even though it would be easy to drive there in a four-wheel-drive vehicle. The climb along the jagged fault line, which is the only way up the vertical cliffs, takes the best part of a day and leaves your leg muscles aching. None-the-less, between three and four thousand hikers scale the mountain each year.



**Photo 19.1** A darter of the genus *Characidium* and a catfish of the genus *Trichomycterus* from rivers of the Gran Sabana. Photos by Bill Magnusson.

There are no fish on the top of Mount Roraima, but we camped near the banks of the T&k River in the Gran Sabana on the first night, and near an unnamed stream at the base of the mountain on the second. We were hot from the long afternoon walk when we got to the first camp and eagerly headed down

to the river for a swim. Two German tourists who were accompanying us said that the water was warm, but that must have in comparison with European rivers! We were hypothermic after a short wash and I wasn't about to lie in the water at night, but I could stand up to my calf in the clear water and hold my waterproof camera close to the bottom without shivering too much. I photographed a species of darter in the genus *Characidium* that lay on the bottom propped up by its fins. A beautiful freshwater crab that was flattened and shaped like a leaf would have been easier to photograph if it hadn't unexpectedly ran out of the water instead of heading for a deeper spot as I had expected. Two species of hylids were calling from the edge and I speculated that they must put their tadpoles in the river with the fish.

The only fish I found in the stream at the base of the mountain was a tiny catfish of the genus *Trichomycterus*, which Jansen tells me is likely to be an undescribed species. The water was even colder than in the T & R River, and I had to hold the camera against the rocks to stop shaking. I also couldn't identify the treefrog calling half-submerged on the edge, but I was able to photograph its newly hatched tadpoles suspended in clear jelly from an underwater branch. They were little balls of protein that would make succulent morsels for the tiny catfish and I assumed that they must be unpalatable for vertebrates. However, I wasn't about to put my hypothesis to the test by eating one and risk diarrhea on the long ascent of the escarpment.

There are many reasons to climb into the clouds that surround the top of the mountain, but I was especially interested in seeing the tiny frogs with the scientific name *Oreophrynella quelchii*. They are bufonids, but only distantly related to the *Atelopus* of the Andes. The first we found was walking across a patch of moss, and I remembered the *Atelopus ignescens* I had seen in the Ecuadorian Andes 30 years before. It was coal black and walked across the green carpet with the same jerky movements. Our guide picked up the frog that

was only the size of her fingernail and turned it over to show its bright yellow belly. It was a marvelous example of convergence in color and behavior to adapt to the demanding conditions of life on mountain tops.



**Photo 19.2** On the left is the extinct *Atelopus ignescens* from Ecuador and on the right is a living *Oreophrynella quelchii* from Venezuela. Photos by Bill Magnusson.

I was thrilled to see the species, and we came across many more individuals, some of which Albertina, Adam and Jeni saw eating flies with their long extensible tongues, like chameleons or the frogs in children's cartoons. However, the experience with the *Atelopus ignescens* made me apprehensive. What if one of those thousands of tourists was to bring in a disease to which the little black frogs had no resistance? Might we lose the last of South America's black mountain frogs?



Today, *Atelopus spumarius* of lowland Amazonia is one of the most colorful of the *Atelopus*, because most of the spectacular species in the Andes have been driven to extinction by the chytrid fungus. There are still some Andean *Atelopus* left. In 2014, Luis Alberto Rueda Solano, better known as Beto, took us to a location in the Serra Nevada of Colombia where we could see a rather nondescript nocturnal species, *Atelopus laetissimus*, which lived around a rocky stream. We had to soak our boots in disinfectant before walking into the forest to avoid introducing the fungus, and Beto showed us photos of a more spectacular species of *Atelopus* that still lives in the highest parts of the Serra Nevada. Beto is extremely careful not to spread the fungus, but the Chytrids have dispersed naturally to many other remote regions, and it is probably just a matter of time before these species follow their relatives to extinction.

Fortunately, the chytrid fungus apparently only reaches its greatest destructive potential in the relatively cool highlands<sup>78</sup>. Species in warmer lowlands are relatively resistant and we hope that the *Atelopus* in the lowlands of Amazonia, such as *Atelopus spumarius*, will one day provide the stock that will allow resistant varieties to once again radiate into the Andean highlands.

The *Atelopus* story brought home to me the importance of putting our observations at Reserva Ducke into a larger picture. Marc Hero has been studying the effects of chytrids for many years, and even invited me to co-author a paper on the characteristics of the disappearing frogs of Australia<sup>79</sup>. However, my limited hearing meant that I took a long time to find out anything about frogs. Fortunately, Albertina could distinguish their calls easily, and that allowed her to quickly sample wide areas.

Albertina was especially interested in frogs of the genus *Allobates*, which

used to be known as *Colostethus*. Most of these relatives of the poison-arrow frogs are small and drably colored, and don't attract the attention of their more colorful brethren. However, Albertina had followed frogs of each species for hours and knew that their behaviors often differed spectacularly. There were species that laid eggs on fallen leaves and carried their tadpoles to water, species whose tadpoles developed directly into little frogs while on the leaves without ever going to water and even species that leapt up and hung onto the underside of green leaves to lay their eggs.



