Inaugural (2021)
Dr. Gregory D. Bossart Memorial
One Health Scholarship
Final Report

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Receiving the inaugural Bossart Memorial One Health Scholarship helped me greatly in achieving my dissertation research aims as well as in making an impact on wild chimpanzee and pediatric health in rural Western Uganda. Addressing a complex issue in the tangled web of human, animal, and environmental health through a One Health framework is always necessarily ambitious. Investigations of causality must be both broad and thorough, and solutions must be creative and interdisciplinary. For these reasons, the opportunity for a doctoral student to use $5,000 for One Health research is a true "game changer." Few awards of this size are available to predoctoral researchers in this field; the Bossart Scholarship is truly a special opportunity.

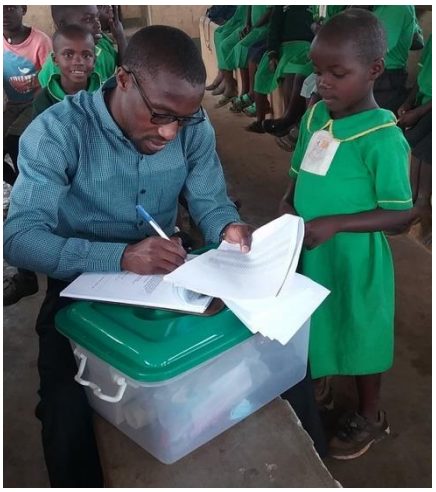
My dissertation research, funded in part by the Bossart Scholarship, addressed lethal respiratory disease outbreaks in a population of wild chimpanzees living in Kibale National Park, Uganda, which previous research has shown have been caused by human pediatric "common cold" respiratory pathogens, such as rhinovirus, metapneumovirus, and parainfluenza virus. These findings alarmed researchers, national park staff, and other wildlife conservation stakeholders, because it was unknown how these viruses, which circulate predominantly in preschool-aged children and generally cause mild upper respiratory tract infections, could find their way into protected chimpanzee habitats. Moreover, the transmission patterns of these viruses are relatively understudied, particularly in lower- and middle-income countries, compared to pathogens that tend to cause more clinically severe disease in people.

Therefore, the main objective of my study was to determine which respiratory pathogens infect people near Kibale National Park, the seasonal patterns of those pathogens, and how they move from humans to chimpanzees. As stated in my proposal, we utilized the Luminex NxTAG Respiratory Pathogen Panel to screen biological specimens (nasopharyngeal swabs from adult forest workers and children living in communities surrounding Kibale and fecal samples from chimpanzees, collected between May 2019 and July 2022) for 20 common human respiratory pathogens, which include all known pathogens implicated in previous chimpanzee outbreaks. A challenge we faced since submitting the proposal was that the NxTAG panel updated to include SARS-CoV-2, a significant human respiratory pathogen during the study period and one of existential concern for wild ape health, was more expensive at $4,800 per 95 samples than the original panel. Consequently, we prioritized chimpanzee outbreak

samples and human samples associated with severe reported respiratory symptoms to maximize the likelihood of identifying high-risk pathogens. The remaining $200 from the scholarship was used for reagents for RNA extraction and reverse transcription to prepare raw samples for use with the NxTAG panel.

The benefit of running these targeted samples cannot be overstated. I analyzed critical pilot samples from after the emergence of SARS-CoV-2, which allowed identification of all high-risk pathogens detected previously in the Kibale chimpanzees that were circulating regularly in children living near the park. SARS-CoV-2 infections were extremely rare in our human study population (only five cases in nearly 2,000 swabs) and thankfully absent in the chimpanzee samples. Crucially, when "common cold" pathogens were detected in adult forest workers, infections were predominantly asymptomatic. These findings supported our overall hypothesis that symptoms-based screening tools for adult workers entering the forest, meant to protect chimpanzees from human pathogens, are insufficient. Improved biosecurity practices that explicitly recognize the role of asymptomatic shedding of respiratory pathogens, as well as strategies to increase compliance for practices already in place, would be more effective.

Additionally, human respiratory infections plummeted during COVID-19 lockdown. Nonpharmaceutical interventions intended to protect against COVID-19, such as social distancing, masking, and increased handwashing, helped reduce the incidence of other common respiratory pathogens, too. In concordance with this finding in people, the Kibale chimpanzees did not experience any respiratory disease outbreaks during lockdown and did not until February 2023, an entire year after children returned to school and "common cold" pathogens started to circulate again.



These exciting results had important ramifications for the success of this ambitious One Health project as a whole. These preliminary data allowed our team to secure a roughly $60,000 grant from the Arcus Foundation to test all 2,000 human nasal swabs and every fecal sample from chimpanzees experiencing clinical respiratory disease throughout the entire study period. The Arcus grant also allowed us to expand the study to three other great ape field sites in Uganda, Budongo Central Forest Reserve, Bulindi Township, and Bwindi Impenetrable National Park, and bring two Ugandan colleagues to the U.S. to learn the molecular diagnostic techniques used in this study.

To our knowledge, this is the largest prospective cohort study of its kind for children in rural Uganda and thus an invaluable dataset. In addition to our findings that support improved measures for wild chimpanzee health management, we identified opportunities for targeted interventions to improve pediatric health in the region. For example, our data showed that young schoolchildren were most likely to get sick in the month of February

(the start of the Ugandan school year) and that children at one of the three primary schools in the study experienced more respiratory disease on average than at the other two schools. When I traveled back to Uganda in early 2023 to disseminate results to study participants as well as conservation and human health stakeholders, local public health officials were very concerned about the primary school with the most respiratory disease and implemented interventions such as building another classroom to reduce overcrowding and paving over dusty dirt floors with cement. Our team has also helped install mobile handwashing stations at these primary schools with the hope that respiratory health in local children, and by extension chimpanzees, will be improved in a more sustainable long-term solution than the societal lockdown endured during the pandemic.

In addition to its contributions to pediatric health and ape conservation, this project also offered me experience managing a One Health initiative—one that has been both international and multisectoral, involving cutting edge molecular techniques, field epidemiology, and capacity building for One Health capabilities in another country. I am immensely grateful to have received the Bossart Scholarship in order to gain these skills during my graduate training.