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COVER POEM & ESSAY

Incubus
Kevin J. Olival

ACKNOWLEDGEMENTS
Prioritizing the ‘Dormant’ Flaviviruses

Probably the most disturbing fact of the ongoing Zika epidemic is that this virus is not new. Zika is not new to science, as SARS coronavirus was when it first emerged in 2003, nor did it experience dramatic evolutionary change like influenza does through reassortment. Instead, Zika has been lurking in the shadows for almost 70 years. It was hidden in developing countries with poor disease surveillance, isolated island populations in the Pacific, and poorly studied animal hosts. We knew about Zika in 1947 when it was discovered in a jungle in Uganda. We knew the epidemic potential when Zika barraged through Micronesia in 2007. In retrospect, we should have also been aware of its link to microcephaly in the Pacific island outbreaks. We knew the possibility of sexual transmission when an American mysteriously infected his wife after returning from a field trip in Senegal in 2008. Yet, we were still unprepared.

In the past two years, the scientific community has rallied to combat the Zika outbreak and fill the longstanding deficit of Zika knowledge. More than 30 candidate vaccines are in development, and scientific papers on the virus are more than ten times as abundant as Zika publications before 2014. Important aspects about the virus’ biology and transmission, like its tissue tropism, interaction with Dengue, persistence in body fluids, and its structure have been elucidated. However, this wealth of knowledge only came after Zika was declared a public health emergency, opening up research dollars and scientific opportunity.

Zika virus is one of 53 viruses in the genus flavivirus currently recognized by the International Committee on Taxonomy of Viruses. Five of these are big hitters, causing epidemics and widespread morbidity and mortality: West Nile virus, Yellow Fever virus, Japanese Encephalitis virus, Dengue virus, and now Zika virus. Twenty-one other flaviviruses are known to cause infections in humans. Perhaps more than any other viral genus, it seems the flaviviruses are especially primed for human infection: RNA viruses with high mutation rates, vector-borne, and found in a wide range of vertebrate and invertebrate hosts. Unsurprisingly, the flaviviruses that only rarely infect humans, or have yet to do so, are vastly understudied with research output for most viruses in this group having plateaued in the years immediately following their discovery. With the exception of a big push by the Rockefeller Foundation and US Government to characterize arboviruses in the 1940s and 1950s that led to the discovery of many of these viruses, there has been a paucity of studies investigating these ‘dormant flaviviruses’ over the last 40 years.

Our global approach to emerging infectious disease research has been reactive for too long, with an increase in scientific investigations and funding (e.g., for surveillance, experimental studies, or countermeasures) only coming after international spread. González-Salazar et al.’s manuscript in this issue (2017) uses an ecological niche modeling approach to identify potential, currently unrecognized, vertebrate hosts for Zika virus in Mexico. This is an interesting approach to help target zoonotic disease surveillance in the animals that may serve as most likely natural reservoirs, and a good start. We need more analytical tools like this. We know virtually nothing about the sylvatic cycle, the vectors, the non-human reservoirs, or the general ecology of Zika. International efforts to map the potential distribution of Zika are focused on *Aedes aegypti* and *A. albopictus*, but we lack knowledge on the 17 other mosquito species that have been tested positive over the years, nor what other viruses these vectors may carry.

We need more predictive tools to forecast the risk that viruses pose before they become epidemics or pandemics. We need creative approaches, and multi-disciplinary col-
laborations to develop these sets of tools. Mathematical modelers need to work with field scientists, clinicians, bioinformaticians, virologists, and veterinarians, and we all need to collaborate more with laboratory scientists who can design experiments to validate our models. If phylogenetic and structural models predict an increase in host range for a virus, how can we design in vitro or in vivo experiments to test this? How can we make the most of the scattered information available on host range, vector range, and viral biology from the last 70+ years of disjunct studies to better prioritize the 53 known flaviviruses for future research? Yaounde virus, Kedougou virus, and Sepik virus are hardly household names, but they are the closest known relatives to viruses we know well—West Nile, Zika, Yellow Fever. How many more flaviviruses will we discover in ecosystems around the world if we make a concerted effort to find them? How can we then include these novel viruses into our prioritization schemes?

