

COVID-19:

Reflections from Entomologists Who Rose to the Occasion

The COVID-19 pandemic forced most entomologists to rearrange their professional and personal lives significantly, affecting research, teaching, extension, and outreach programs worldwide. Changes to entomology programs stimulated by the pandemic in 2020 may very well have long-lasting effects far into the future.

We invited multiple authors to share major takeaways, new ideas, and surprising experiences related to the constraints resulting from the pandemic. The authors represent many types of programs and positions, including (but not limited to) teaching, research, extension, and outreach, among the broad categories of academia, government, industry, and other types of employment. The authors graciously shared their stories of adjustments to demonstrate how entomologists in various careers stepped up to the plate during an unprecedented situation.

The stories that follow reveal both professional and personal reflections at a time when the pandemic persists. We can all learn from their practical and heartfelt contributions.

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SUPPLEMENTAL MATERIALS
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David Coyle at home with his two sons.

Frantic Changes, Asian Longhorned Beetle, and Homeschooling: My Extension Program During COVID-19

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I have an extension and research program in forest health and invasive species, and the immediate aftermath of our university's travel shutdown was a mad scramble of logistics. I applied for grant extensions and worked with our county agents to cancel, reschedule, or convert in-person speaking events and programs to online formats. After logistics were handled, new presentations were completed, and grant extensions were given, I breathed my first sigh of relief—my extension ship was no longer sinking.

Since 2015, I've embraced technology as part of my extension program, so I wasn't in as bad a spot as some of my colleagues who had not. Radio, video, and podcast interviews are easy to do remotely, and fact sheets are still popular. I continued giving webinars and online training modules (professionals still need their CEUs). Much of my work was business as usual—sans travel or site visits.

Just when I thought I had things figured out, South Carolina became the sixth state to discover an active infestation of the federally regulated Asian longhorned beetle. Although this was exciting for me, it presented a communications conundrum. Normally, I would do in-person training for arborists and tree health professionals in the area and town hall meetings for local residents, set up research plots, and spend many days and nights in the area (a 4-hour drive from home). But we're still not having in-person events, and I'm not comfortable staying a week in a hotel, especially with South Carolina's handling of the COVID-19 situation. So, I now make a weekly day trip to the area and do everything else online: not ideal, but the best option I have.

The silver lining to all of this is that I've had a chance to slow down and reevaluate my work-life balance. In extension, an unwritten rule is that you "have to be

there" for meetings, field days, and site visits, but I've learned it's not the end of the world if I'm not somewhere, or if that thing doesn't get done, or that e-mail doesn't get answered. I have two little kids; this is the most I've been home in years, and the irreplaceable family time is glorious! I was once told that family has to come second during pre-tenure, that I had to get tenure at all costs, and that I would have to rely on my wife to shoulder the majority of work at home. I thought that was misguided, archaic bulls*** then, and even more so now. This whole situation has been challenging, but I wouldn't trade it for anything.



South Carolina became the sixth state to discover an active infestation of the federally regulated Asian longhorned beetle.

Teaching During COVID-19: A Positive Takeaway

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I teach at a small liberal arts college. Like everyone else, my life was turned upside down at the beginning of March. I could focus on the many difficulties caused by the pandemic and write about how this crisis has put schools like mine in financial jeopardy, or how I had no idea how to teach an online course when this all started. I could describe the near-impossibility of working from home and educating my own children. I could consider the student trauma: I had a student lose a father to COVID-19, and another suffered a serious mental health crisis. I could dwell on how overwhelming and scary it all was, and continues to be. We all have many stories to tell; what I focus on here is the positive impact that restrictions associated with COVID-19 had on my teaching.

Without the traditional classroom, I felt freer to be creative and more flexible. I partnered with colleagues who were teaching the same introductory biology course, and shared labor meant more time to have fun and be thoughtful with each lecture. We regularly appeared in each other's videos, role-playing as students asking questions, responding to the content, and going so far as to wear ridiculous hats. We tried (and intentionally failed) to adopt YouTuber lingo and included our family and pets in the lectures. My son joined me on a backyard worm-hunt while I talked about annelids, and we encouraged students to flip over some rocks the next time they were outside. I received several excited e-mails from students with photos of their own backyard diversity. Our willingness to have fun and invite students into our lives and homes (even if just a little bit) allowed them to understand that we were human, doing the best we could with an unprecedented situation.

