We have been in lockdown, but deforestation has not

Douglas C. Daly[a,1]

Edilson Consuelo de Oliveira has regained his sense of taste and smell, so he has finally been able to enjoy a plate of pirapitinga, his favorite fish in all the Amazon. Before contracting coronavirus disease 2019 (COVID-19), Edilson had been in lockdown on a small farm outside of Rio Branco, the capital of Acre state in Brazil, but in early June a nephew came to visit from the city, bringing a dry cough. Edilson was hospitalized for only two days and felt ill for two weeks; since then he has been recovering back on the farm. It's lucky for him and for the Amazon, because Edilson is a "super-mateiro," or master woodsman, one of a handful in that vast region (see Fig. 1). Edilson is something of a taxonomic shaman, as he can name hundreds of species of Amazonian trees on sight and is familiar with several thousand more.

Rarities like Edilson are highly sought after by researchers, forest concessions, and conservationists. That is because any valid effort to conserve or manage biodiverse tropical forests requires that we know their species composition. However, now that the pandemic has put much of nature at a distance, field-based biologists have had to take stock: What can we be doing now? What must we do when the coast is clearer and we can safely travel to our study sites once again? Most importantly, why must we never let up in our efforts to buttress conservation programs and train new cohorts of researchers and super-mateiros?

Unlike millions of citizens residing in COVID-ravaged countries, devastation of tropical forests has not been in lockdown. Deforestation in Brazil was up 72% between August 2019 and May 2020 in comparison with the previous year, giving rise to a horrifying new metric: more than half a square mile of deforestation per hour (1). And the annual August–September "burning season" in Amazonia is still heating up.

There is nothing inevitable about this situation. For example, Brazil's environmental institute, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), was able to reduce deforestation in that country by 80 percent between 2004 and 2012 through satellite detection and on-the-ground enforcement (2). But times have changed. Some governments are using the pandemic as a smokescreen to eviscerate regulations and slash the staff and

Fig. 1. Although the pandemic has put much of nature at a distance, Douglas Daly (*Left*) asks what field-based researchers can be doing now, what should be done when it's again safe to travel to study sites, and how to best train new cohorts of researchers and super-mateiros like Edilson de Oliveira (*Right*).

[a]Institute of Systematic Botany, The New York Botanical Garden, Bronx, NY 10458-5126

The author declares no competing interest.

[1]Email: ddaly@nybg.org.

First published September 16, 2020.

operating budgets of key government agencies (2–4). Environmental protections become both blind and toothless. Meanwhile, deforestation is spiking along with COVID-19.

"Tele-Communing" with Nature

With fieldwork unavoidably on pause because of COVID and access to our labs and preserved specimens restricted, what have field-based biologists been able to do to advance our knowledge of the natural world and bolster its sustainability? Quite a lot, as it turns out.

A top priority has been to strengthen the many international networks we have built over decades, ranging from research colleagues and government agencies to local nongovernmental organizations (NGOs) and remote forest communities. We've also been working with our host-country collaborators to secure adequate support for training, training, and more training, from Ph.D. systematists to woodsmen. We must keep in mind that although biological collections and research programs worldwide have been slammed financially during the pandemic (5), many of our counterparts in the developing world face slopes made much steeper by deep cuts in funding and personnel.

We field-based biologists all have multiple projects underway, as well as piles of data to crunch and results to write up and publish. We also have a battery of resources at our disposal. In recent decades, natural history museums worldwide have contributed incalculably to our work by digitizing millions of specimens and making them available virtually as high-resolution images linked to field data; an example is the C. V. Starr Virtual Herbarium of the New York Botanical Garden [NYBG (6)]. These go hand-in-hand with the hundreds of thousands of scientific articles freely available electronically, including many thousands of historical references, once the treasures of a few rich institutions but now scanned and posted online for all to use (7).

Copious data and precious online resources enable us to continue our role as biodiversity detectives during lockdown. On a macro scale, we can combine DNA analyses and physical features of organisms to understand the evolution of adaptations and of lineages and their ancient migrations. We can also document diversity on a finer scale, completing manuscripts for new species of plants, fungi, and lichens from Myanmar, Peru, Tennessee, and beyond. To give an idea of the immensity of the biodiversity that remains undocumented, on average a new species of plant from Brazil is published every two days (8), with no end in sight.

Rebooting the Meaning of Research

Such biological frontiers are not just romantic concepts with appeal for curious outsiders and academic insiders; more than just publishing results, much of our work builds toward a convincing weight of evidence and argument. It is our job to inform the choices of decision makers that bear on the protection and management of the organisms and biomes that we devote our professional lives to understanding. These choices have enormous consequences for health and well-being beyond political borders. For example, excessive deforestation in Amazonia means drought in São Paulo, Brazil, pulmonary problems from forest fire smoke blanketing lowland Bolivia, and, as it reaches the tipping point toward savannification, progressive loss of livelihoods for some 30 million people in the nine countries that Amazonia's forests embrace. Globally, the Amazon's trees—still in the billions—absorb 2 billion tons of CO_2 per year, or 5% of annual emissions, making it a vital buffer against climate change (9). But for how much longer?