Just as weather forecasting seemed like an impossibility before the advent of satellites, computer algorithms, and telecommunication equipment, to some naysayers the era of pandemic forecasting may seem impossible, or a very a long way off. It is not. We are in this era now, but these are still early days. A growing and diverse community of scientists are working hard each day to build and experiment with tools to forecast and prevent emerging viruses. Many of these analytics can be applied directly, right now, to improve public health. For example, they can identify geographic regions, host species, host traits, vectors, and viral traits that rank their likelihood of disease emergence. This allows agencies to target how they prioritize field surveillance or prioritize which viruses we should research more before they infect humans on a wide scale. They can also start to estimate how many other unique flaviviruses are out there on the planet so that we can begin to catalog and characterize them all. These messages should not be lost in our rush to focus on the current public health emergency. Part of our public health response should be to set research priorities for those quiescent viruses we already know about before they become the next Zika.

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In This Issue

Now We’re Cooking with Biomass!

Household air pollution from burning solid fuels is the sixth largest risk factor for disease burden in Africa, but little is known about the relative impact of cooking with different biomass fuels on human health. Das et al. used data from a structured household survey to test whether type of biomass influences prevalence of disease and injury in Malawi. They found that use of inferior biomass fuels (e.g., low-quality firewood; crop residues) is associated with prevalence of cardiopulmonary and neurologic symptoms. To reduce disease burden, they urge for improved access to high-quality biomass fuels and promotion of cookstoves that reduce fuel consumption.

Wildlife Health Professionals’ Occupational Risks

Most recently emerging infectious diseases are zoonotic in origin and frequently with wildlife a source. Garland-Lewis et al. assessed occupational exposures among wildlife health professionals working in multiple countries by administering an online survey to 71 wildlife workers in 14 countries recruited through an ongoing international wildlife pathogen surveillance project. Exposures reported included bites from bats and rodents and touching dead animals. These results show that wildlife workers are at risk of occupational injury and infection. Enhanced occupational health services targeting wildlife workers may reduce both risks and consequences of zoonotic exposure and infection.

US Wildlife Trade and Disease

Wildlife comprises one of the largest commodity groups traded globally, yet associated risk of disease introduction and spread remains uncharacterized. Major barriers to assessing risks include lack of global regulatory requirements, enforcement, standards for data, and the large proportion of trade that is illegal or unreported. Smith et al. characterize the US role in global exchange of wildlife and describe high-volume trade with the data available with an eye toward prioritizing health risk assessment questions for further analysis. Data for over 5 million shipments including over 11 billion specimens imported during a 13.5-year period were examined.

Surf’s (Cough) Up

The surfer health study pilot project examined the health status and possible adverse health effects associated with seawater exposure among surfers in Monterey Bay, Central California. Forty-eight surfers enrolled and completed an initial health background survey and weekly health surveys for several months. 10% of the surfers reported gastrointestinal symptoms and 29% reported upper respiratory symptoms. O’Halloran et al. found that surfers were more likely to report upper respiratory symptoms when they had a history of allergies, housemates with upper respiratory symptoms, or a history of previous adverse health symptoms during “red tides.”

Leptospirosis in Mexico and Spain

The main sources of transmission of Leptospirosis are domestic and wild mammals, but recent cases of infected
people involved with crocodile handling suggest that reptiles may play an important role in transmission. Pérez-Flores et al. detected serum antileptospiral agglutinins in wild crocodiles from the most important ecotourism region in the Yucatan peninsula of Mexico. The prevalence was of 100% in fresh and saltwater crocodiles with titers ranging from 1:50 to 1:3200. These results indicate a risk of transmission, and thus, precautions should be taken when recreational activities are carried out in places inhabited by crocodiles. In Spain, Leptospira serogroup Pomona infections are very common where livestock can maintain these pathogens or be at risk from wild rodents. Arent et al. report the results of Leptospira isolates from domestic and wild animals. Serovar Pomona was only isolated in farm animals which are recognized as the maintenance host. All strains isolated from small wild mammals were identified as serovar Mozdok, which can be a cause of accidental infection in food animals and likely infected by wild species such as those from this study.