Our online short essay exams turned our students into explorers. The questions tasked them with being lead scientists exploring the depths of the ocean, untouched rainforests, or newly discovered life on other planets. We gave them the opportunity to use what they



Tierney Brosius checking on students' plant experiments.

were learning in a creative exercise. These essay exams took a long time to grade, but with a simple rubric, they were manageable and often fun to read. They went so well, in fact, that we have all agreed to include similar questions in future exams.

Shifts in assessment and more willingness to post lecture videos online are welcomed changes in my classroom, but the primary benefit from the spring of 2020 has been my willingness to try new things. Nothing about teaching this spring was ideal, but when students see a sincere effort by faculty to connect and deliver quality lectures, they forgive our mistakes—especially when we can laugh at ourselves and move on.



DeVries carpenter ant project

One Person, Many Roles: How COVID-19 Has Affected a Young Urban Entomologist

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The ongoing pandemic has brought with it a multitude of challenges for all members of society, and the entomological community is no exception. In December 2019, I began a new position as an assistant professor with a split research/extension appointment, and my personal life changed when my wife and I welcomed

a son into the world in April. Given how these changes complicated the challenges created by COVID-19, I have embraced several ideas that have helped me persevere.

First, I have recognized the importance of *adaptability*. As states began to realize the dangers of COVID-19, many quickly shut down all non-essential operations.

A House Full of Mites: Conducting Research at Home During the Pandemic

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As a federal scientist, I am grateful for the immediate emphasis that USDA-ARS put on the safety of its employees during the pandemic. Employees have been conducting as much “telework” as they can from home while maintaining critical research functions such as keeping research colonies alive. Creative telework opportunities have included taking home sticky cards to catch up on data collection from the summer and caring for colonies at home. I brought home three sets of things to rear: uninfested bean plants, plants with spider mites, and one of our predator mite colonies. Rearing the predators requires cycling plants through these three stages. There is no such thing as a “mite-proof cage,” so the best way to isolate colonies is to keep them in separate rooms and follow a sequence of which rooms you enter. Our guest room became the “clean plant room,” where I kept the uninfested lima bean plants. Once a week, I moved two flats of uninfested lima beans into the tub in the guest

bathroom (now the “spider mite rearing room”) and took two older flats from this colony into my office (the “predator mite rearing room”). Once I entered my office, I couldn’t reenter the guest bathroom or the guest room.

After sitting at home with thousands of mites for a bit, I realized I could still conduct experiments. I had a microscope and a weather data logger, and I could get the tools needed to set up an assay. One of the focuses of my research is non-target effects of pesticides on natural enemies, but naturally, I didn’t want to spray pesticides in my house. Fortunately, before the pandemic, we were in the process of testing food-grade erythritol (an artificial sweetener), which shows promise for controlling some pest insects. I set up experiments to examine different routes of exposure (direct spray, contaminated prey, dry residues) to two doses of erythritol and was able to monitor the assays at home. The assays involved placing small bean-leaf disks on moistened cotton balls inside a condiment cup. In the lab, we usually



Schmidt-Jeffris' office, the “predator mite rearing room.”

treat organisms with pesticide using a Potter tower, but I found that a hand-pump atomizer bottle, although less precise, will work in a pinch.

While working from home during the pandemic, I learned how privileged I am. I am fortunate that much of my research involves the ecology of small organisms—not everyone’s research can be transported home. I also came to admire those whose life circumstances make working from home very difficult: people with family care responsibilities, disabilities, and other challenges that add to an already frustrating situation. Going forward, I hope the pandemic teaches us to provide greater support to our colleagues, family, and friends.

Pest control was deemed essential, requiring me to rapidly expand my knowledge of state policies and procedures so that I could answer questions regarding how businesses could continue to operate. I quickly developed guidelines for both the pest control industry and residents so that we could continue to protect people and their properties from pests while minimizing the spread of COVID-19. Although I typically don’t work in these areas, the situation and my responsibilities to the pest control community required that I learn and adapt to this challenge.

