entomologists fall into the sidelined category. There are exceptions—some medical entomologists and disease ecologists, for example, have been recruited to apply their professional skills toward modeling dynamics of pandemic spread—but, for the most part, entomology departments are under orders to work remotely, if at all. At the University of Illinois at Urbana-Champaign, our Vice Chancellor for Research issued an order for faculty to remain at home, with exceptions limited to “essential personnel,” designated as such because they look after living organisms or because they are involved in long-term or seasonal work that, if interrupted, would “result in loss of significant data and samples.” In a way, this policy has been humbling—as Head of the Department of Entomology, I’m not considered essential, but our long-time insectary manager, who takes care of our departmental insect colonies, including thousands of cockroaches, flies, and milkweed bugs, is essential; even if they’re only insects, many more lives depend on him doing his job in person than depend on me doing mine.

Beyond posing a mortal risk to entomologists, the COVID pandemic also presents a threat to careers. Sheltering in place is incompatible with most forms of entomological research, although admittedly inspiration might strike anywhere: entrepreneurial pest management specialists have determined that heat treatments for bed bug control can also decontaminate coronavirus on personal protection equipment (https://denver.cbslocal.com/2020/04/24/bed-bug-treatment-kills-coronavirus-sterilize-masks/).
Limited access to laboratories and field sites presents a particular challenge to graduate students and early-career faculty, who are often constrained by strict timelines to produce research results on schedule. As well, networking opportunities that could lead to collaborations or employment have pretty much evaporated. Among others, the in-person joint meeting of the North Central Branch and the Southwestern Branch of the Entomological Society of America in March 2020 has been postponed until March 2021 (although the student competition and business meeting were held virtually, at the originally scheduled time); the Royal Entomological Society Annual General Meeting, scheduled for August 2020 at University of Exeter in Cornwall, has been postponed until further notice; and the 26th International Congress of Entomology, scheduled to take place in Helsinki, Finland, in July 2020, has been postponed until July 2021.

The internet is full of sites where global pandemics are ranked in terms of death tolls (which, if you think about it, is kind of in questionable taste), with lists ranging from “The 5 Deadliest Pandemics and Epidemics” (Bonner et al. 2020) to the “Top 20 Worst Epidemics in History” (https://www.youtube.com/watch?v=xZrzVsPZyl). It’s not really a point of pride for entomologists that so many of the world’s worst epidemics have involved pathogens transmitted by insects. Of course, until very recently in the span of human history, no one even suspected that insects might have anything to do with epidemics. Insect vectors didn’t garner much attention until the turn of the 20th century: Ronald Ross, e.g., linked mosquitoes and malaria in 1897 (Ross 1897); Walter Reed and his colleagues began clarifying the association between mosquitoes and yellow fever in 1900 (Reed et al. 1900, 1901); and Nicolle and colleagues established the body louse Pediculus humanus as the vector of Rickettsia prowazekii, the pathogen causing epidemic typhus, in 1909 (Nicolle et al. 1909).

Worrying about how entomologists today are handling COVID-19 led me to wonder how entomologists weathered the “Spanish flu” of 1918 to 1920—Number One on several of the internet’s “pandemic greatest hits” lists. Signs of professional disruption aren’t immediately apparent, at least to me. Both the 31st Annual Meeting of the American Association of Economic Entomologists and the 13th Annual Meeting of the Entomological Society of America, for example, took place, apparently on schedule, on 26 December 1918 on the campus of Johns Hopkins University, in Room 9, Gilman Hall, starting at 10:30 a.m. and 1:20 p.m., respectively (Aldrich 1919, Burgess 1919). Many members, including the President and Vice President and five members of the Executive Committee of the ESA, were missing from the meeting, but their absence appeared to have been more due to military action in the Great War than to influenza. In fact, the only reference to influenza in the proceedings of the ESA’s annual meeting was a comment that the American Association for the Advancement of Science was having problems planning for their upcoming meeting in Baltimore “by reason of an unexpected shortage of meeting rooms in Baltimore, the prevailing influenza epidemic, the general war conditions, and the railroad and hotel congestion,” and consequently exhorted affiliated societies (including ESA and AAEE) to abandon their program “as our logical duty in the premises” (Aldrich 1919). ESA did in fact limit its program, but regretted doing so when, by December, it appeared that both the war and the pandemic had burned themselves out. Between war and pandemic, war had a more palpable effect on entomologists. The Report of the Secretary of the AAEE included a resolution expressing esteem for the 12 members who had died in active service during the war; by contrast, only one death due to pneumonia (S. C. Vinal) and one due to influenza (A. D. Duckett) were mentioned. Both societies also remitted dues for members serving in the “United States or allied armies or navies … until the close of the war” (Burgess 1919).