**Feces of Fur Seals**

An increasing number of humans inhabit coastal regions raising concerns about the impact this has on the health of aquatic ecosystems. Pinnipeds are probably one of the best sentinels in these environments. Investigation of novel viral agents in pinniped species may provide a better understanding of terrestrial viral agent flow and the emergence of disease at the interface between wildlife, domestic animals, and humans, in addition to increasing the likelihood that humans will pay more attention to ocean health issues. Chiappetta et al. use phylogenetic analysis to support evidence of three new putative circoviruses and human adenovirus occurrence in feces of South American fur seals.

**Not So Happy Feet**

García-Peña et al. conducted a large survey of prevalence of Campylobacter in three species of penguins (n = 390) in the Antarctic Peninsula. Their results indicate that Campylobacter is widely distributed in 9 out of 12 rookeries sampled. *Campylobacter lari* and *Campylobacter volucris* were isolated. Genotypes from each rookery were different possibly due to different sources of infection.

**Human–Primate Mosaic in Uganda**

The mosaic of fragmented landscapes is emblematic of subsistence livelihoods in Western Uganda and enhances human–primate interactions, which lead to primate population declines and increased cross-species disease transmission. Through microscale mapping, cluster analysis, and hotspot estimates, Paige et al. show that the extent and intensity of human–primate overlap varies greatly in each fragment location. They demonstrate that specific subsistence livelihood activities, like firewood collection, are primary drivers of ecological overlap. Their research demonstrates the value of fine-grained social and ecological systems analysis to inform policy and programming activities to interrupt human–primate interaction and minimize risk of zoonotic disease transmission.

**Diversity of Retroviruses in DRC Bushmeat**

Steve et al. report prevalence of simian immunodeficiency virus (SIV) and Simian-T-lymphotropic virus (STLV) infections in primate bushmeat in the Democratic Republic of Congo. Overall, 5 and 15.4% of primate bushmeat was infected with SIV and STLV, respectively. A new SIV lineage and three new STLV-1 subtypes were identified, and SIV and STLV prevalence varied according to species and geographic region. This study illustrates how knowledge of genetic diversity and geographic distribution of simian retroviruses is still limited and that humans continue to be exposed to relatively high proportions on infected primate bushmeat.

**Bacteria in Mexican Wild Carnivores**

Bartonella are vector-borne bacteria that infect the erythrocytes and endothelial cells of mammalian hosts. Bartonella infections are reported worldwide, but little is known about their presence in wild carnivores in Mexico. López-Pérez et al. found different Bartonella genotypes in blood and fleas from wild carnivores. Genotypes were associated with three different Bartonella species and in some cases were identical to strains previously detected in humans. This suggests there is a risk to human health and that the highly prevalent flea *P. simulans* might play an important role in transmission of Bartonella.
**T. CRUZI FROM TEXAS**

Trypanosomes are parasitic protozoa of medical importance with a life cycle involving mammalian hosts and most are transmitted via blood-feeding invertebrates like conenose bugs. Wild mammals have variations in their roles as pathogen reservoirs due to differences in behavior, physiology, and ecology. Trypanosome prevalence information from wild mammals within the USA is scant. Aleman et al. screened an extensive collection of rodents from Texas for T. cruzi prevalence. They found low prevalence restricted to a southernmost site suggesting that prevalence of this pathogen is highly heterogeneous across taxa and landscapes within Texas.

**SEEING URBANIZATION AND AVIAN FLU IN NORTHERN VIETNAM**

Finucane et al. examined how perceptions of outbreaks of highly pathogenic avian influenza (HPAI) subtype H5N1 in poultry are related to urbanization. Via in-depth interviews with village leaders, household farmers, and large farm operators in modern, transitional, and traditional communes in the north of Vietnam, they explored behaviors, attitudes, cultural values, and traditions that might amplify or attenuate HPAI outbreaks. Analyses highlight how urbanization improves some aspects of life, but simultaneously pose significant challenges for poultry farming and disease management. Awareness of qualitative aspects of HPAI risk perceptions and behaviors and how they vary with urbanization processes may help to improve the prevention and management of emerging infectious diseases.