I also had to do what we often forget: *ask for help*. In normal times, it is difficult to do things on your own; we rely on one another for support and advice. This is even truer now, despite the difficulties in connecting with one another while social distancing. As I worked to address the needs of the pest

control community, I reached out to every pest management professional (PMP) I knew to seek advice and understand the practices they employed to continue working while keeping people safe, allowing me to create a robust and comprehensive document with advice for PMPs, largely informed by PMPs.

Asking for help is important, but it’s equally important to look out for one another and offer help, even when others aren’t asking. As you might imagine, giving birth during a pandemic isn’t a walk in the park, and I’m not sure where we’d be if it weren’t for the support of friends and family who stepped up to help when our son was born.

Lastly, COVID-19 has reinforced the importance of *diversifying* my work. It’s unclear what the funding landscape will look like as we emerge from this pandemic, but it’s not unreasonable to suspect

that things will not be good. Therefore, it’s more important than ever to look for new opportunities to expand our work. In my case, I was presented with several projects that fell outside my comfort zone, but given my interests and willingness to diversify, I took on these new challenges. Not only has this opened new doors, but it also has made me a more well-rounded scientist.

In closing, I have been amazed and inspired by the efforts of my colleagues and friends to continue their work despite everything going on around them, and I hope that sharing my experiences and the lessons I have learned helps others.





Group tours of three outdoor gardens to discuss pollinators and how to support them were canceled.

Entomological Education in a Public Garden Follows Insects' Lead During COVID-19: Adapt and Diversify

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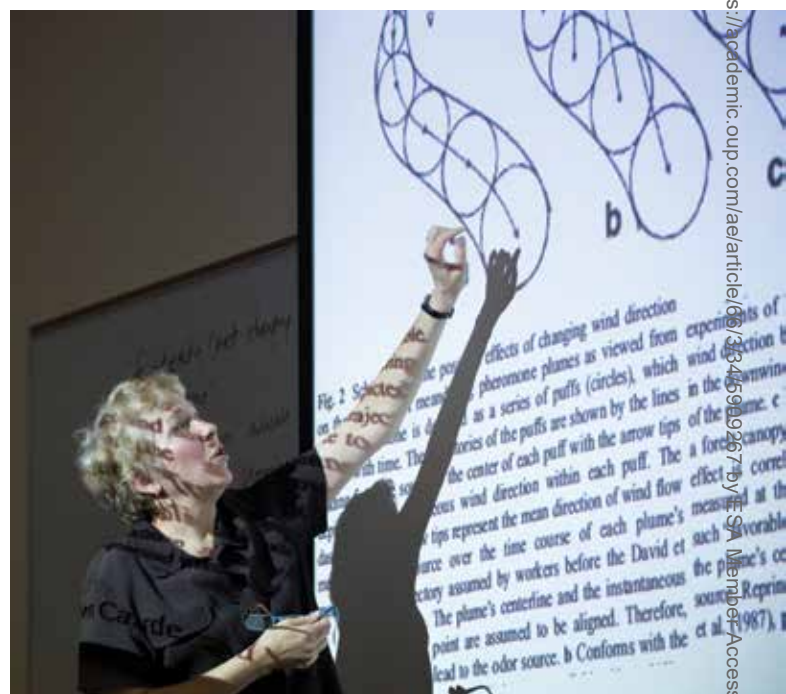
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Winter 2019: Phipps Conservatory and Botanical Gardens solidifies plans to restore several historic rooms. Consequently, without walls or glass ceilings, the annual Butterfly Forest that occupies these spaces will not happen. I brainstorm alternate programming to replace the forest, keeping it educational and especially entomological. I pitch a summer of courses, events, and activities themed around native pollinators and plants. The idea is well received, and the "Summer of Pollinators" is born. During the subsequent months, I collaborate with the horticulture, education, and marketing departments to pursue an institution-wide endeavor. Pollinators will be infused into formal courses, research-based flower selections for gardens, children's story times, film nights, cooking classes, summer camps, speaker series, and our annual short course symposium. We even find a summer intern to interpret pollinators in the gardens and engage visitors as they watch live insects. Teamwork is great; enthusiasm is high. Then coronavirus begins in earnest.