**Photo 19.3** *Atelopus laetissimus* is nocturnal and lacks the bright colors of most of the diurnal Andean *Atelopus*. Photo by Bill Magnusson.

When I first arrived in the Amazon, only two species of *Colostethus* were generally thought to occur in the Amazonian lowlands. Small brown individuals with a dark stripe down the side were called *Colostethus marchesianus* and individuals with a dark hour-glass pattern on the back were called *Colostethus*

*brunneus*. Albertina went to the type localities for these species and showed that they were distinct from the *Colostethus* in other localities and had relatively restricted distributions. There were obviously two species of *Colostethus* in Reserva Ducke, and Stephen Edwards had described several other species based on museum specimens in his unpublished Master's thesis.

When I visited Ron Heyer at the Smithsonian Institution in Washington, he showed me Edward's thesis and lent me specimens of the species he had described. I brought a copy of the thesis to Manaus and Márcio Martins later published a description of one of the species, giving it the name *Colostethus* (now *Anomaloglossus*) *stepheni* in honor of the person who first recognized it as a new species. We would later find out that the species at Reserva Ducke we called *Colostethus marchesianus* was in fact *Allobates sumtuosus*, which had been described by Victor Morales in 2002 based on specimens from a site a few hundred kilometers away.

Two species of *Allobates* (*Colostethus*) was not a lot to deal with and later genetic studies showed that the large colorful *Epipedobates femoralis* was also a species of *Allobates*. However, Reserva Ducke was an exception in having few species of the genus. Almost everywhere else Albertina went she found four or five species of *Allobates* where most people had assumed that there was only one or two.

The descriptions of most species of *Allobates* in the literature, which were based on formalin-preserved museum specimens, were so poor that Albertina had to go to the type localities of most of the previously described species and redescribe them before she could confidently identify new species. The problem was that, if there were four species at the type locality, which one had been described?

Albertina asked me to accompany her to Uruá in the Amazon National Park, where Lyn Branch had done her studies of *Phyllomedusa vaillanti* tadpoles. Ron

Crombie, who Lyn had recruited to help with the survey of the park, had collected a species of *Allobates* and Victor Morales described it in 2002 based on preserved specimens. Albertina wanted to redescribe the species based on color in life, vocalizations and mode of reproduction, and to describe the tadpoles.



**Photo 19.4** A male *Anomaloglossus stepheni* calling in Reserva Ducke.  
Photo by Albertina Lima.

The base was much as I had remembered it, but the wooden buildings had deteriorated in the intervening 20 years. We went to the lookout in front of the base and I felt great sadness as I looked down onto the river, which was several kilometers across at that point and graced with turbulent rapids that often made boat travel dangerous or impossible. The river is currently being dammed at that location and I probably will never again see the rapids of the mighty Tapajós.

It was 4 a.m. when Albertina woke me and we walked out into the dark forest. The track wound through low regrowth towards a valley that led to the river. I

could hear many sounds, but they just merged into a cacophony of chirps and whistles, and I could not distinguish the calls of frogs from those of the crickets and the dawn chorus of birds. Albertina signaled me to stop and pointed into the undergrowth. I could hear nothing, or perhaps I should say that I could hear everything, but distinguish nothing. She said incredulously in Portuguese “Can’t you hear that? You go around the other side.”

I thought “Hear what?” and followed her off the track. She seemed to be concentrating on a patch of leaf litter at the base of a small tree and I circled around to the other side. As she was pointing eagerly at the ground in front her, I knelt down and started to crawl forward. When I was about two meters from her I heard a faint chirping sound, but couldn’t make out where it came from. Albertina exclaimed “There it is!” and pointed to a spot a short distance in front of me. It was still dark, but I could see the tiny white vocal sac of a frog the size of my thumb nail vibrating on the point of a fallen leaf. The call now seemed louder and I was surprised that I couldn’t hear it before. Perhaps I needed my eyes to hear it!

Albertina said in Portuguese “You film that one while I find another.” I carefully unpacked my camera, happy to be able to do something useful at last. I had relatively basic, but effective, equipment. Although I am not very technologically oriented, I realized early in my career that a picture is worth a thousand words, and later found that video was worth reams of script<sup>80</sup>. Albertina had been impressed by the first photos of frogs that I showed her, but after I pointed out the faults, such as that the frog was not in a natural position or that its iris had contracted because of the artificial light, she never again enthused over my photography. I had just finished accumulating photos of all the frogs of Reserva Ducke and we were ready to publish a field guide when the digital photography revolution began. Albertina looked at our first photos with a digital camera and said in Portuguese “Those old slides aren’t good enough now – you’ll have to start again!”