**ECOHEALTH AND ONE HEALTH IN INDONESIA**

Toxoplasmosis is caused by the protozoan parasite Toxoplasma gondii. On the island of Java, Retmanasari et al. found seroprevalence of Toxoplasmosis of 62.5% of 630 participants. Observed risk factors such as unfiltered water sources and direct contact with raw meat may readily be addressed by encouraging people to use filtered water and wear protective clothing such as gloves when handling raw meat. This study exemplifies how an ecohealth approach is essential to developing interventions to reduce toxoplasmosis transmission in high-risk populations. Countries need practical ways to optimize shared-resources across their existing multi-sectoral and multi-level (national, regional, district-level) animal, human, and environmental health sectors. Errecaborde et al. offer an example of the use of the One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART) to operationalize One Health using minimal resources in the Indonesian province of West Sumatra.

**WILD MIGRATORY BIRDS IN PAKISTAN**

Wild migratory birds constitute an important component of the ecosystem and a potential source of transmission of antibiotic resistance beyond countries borders. Pakistan hosts tens of thousands of overwintering birds from Siberia and Central Asia. Raza et al. studied the occurrence and molecular characterization of extended-spectrum β-lactamas producing K. pneumoniae (ESBL-K. pneumoniae) from these migratory birds. They found high prevalence of multi-resistant K. pneumoniae and molecular characteristics showed emergence of clinical relevant ESBL genotype. Genetically similar strains were identified from geographically distant areas suggesting migratory birds are a vehicle for trans-boundary spread of multi-drug-resistant bacteria.

**CASCADES OF CHYTRID IN CALIFORNIA**

The pathogenic fungus Batrachochytrium dendrobatidis (Bd) has been associated with global amphibian declines, but it is often difficult to discern the causality of Bd after a species has declined. Cascades frogs (Rana cascadae) have experienced dramatic declines in northern California, but it is not clear whether the onset of declines corresponds with the arrival of Bd. De León et al. assayed Cascades frog samples collected from museum specimens between 1907 and 2003 to determine Bd prevalence and detected Bd in 3.5% with the first positive result from 1978. Results suggest that Bd arrived in the region between 1973 and 1978 which corresponds with first observations of declines in the 1980s.

**GETTING ZIKA**

The role of wildlife hosts in the emergence or re-emergence of arboviruses such as Zika, Chikungunya, and Dengue in human populations has received little attention. Considering Aedes aegypti as a principal vector and using a spatial
data mining framework to identify potential biotic interactions based on the degree of co-occurrence between different species, González-Salazar et al. identified mammal species with the highest potential for establishing mammal–vector interactions. Seven of the top ten species identified with highest potential were bats two of which previously had been confirmed as positive hosts for dengue in Mexico. These results call for further investigation into the role of wild hosts in the maintenance and spread of arboviruses.
What’s New

What’s New?

**2ND WORLD CONGRESS ON PUBLIC HEALTH AND NUTRITION**

This international, interdisciplinary conference will act as a center for public health professionals, nutritionists, epidemiologists, statisticians, clinicians, business professionals, foundation leaders, direct service providers, policy-makers, researchers, academicians, advocates, and others to discuss and exchange on recent public health-related concepts, encouraging the use of public health methods in studying disease burden, and highlighting existing opportunities in the fields of public health, epidemiology, and nutrition.

*March 22–24, 2017, Rome, Italy*

http://publichealth.global-summit.com

**NATIONAL PUBLIC HEALTH WEEK**

Join the American Public Health Association in celebrating National Public Health Week from 3 to 9 April and become part of a growing movement to create the healthiest nation in one generation. National Public Health Week celebrates the power of prevention, advocating for healthy and fair policies, sharing strategies for successful partnerships, and championing the role of a strong public health system. The National Public Health Week Web site lists several ways to join the movement on both local and global levels.