Today, the picture at Phipps is very different than before COVID-19. The gardens were shuttered to the public for two months. After that quiescent "pupal stage," we emerged with transformed programming, visitor experiences, and daily operations. Classes (including those associated with the Summer of Pollinators) went virtual, using Zoom and prerecorded content. While limiting or eliminating hands-on activities, virtual classes accommodate larger class sizes and increase accessibility of courses for those who cannot visit on-site locations. More than 200 online participants attended our virtual BioBlitz festival, joining me to learn about using household items to catch and observe arthropods in their own yards.

Some COVID-19-related losses were unavoidable. Weekend programs about pollinator illustration and orchid-pollinator relationships were canceled to maintain physical distancing and eliminate touchable materials. Group tours of three outdoor gardens where I would discuss pollinators and how to support them were also canceled. The loss that hurt the most was cutting the Summer of Pollinators internship; I was looking forward to working with the intern during one-on-one interpretive interactions with visitors to spark fascination with our insect friends. Luckily, the selected intern received an alternate paid internship at Phipps for the summer.

I hope what we transformed, pushed forward, and delivered to the community electronically can be a model to others facing programming challenges. At Phipps, we likely will maintain virtual programs beyond the pandemic; the accessibility and reach they provide are unparalleled. We will stay vigilant and explore new opportunities as they arise. Just as in insects, adaptation and diversification will prepare us for whatever the future may hold.



Initial Impact of the 2020 Pandemic on Teaching at a Large University

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The impact of the coronavirus pandemic on teaching spread rapidly at the University of California, Irvine. On 1 March, with three weeks left in the winter quarter, the first action occurred: all faculty members were asked to immediately ensure that our online gradebooks were accessible and up to date, in case any instructors became ill. We were also asked to

International Consequences of COVID-19 on Entomology

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The COVID-19 pandemic has had many impacts on entomology worldwide. In 2020, many laboratories and research centers were closed and projects were cancelled or postponed. The disruptions did not stop there; some colleagues started to maintain their insect colonies at home, and entomological courses have evolved. No country has been spared. During this time, insect outbreaks have continued to

adjust class attendance policies so that any ill students would not be penalized. Within days, instructors were given a crash course in remote teaching via a flood of e-mails with links to resources, webinars, and online teaching workshops. By coincidence, I was teaching a fully online lab course that I had just developed, so my teaching was unchanged in terms of content delivery. However, my teaching (like that of others) was impacted by what was happening to my students; students across campus were moving out of their dorms because of family pressures and dorms closing before final exam week. Not only were students distracted by packing and moving, but after leaving campus, some did not have access to reliable internet or webcams. Many final exams across campus were canceled or made optional.

During the week of spring break, instructors had to reconfigure their courses for remote-only instruction for the upcoming quarter. They switched from face-to-face lecturing to Zoom and pre-recorded lectures, with many learning to use the software for the first time. The conversion was particularly challenging for lab courses. Instructors used a combination of materials for lab activities: commercial simulations, educational videos, or data sets from previous years. Some of my colleagues teaching field courses recorded videos in the field with their smartphone cameras. One colleague had her students observe pollinators on flowering plants and attempt to identify them. She found that the students had difficulty identifying both plants and pollinators, and their photos were insufficient for identification. So, some activities proved more successful than others, but students responded positively to instructors' attempts to engage them in content.

Evaluation policies were changed to reduce anxiety for instructors and students alike. Student evaluations of instructors during the pandemic are no longer required for faculty merit and promotion actions, and students were given the opportunity to opt for pass/fail grading until the end of instruction for the pandemic-impacted quarters.

Teaching practices have fundamentally shifted here at UCI. Although there are extensive lists of resources for remote instruction on the internet, these can be overwhelming and time-consuming to sift through. Colleagues are turning to each other for help, with increased conversation among instructors about teaching tools and approaches. As we grapple with the loss of our face-to-face interactions, a new spirit of compassionate flexibility is infusing our teaching.

make international headlines (e.g., desert locust in East Africa; giant hornet in the U.S.; large aspen tortrix in Canada; fall armyworm in Africa, the Far East, and Australia), and monitoring and management programs need to be maintained.