With respect to other entomological meetings, 13 years elapsed between the Second International Congress of Entomology (ICE) in Oxford, UK, in 1912 and the Third International Congress of Entomology in Zurich, Switzerland, in 1925. However, in his review of the Third ICE, Horn (1925) doesn’t mention the influenza epidemic as a factor at all. Rather, he cites difficulties with fund-raising, the need to identify a neutral location to host the meeting, and lingering post-war animosities leading to boycotts by entomologists from France and Belgium who were unhappy about the prospect of attending a meeting with German entomologists. Although Howard (1926) also made no mention in his review of the Third ICE of influenza as a factor delaying the Congress, he asserted that the absence of French, Italian, and Belgian entomologists in Zurich was “not due to international feeling but to the unfortunate rate of monetary exchange.”

To determine, in a general way, whether the 1918 influenza epidemic had an impact on research productivity of entomologists, I carried out a Web of Science search of the literature between 1910 and 1920, using “insect” as a search term. Of 933 papers published between 1910 and 1920 retrieved by the search, the fewest papers (20) were published during 1918, which might have suggested an interruption in research but for the fact that the number nearly doubled by 1919, close to a record for the decade. In 1917, the Journal of Economic Entomology published 572 pages, whereas, during 1918, 494 pages were published, but there is no indication that influenza was a factor; rather, the reduction may have been an effort to reduce costs, given general price increases “on nearly everything
Europe, and today, the disease is, in fact, so was just about every other country in Spain was indeed wracked by influenza, although not for sound epidemiological reasons. Although “Spanish fever” became known as “Spanish flu,” but not for 1918. Despite uncertainties about its origins, what today is called H1N1 influenza diseases—in the first 15 years of the century, it must have seemed that ultimately insects could be linked to just about any disease. The “Spanish flu” epidemic began suddenly and seemingly simultaneously in the USA, Europe, and Asia in the spring of 1918. Despite uncertainties about its origins, what today is called H1N1 influenza became known as “Spanish flu,” but not for sound epidemiological reasons. Although Spain was indeed wracked by influenza, so was just about every other country in Europe, and today the disease is, in fact, thought to have originated in the USA. For a variety of reasons (not least of which is that Spain was neutral in the Great War and its government, in contrast with governments of other European nations, wasn’t censoring fatality reports), Spain became by default most closely associated with the flu. Beyond its origins, there was uncertainty about the identity of the disease itself; there wasn’t even a consensus in 1918 that the disease was “the flu” at all. Many publications of the era refer to the disease as “influenza” with quotation marks (Hunt 1918, Wrigman 1918) and the phrase “so-called influenza” appears in at least two dozen publications from 1918 and 1919, even accorded titular status in some (e.g., Hunt 1918, Kinnicut and Binger 1919). Probably because the role of insects as vectors was still new, there were quite a few publications associating the disease with possible insect vectors. In Italy, there was a deep-seated conviction that the disease was being spread by phlebotomine sand flies. In a letter to The Lancet, Lambert (1918) debunked the idea, based at least in part on the fact that patients suffering from “the so-called Spanish influenza” were remarkably free of any sign of sand fly bites on exposed parts of their body. “Sandfly fever” also differed from the Spanish influenza by virtue of the “rarity of catarrhal conditions of the respiratory passages” and a “negligible mortality rate … These suffice to distinguish the two diseases, quite apart from any bacteriological investigations or the prevalence of the sandfly in the district affected” (Lambert 1918). By contrast, Samuel (1918) noted that “in the lay mind especially the present influenza has been looked upon by some individuals as a type of malaria, probably spread by the returning malarial soldier, and this, amongst other reasons, accounts, to a certain extent, for the great consumption of quinine, both as a prophylactic and as a curative drug.” Among the symptoms consistent with this notion was a case in which “the patient passed quite an abnormally large quantity of urine as black as ink, with a reddish tinge … An examination of the urine revealed the same features as are present in typical blackwater fever” (Samuel 1918), a condition known as hemoglobinuria, a complication of some forms of malaria. For his part, Symmers (1918) pointed out the resemblance between the pneumonia characteristic of bubonic plague, the bacterium of which is vectored by the Oriental rat flea Xenopsylla cheopis, with “the confluent lobular exudative and hemorrhagic pneumonia” characteristic of pandemic influenza, making for an “interesting study in similarities” but ultimately reliably differentiated by bacteriology; “bacteriology of the prevailing pandemic is vouched for by a number of exceedingly able investigators, and … Bacillus pestis has found no place in their results.” More than a century after insects were directly or indirectly linked to a deadly pandemic, the idea has surprisingly reappeared
in the scientific literature. In 2020, at least two papers have been published suggesting a possible role of insects in a global pandemic. Dehghani and Kassiri (2020) suggested that because "Coronaviruses can be transmitted through the fecal-oral route ... feces can be considered a possible important source of COVID-19 transmission. Therefore, any organism in contact with or feeding on human feces may play a role in COVID-19 transmission. Therefore, the role of insects such as houseflies and cockroaches in the transmission of COVID-19 becomes important." At the moment, the link is theoretical; in what appears to have been the only study to date investigating possible transport of SARS coronaviruses by cockroaches, nested RT-PCR of surface swabs yielded only "one uncertain positive result" (Duan et al. 2003).