Amid all the bad news about degradation of people, of institutions, and of nature, each newly named species, each revealing analysis, each scientific step forward, is a small triumph of affirmation: something positive, constructive, resolved—even if it's the identification of a rare and endangered tree. The results of our many international collaborations allow us to assess the conservation status of such species, to call attention to their occurrence in areas proposed for protection, and to improve the accuracy of the forest inventories that form the basis for sustainable management.

Pending renewed access to the biomes we study, we field-based biologists must prepare to hit the ground running. We need to drum up government and private support so that our collaborative work can continue, enhanced, post-COVID. Support should come from international aid agencies and research consortia, the "BINGOs" (Big International NGOs), academia, and government agencies, and it should come in many forms: personnel, fellowships, individual projects, and help with logistics and red tape. International training grants should be at the heart of this response.

Amazonia has some compelling initiatives focused on management and conservation of its still poorly explored flora, but they need to be conducted on a scale that the region's size and importance demand. Almost none of them are. In one of the rare partial exceptions, Brazil's biodiversity institute Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), is coordinating a remarkable project on a number of sites across the Amazon, which is training representatives of communities in protected areas to monitor wildlife and tree populations and, ultimately, the health of their forests.

With my Brazilian colleague Flávio Obermüller, a freelance ecologist working with me for NYBG, I am coordinating that project's tree-monitoring component, with Edilson as the linchpin who knows the trees best. In our early collaborative workshops I trained Edilson, but now his knowledge of the Amazon's forest flora greatly exceeds mine. And that's the whole point. We have developed a multi-institutional program for training future generations of Amazonian super-mateiros, with large inputs of time and logistical support from staff at ICMBio, the Rio de Janeiro Botanical Garden, and the Brazilian Forest Service. However, such training initiatives require massively more governmental and foundation support, enough

to train and sustain a small army of apprentices. Our team as it stands can't be everywhere at once, so scaled-up propagation of international collaborative programs like ICMBio's would provide oversight throughout the Amazon Basin by communities invested in the future of the forests where they live.

Until our study sites are safe enough for the return of botanists and other field-based biologists, we can of course confer with our counterparts across the globe and easily access mountains of data and images. However, "tele-communing" with nature works only up to a point. There is no substitute for the real biological world, where the processes we study are actually underway. We can be productive remotely for quite a while, while shoring up our counterparts in less fortunate countries with human and financial resources. But ultimately we get our nourishment from fresh data and the new puzzles the forest has to offer. We are aching to rejoin Edilson de Oliveira and future Edilsons with our boots on the ground—and up in the trees. We can almost taste it.

Acknowledgments

Support for my recent and current projects at NYBG comes from the Tinker Foundation, the Ford Foundation, and the Leo Model Foundation. I thank Dennis Stevenson for critical insights.

1. H. Escobar, Pesquisadores temem explosão de desmatamento em 2020. *Jornal da USP*, 5 June 2020. https://jornal.usp.br/ciencias/pesquisadores-temem-explosao-de-desmatamento-em-2020/. Accessed 20 June 2020.
2. J. Spring, S. Eisenhammer, Exclusive: As fires race through Amazon, Brazil's Bolsonaro weakens environment agency. *Reuters/Environment*, 28 August 2019. https://www.reuters.com/article/us-brazil-environment-ibama-exclusive/exclusive-as-fires-race-through-amazon-brazils-bolsonaro-weakens-environment-agency-idUSKCN1VI14I. Accessed 20 June 2020.
3 E. Gonçalves, Ricardo Salles fala em aproveitar a pandemia para 'ir passando a boiada''. *Veja* (22 May 2020). https://veja.abril.com.br/politica/ricardo-salles-fala-em-aproveitar-a-pandemia-para-ir-passando-a-boiada/. Accessed 20 June 2020.
4. C. Davenport, L. Friedman, Trump, citing pandemic, moves to weaken two key environmental protections. *The New York Times*, 20 June 2020. https://www.nytimes.com/2020/06/04/climate/trump-environment-coronavirus.html. Accessed 20 June 2020.
5 E. Pennisi, Shuttered natural history museums fight for survival. *Science* **368**, 1042–1043 (2020). , https://science.sciencemag.org/content/368/6495/1042?utm_campaign=toc_sci-mag_2020-06-04&et_rid=97148884&et_cid=3352260.
6 The New York Botanical Garden, The C. V. Starr Virtual Herbarium. https://sciweb.nybg.org/science2/VirtualHerbarium2.asp.html. Accessed 20 June 2020.
7 Biodiversity Heritage Library, https://www.biodiversitylibrary.org/. Accessed 13 August 2020.
8 M. Sobral, J. R. Stehmann, An analysis of new angiosperm species discoveries in Brazil (1990–2006). *Taxon* **58**, 227–232 (2009).
9. A. J. Kaiser, AP Explains: Role of the Amazon in global climate change. *AP News*, 27 August 2019. https://apnews.com/384fdb5ee7654667b53ddb49efce8023. Accessed 20 June 2020.