Thomas Simonsen (Researcher, Natural History Museum Aarhus) stated, "In Denmark, the full-scale lockdown has been relatively brief as universities and museums have started to reopen partially during the summer. Still, access is restricted to many facilities, and both university courses and exams are to a degree executed online. Fieldwork and lab work is still a challenge, and recruiting new graduate students is particularly difficult."

Johnnie Van Den Berg (Professor, North-West University), added, "In South Africa, the lockdown commenced as autumn approached and the impacts on field trials were not severe. Entomology training went online and many rearing colonies were taken home and some ingenious methods evolved along the way."

According to Julien Saguez (Researcher, CÉROM), "In Quebec (Canada), this unprecedented situation forced the pest monitoring network (PMN) to adapt. The provincial government limited travel to essential works. The PMN was considered an essential service, and the team decided to introduce new technologies based on artificial intelligence. For example, a lot of money was invested to buy and rent automated traps that allow monitoring of pests, reducing the number of in-person visits in the fields. These traps are equipped with counters or with cameras that allow daily checking of the number of pests collected. Using automated traps, PMN was also able to report outbreaks and maintain a service for agronomists and producers."

The pandemic has also changed communication and research dissemination. Although several meetings were postponed or cancelled (including ESA branch meetings), the International Branch was fortunate to have already organized its third virtual symposium for April. Our virtual symposium was attended by 453 participants from 39 countries and featured three days of keynote and poster presentations focused on chemical ecology, insect genetics and molecular biology, and biodiversity and global change.

The pandemic has revealed how online conferences can connect researchers across the globe while they are at home. The International Branch hopes that our virtual symposium helps maintain relationships and facilitates scientific exchanges between all members of ESA, no matter what country they work in. Regardless of when the pandemic ends, we are preparing for the fourth International Branch Virtual Symposium (26–28 April 2021) and plan to highlight invasive species and insect–plant interactions.



Automated trap
to monitor several
moths.



Corteva Grows volunteers maintain social distance while working in the Harvest for Hunger Garden.

Chronicling the COVID-19 Pandemic: Perspectives from Corteva Agriscience

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Through the COVID-19 pandemic, we are now more aware of the essential workers who supply materials and enable activities in our lives. This analogy holds true in the development of new technologies, whereby scientists of different disciplines work together from discovery to commercialization. Because the development timeline of new chemistry or trait technologies is a decade or more, disruptions in research and development (R&D) that last even a few months could delay innovations by years. The pandemic posed a new challenge within our company, requiring a well-planned and thoughtful approach to minimize impacts to farmers and consumers, with the highest compassion for employees and collaborators.

Technology development requires a constant cadence of decision-making, relying on the coordination of many scientists who conduct year-round field, greenhouse, and lab studies. For entomological studies, samples of seed, chemistry, and insects are materials essential for research. A rapid first step was to prioritize research assignments and identify essential personnel who required access to facilities. Limiting the number of individuals allowed on site



Corteva entomologists count insects while wearing masks to protect each other from COVID-19 exposure.

enabled social distancing and ensured availability of personal protective equipment. Some work spaces were redesigned to minimize impacts if COVID-19 cases were identified. We enhanced our efforts to help employees, especially regarding personal situations and the need for flexibility.

Four behaviors were consistently observed during the pandemic: communication, compassion, teamwork, and innovation. Effective communication ensured that assignments were completed and support was available. Colleagues showed compassion by observing safety measures at work and home and being honest about the risk posed to one another. Teamwork was exemplified by employees who volunteered to stand in for peers in vulnerable groups, and field scientists who assisted with applications and assessments when collaborators' staff were unable to work. Corteva entomologists hand-delivered shipments when we recognized that site closures would prevent essential materials from reaching their destination. Field scientists demonstrated innovation by hosting live "virtual field tours," connecting with a wider audience that would not otherwise have had the opportunity to participate. The impact of COVID-19 to our R&D pipeline has been minimal, and we believe that is related to the nature of our global work and the design of our R&D programs. We plan for failures and create strategies to minimize impact on research outcomes through planned repeated trials and globally dispersed internal and external capabilities.