Elnady (2020) has suggested an indirect role of insects in the current pandemic. This author argues that because countries with endemic malaria have experienced "the lowest rates of COVID-19" and countries with aggressive malaria eradication programs (including China and the USA) are experiencing high rates of infection, malarial mosquitoes might confer protection against COVID-19 by "changing the human immune response." If that’s the case, the fact that “the Americans’ excessive fear of the Zika virus caused them to take strict measures to get rid of mosquitoes and prevent their bites” (Elnady 2020) may have come back to bite us, as it were, in the form of elevated COVID-19 mortality. As well, Poinar (2020) has observed that, because coronaviruses and flaviviruses are common in insectivorous horseshoe bats of the genus *Rhinolophus* and because these bats are thought by some to be reservoir hosts of COVID-19, the possibility exists that mosquitoes might, by feeding on the blood of infected bats, acquire COVID-19 virions and subsequently transmit them through blood-feeding to other hosts, including humans.

Although insects and pandemics seem to be inextricably linked in a bad way in the minds of most people, I feel compelled to mention that, for one brief shining moment a half-century ago, the Center for Disease Control relied on an insect for a massive public education wellness campaign about infectious disease. Beginning in 1962, a cartoon bee named Wellbee became the CDC’s “national symbol of public health,” appearing on posters, in newspapers, on radio and television, and even in person at public health events to encourage members of the public to adopt health-promoting practices, including taking the Sabin Type-II polio vaccine and washing their hands to protect themselves against the polio virus (CDC 2015, Science Source, Inc. 2020). A press release from the era described him as “a pleasant-faced, bright-eyed, happy cartoon character, who is the personification of good health.” I’m not sure Wellbee would be a good fit for public outreach during the COVID-19 pandemic, particularly in the absence of a vaccine, but, if the CDC wants to bring him back, I think there’s finally a way that entomologists can help—among other things, we could suggest to the CDC’s Public Information Officer that Wellbee might be more entomologically credible with another pair of hands to wash.

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