*Photo 19.5 Sunset over the Tapajos River in front of the research base in the Amazon National Park. Photo by Bill Magnusson.*

The most important piece of equipment for filming small things, or things that are far away, is a tripod. Almost any will do, but if you have an expensive one with a head that swivels easily and smoothly you will avoid many lost opportunities. A good light is also essential for filming in the early morning or even during the day in the gloom of the forest. I set up the camera and started filming with an infrared light that the frog couldn't see, but I soon found that he was so emotionally wound up and obsessed with his serenade that I could switch to visible light.

I lay on the ground, which is a good way to collect the tiny red mites called chiggers that like to burrow into the skin of your more sensitive regions. However, there were few mosquitoes. Filming frogs around the white-water rivers, such as the Amazon, can be excruciating. When you bend over, the

clothing stretches and makes it easy for mosquitoes to push their proboscis through. You don't want to squirm, but their sucking becomes unbearable and you risk disturbing the frog by moving position, but this usually just results in the mosquitoes moving from your back to your buttocks or testicles.

Close up, I could see that the apparently nondescript frog had beautiful, almost luminescent blue-white dots scattered over its side, and the vocal sac was yellow rather than white. It was no wonder that most people couldn't distinguish the species of *Allobates* – they generally looked at them from too far away, and never when they were doing what comes naturally in their native environment. I realized that most professional herpetologists were more like stamp collectors than bird watchers, and that was why their descriptions left so much to be desired.

Filming and photographing allowed me to register things about the frogs that I never would have seen if I hadn't had to spend hours getting close and waiting for them to act naturally. Perhaps that is why photographers are often such avid naturalists. However, I wasn't a frog photographer by vocation, I photographed them because my ears were too poor to find them myself. That led to some complicated decisions about authorship of the photos. Who was responsible for the photo, I who had endured the mosquitoes and tweaked the dials on the camera, or Albertina who found the frog and put me in position? In the end, we just left the authorship off the photos in the books we published.

There were four species of small brown *Allobates* in the park, and that led to some tricky questions as to which species had been described by Victor Morales. It even seemed that the type series included individuals of more than one species. Albertina finally got things sorted out and even named one of the new species after me<sup>81</sup>. I was honored, but Albertina has been my wife for over twenty years and I guess it doesn't count as much if you have slept with the person who named the frog after you!



**Photo 19.6** *The first photo of a frog, *Pristimantis fenestratus*, taken with Albertina's digital camera, which led to her rejecting all my slides for our frog book.*  
*Photo by Bill Magnusson.*

We don't know how many species of *Allobates* there are in Amazonia, but there must be many more than have been described. Even Albertina's many expeditions left large areas unexplored, and it is getting harder to find students willing to do field work. Lorena Carneiro<sup>82</sup> used Albertina's data to investigate the possibility of using species-distribution models to fill in the gaps, but she concluded that they work poorly in the Amazon and the species that most need to be modeled are exactly those for which we don't have enough data for analysis.

Our studies had shown complex ecological relationships between frogs and fish, and we had published many other papers on the natural history of amphibians. Almost all the papers started with a platitude of the type "It is important to have natural-history information to conserve species, and the information in this paper may be of use to someone." Unfortunately, the

proverbial someone never showed up and we found that few conservation decisions were made on the basis of natural history, except in the case of very large iconic species of cultural or economic significance, such as monkeys and migratory catfish. In the Amazon, the biodiversity is just too great for most decisions to be made on the basis of the natural history of individual species.

The major land-use decisions were being made in relation to large government infrastructure projects, and Albertina started working in collaboration with institutions doing environmental-impact statements for hydro-electric dams. These resulted in some scientific publications<sup>83</sup>, but they also showed that, despite their alleged sensitivity to environmental impacts, the frogs were little affected. Perhaps I should clarify what I mean by little affected. Obviously a large hydro-electric dam will flood a large area and kill many individuals of the species that occur there. However, hydro-electric dams cover only a small portion of the distributions of most Amazonian amphibians, and no species is known to depend only on resources found in the impacted areas. Perhaps our largest contribution was economic, showing how to analyze the data and avoid the common problem of biologists crying wolf with no solid information.

In contrast to the frogs, many species of fish are severely affected by hydro-electric dams. The large migratory catfish are often stopped by them, even when fishways are built to bypass the turbines. Many species of fish are only known from rapids, especially in the clear-water Rivers, such as the Tapajós and Xingu. If all the plans for dams in the Amazon come to fruition, there will be virtually no turbulent white water in the Amazon, except that which flows over spillways. Most of the headwaters of the Amazon are already dammed in the Andean countries<sup>84</sup>.

Questions of conservation in the Amazon are complex and mixed with doubts about food security, energy security and economic development. Few of them will be resolved based on the natural history of a few species of fish or frogs.

Each region has its own problems and a different range of possible solutions. If biologists are going to contribute to those solutions, they are going to have to come out of their safety zones and learn to think big<sup>85</sup>.



**Photo 19.7** An *Allobates magnussoni* from the Amazon National Park on the Tapajós River. Photo by Albertina Lima.