A significant percentage of Corteva employees were able to transition quickly to working from home, aided by an existing infrastructure designed to connect a global workforce. Many employees had experience leading critical projects in virtual environments. Scientists and interns were interviewed and on-boarded virtually to support our talent pipeline. We learned new ways of making personal connections without conference rooms as some of us turned on webcams for the first time ever, children "bombed" meetings, and canine friends barked in the background. This contributed to a greater sense of family and inclusion among colleagues. Although virtual interactions maintained progress, we missed connecting face-to-face with our colleagues, customers, and recruits during car rides, hall talk, and meals.

Corteva Agriscience has a bold purpose "to enrich the lives of those who produce and those who consume, ensuring progress for generations to come." We are proud of our service to communities and our role in ensuring progress during the pandemic. Corteva partnered with global food banks to aid community food access: a two-acre garden at our Indianapolis site harvests more than 12,000 pounds of fresh produce annually, which is donated to local food pantries, and the Corteva Challenge at the Food Bank of Iowa supported more than 900,000 meals. To assist with distance learning, employees provided science content through social media (YouTube: "Corteva Grows Science Outreach") to parents, teachers, and students. We distributed printed activity books through food bank collaborations for families unable to access virtual content. Corteva partnered with MercyOne hospitals, providing genetic and molecular technical expertise and capacity to process and analyze more than 20,000 COVID-19 samples in Iowa.

Corteva's CEO, Jim Collins, stated: "As a company whose very purpose and structure was built on connecting farmers and consumers, the responsibility of resolutely facing whatever affects them, adversely or otherwise, is Corteva's business." The examples we have provided were focused on U.S. partnerships, but as a global company, we responded worldwide to these challenges. As Corteva employees, we have exemplified the company purpose by enriching lives when and where it was needed most.

COVID-19: Making the Best Something of a Bad Situation

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My last normal day of 2020 at UIUC was 10 March. On 11 March, the World Health Organization declared a coronavirus pandemic, and UIUC began to move classes online and discouraged large gatherings. The following week, I first saw someone wearing a mask, and I learned how to use a program called “Zoom.” By 23 March, UIUC was an online university with a locked-down campus. I went home that day and stayed for a month, crunching data, collaborating remotely, interviewing potential summer assistants, writing, and becoming a scientist in slippers.

While online instruction continued, administrative units developed safety protocols to allow essential on-campus research activities to resume. Fortunately, agricultural research is essential at land-grant colleges. I had ambitious summer plans, seed was arriving, and field plots and greenhouses would need attention. However, a dark cloud of uncertainty was hanging over my unplanted corn. What would I do if I wasn't permitted to have summer

assistants? I didn't know, but it would suck!

A taste of what a “workerless” field season might be like came in early April. I received permission to begin projects that I could accomplish alone. For the next 30 days, I worked in an almost-empty building on tasks I'd normally assign to student assistants. Although the prospects for employing assistants were uncertain, I extended tentative job offers (contingent on stay-at-home orders) and updated my “return-to-work” plan to safely include student assistants.

I enjoyed the quiet, interruption-free work environment of empty buildings on a largely deserted campus, but there were downsides. I ran low on ethanol in early May and learned that campus chemical stores were closed until at least 1 June. Unable to wait for delivery of backordered ethanol from outside suppliers, I left my bubble of safety to visit a local “beverage depot” where I bought four large bottles of off-brand 192-proof ethanol. Though I was masked and gloved like a thief at the checkout, I felt like I was the one being robbed, paying five times

the campus price per liter on my personal credit card—an unavoidable expense if my work was to continue. When a large campus closes down, its centralized supply system can leave you high and dry (literally)!