*April 3–9, 2017*

http://www.nphw.org

**ANNUAL CUGH CONFERENCE**

The Annual Consortium of Universities for Global Health (CUGH) Conference is designed to attract professionals from the health, social sciences, and public policy fields. In particular, the CUGH is interested in promoting interdisciplinary, cross-jurisdictional conversations across the globe to tackle challenging and complex problems.

*April 7–9, 2017, Washington, DC, USA*

https://www.cugh.org

**INAUGURAL PLANETARY HEALTH/GeoHealth ANNUAL MEETING**

The inaugural Planetary Health/GeoHealth Annual Meeting will bring together a diverse group of students, investigators, instructors, policy-makers, and other interested individuals who are committed to understanding and communicating the human health impacts of global environmental change with an objective to showcase the extraordinary momentum that is taking place around the world in the field of planetary health while highlighting institutional developments, emerging investigators, research developments, and applications to policy-making and natural resource management.

*April 10–11, 2017, Boston, MA, USA*

https://planetaryhealthannualmeeting.org
3RD INTERNATIONAL CONFERENCE ON ANIMAL HEALTH SURVEILLANCE

The 3rd International Conference on Animal Health Surveillance (ICAHS) will be a small, high-quality, and innovative conference, which facilitates and encourages networking and exchange of ideas and experiences of like-minded health professionals. Current information, communication technologies, and social media will be used to facilitate discussion and collaborations before and after the conference.
April 30–May 4, 2017, Rotorua, New Zealand
http://www.animalhealthsurveillance.org
Microcephaly

Unmoored from shallow berths of labored breath and borne awash by screams diluvial as those unfurled at only news of death,

her wailing sounded the resounding, full abyss of grief new-fathomed by the glance the doctor shot the nurse before the lull

of adamantine faith could serve to lance the race of knowledge toward what lies ahead, for grace, though limping, had become the dance.

Mark Olival-Bartley
Incubus

Kevin J. Olival

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Zika is insidious. Its symptoms are overwhelmingly mild, inconspicuous, and even go unnoticed—a rash, a fever, a headache—sequela that could result from any number of causative agents. Yet, on rare occasion its impact can be disastrous—deforming and depriving the unborn. Because of this, Zika strikes a deep chord of terror in many millions more than it infects. Like HIV in the 1980s, it is changing societal behavior—how we engage in love, where we travel, when we travel, and, now, whether we reproduce. Zika virus oppresses our most primitive and instinctual biological desire—procreation.

Zika is an incubus. A nasty demon who preys on unexpected young women in their sleep. Zika is an incubus. A nightmare—a horrific, tropical nightmare where mosquito bites beget babies with shrunken heads.

Zika is sexist. Zika is ageist. It disproportionately impacts women of child-bearing age, and young couples ready to start a family. It’s one of few vector-borne diseases that is also transmitted sexually. The fear and uncertainty are much worse than the odds suggest. Microcephaly, blindness, developmental abnormalities, arthrogryposis, and Guillian-Barré each may be exceedingly rare, but the unknown terrifies us. Will I draw the unlucky card? What will we discover next about this disease? The wave of knowledge about this old viral foe is just beginning to swell, and, just ahead of it crests another wave—the Zika epidemic itself.

Mark Olival-Bartley’s small and beautifully crafted poem, “Microcephaly,” reminds us of all of this. In nine undulating lines of iambic pentameter, replete with imagery of biblical floods and oceanic depths, he conjures up the terror of a birthing woman who drew that unlucky card. In three short stanzas, the reader is taken on an epic journey from terror to grief to respite. It’s the third and final stanza that is most interesting to me. We are left with, if only briefly, a feeling of hope. Some may interpret the reference to “adamantine faith” as the religious faith of the birthing woman; I interpret the reference as a faith in science. In less than two years, we have learned infinitely more about Zika virus than we knew in the 70 years since its discovery. We must have faith, that with science as our tool, we will knock this epidemic down. It seems a vaccine is around the corner; we’ve developed them for Zika’s cousins—Yellow fever, Japanese encephalitis, and Dengue. Yet we need more than vaccines.