By late May, a few trusted colleagues and I had planted our hundreds of corn plots, but looming large on the horizon were the thousands of corn roots that eventually would need to be dug, washed, and rated for rootworm injury to meet the obligations of research agreements signed long before COVID-19. No amount of toughing it out by a stout 50-something scientist and his colleagues could ever equal the $E = mc^2$ contained in the “matter” of a corps of shovel-wielding college students digging their way through corn plots toward a free pizza lunch!

By mid-June, Illinois' declining infection rate allowed me to bring four summer assistants into my laboratories. To reduce risks, the number of mask-wearing, socially distanced students per laboratory was limited by square footage to two per room. Each worker was assigned to a workstation outfitted with a microscope, light, tools, and everything necessary for field and laboratory work—including disinfectants to clean their spaces. In the hallways, a system of arrows taped to the floor guaranteed one-way traffic flow.

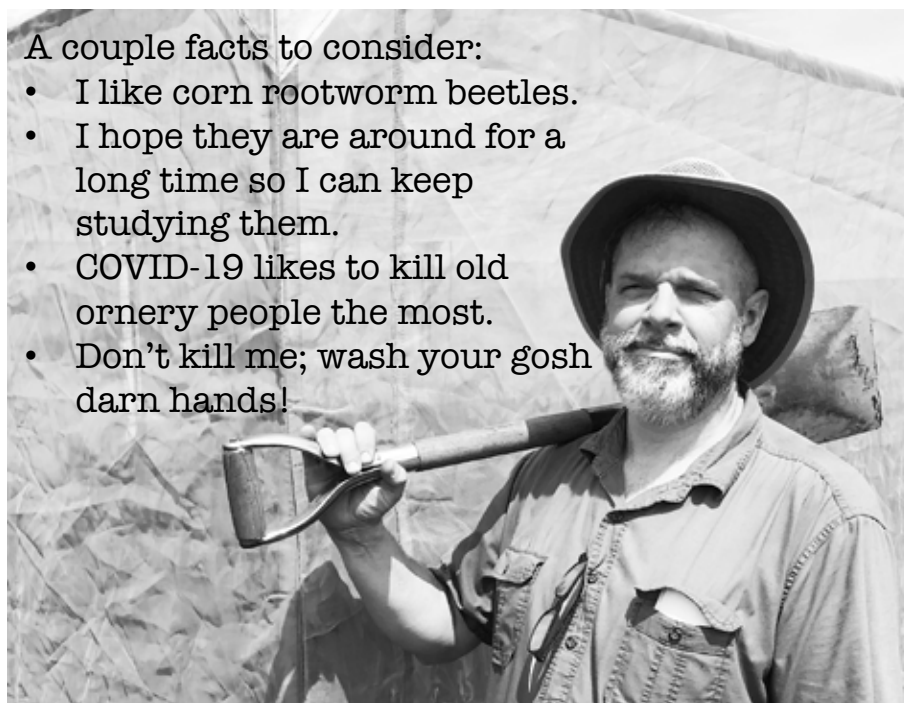
University guidelines also dramatically changed the way we traveled to the field. I had to rent a motor pool car for each student and equip each with a cleaning kit. Instead of hauling a noisy crew in one SUV, now I led a five-vehicle “COVID caravan,” robbing us of opportunities for camaraderie and the fun and teachable moments associated with backroad driving.

Regardless of COVID-19, this season of research will reach a conclusion. Some data will be collected; some bioassays will be completed; and (fingers crossed!) some roots will be dug, but I will vividly remember the burden of uncertainty inherent in this crisis and each hesitant step toward this field season. When you can't predict what will happen tomorrow, planning for weeks or months ahead is frustrating.

In these strange times, doing entomological fieldwork is when life feels almost normal. I am lucky to conduct field crop research; social distancing is easy in a cornfield. I can't wait for the future, when I can smile, lower my voice, and close the conversational distance between myself and others. Despite inevitable changes that will follow the pandemic, I am comforted by the realization that there will never be a remote workaround for enthusiastic students wielding shovels.

A couple facts to consider:

- I like corn rootworm beetles.
- I hope they are around for a long time so I can keep studying them.
- COVID-19 likes to kill old ornery people the most.
- Don't kill me; wash your gosh darn hands!



Joe Spencer posted friendly hygiene reminders for students in his laboratories.