In the penultimate line of “Microcephaly,” “the race of knowledge toward what lies ahead,” we are reminded that this virus, like all emerging infectious diseases, will continue to surprise and challenge us. The virus has already spurred a large and growing scientific body of knowledge. The final line of the poem leaves us with further hope. As with other past epidemics, society will walk away damaged from Zika, “limping,” but ultimately we will walk away and the dance (between pathogen and host?) will continue. Zika will make us smarter as a scientific community and better prepared as a society to deal with the next one. This too shall pass.

On this Issue’s cover, Kuniteru Utagawa’s 1885 wood-block print “Ten Realms within the Body” visually reminds us that both the hope and peril of society already lie in the hands of the unborn generation. A reclining woman points to her pregnant belly, cross-sectioned into 10 panels, each representing the ten spiritual realms of humanity. These are represented through the trials and joys of everyday life: transporting goods (humanity), teaching children in a classroom (learning), engaging in a fierce battle (hell), pulling a frail figure in a wagon (hunger), and gathering in a community circle (Buddhahood). In the center of all of this, appears her baby in utero. I can’t help but see in this artist’s rendition of baby a head too small, a sloping, and lowered braincase that differs from the other children depicted in the print. This is most likely an unintended artistic consequence—maybe Utagawa wanted the shape of the fetus to
better fit within the circular inner panel or he ran out of room on the woodblock when adding in this final figure? I see it as prescience—a vision of a Kanashibari-conceived son of an incubus. An artistic clairvoyance carved into wood 62 years before the initial discovery of Zika in 1947, and 130 years before the current epidemic began.

The final word of “Microcephaly’s” penultimate line, “ahead,” is an allusion to the poem’s title and difficult theme, but also, more subtly, a crafty near-rhyme with the opening (and third) line(s) of the poem. Through this brilliant work of prosody, Olival-Bartley loops us back to the beginning. To the terror, then the grief, and finally respite… pause… again… terror, grief, and respite. He has turned a short linear poem into a circle. Humanity will face this fate again. Emerging infectious diseases are on the rise. Zika, Ebola, Marburg, SARS, Nipah, and Mayaro—the respite are shortening. There will be another Zika. We must wake from this dream and stop it.
ABOUT THE POEM AND THE POET

To connote the damning nature of this lifelong sentence, these three tercets employ the sacred number, nine, and rhyme scheme, terza rima, of Dante’s *Commedia* while alluding to the myth of a great flood that anoints a new world by drowning the old.

Mark Olival-Bartley is the resident poet at EcoHealth Alliance. He is presently reappraising the sonnets of E. A. Robinson for his dissertation at the Amerika-Institut of Ludwig-Maximilians-Universität München, where he tutors composition and poetics.

ABOUT THE ART AND ARTIST

Buddhist cosmology is the description of the shape and the evolution of the universe, according to Buddhist scriptures, ideology, and commentaries. Buddhist cosmology recognizes ten spiritual realms that humans and sentient beings are subject to, and experience moment to moment. The ten realms are separated into two sections, the six realms of desire: Hell, Hunger, Animal, Arrogance, Humanity, Heaven, and the four higher realms: Learning, Realization, Bodhisattvahood, and Buddhahood. This Japanese print, “Tainai jikkai no zu,” illustrates the ten realms within the womb of a pregnant woman, with the middle figure representing the heart. Unfortunately, there is little information known about the artist, Utagawa (Toyohara) Kuniteru III. It is believed that he lived from 1830 to 1874, and specialized in the ukiyo-e genre of Japanese art, iconic for its woodblock prints and paintings of travel scenes and landscapes, sumo wrestlers, scenes from history and folklore, and even erotica. This is from a collection at the University of California, San Francisco, containing hundreds of Japanese prints and paintings depicting and representing the relationship with Japanese society and health issues such as contagious and infectious diseases, most commonly introduced by Western travelers.