The PHI BETA KAPPA Society

VISITING SCHOLAR PROGRAM

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PUBLIC LECTURE OFFERINGS

EXTREME WEAPONS: A NATURAL HISTORY

Every animal has a weapon of one sort or another, but the overwhelming majority of weapons stay small. Yet, sprinkled through the tree of life are species where weapons become extreme. Occasionally, human manufactured weapons also evolve to extremes. Emlen reveals that the same critical conditions trigger arms races in both cases, and the most crucial prerequisite is duels. A journey that begins with biology becomes the story of all weapons, as Emlen discusses beetles and battleships, crabs and the Cold War.

This talk tackles head-on several controversial topics such as costly state-of-the-art military technologies and the escalating tensions between the US and China (the next big duel?). It weaves the stories of military arms races with the stories of a menagerie of heavily-weaponed animal species. Ultimately, it is a talk about the surprising relevance of basic “muddy boots” biology to pressing national security issues of our age, and the value of reaching outside of traditional disciplines to bring fresh perspectives to old questions.

THE EVOLUTION OF EXTREME WEAPONS (LESSONS FROM A RHINOCEROS BEETLE)

What limits the size of nature’s most extreme structures? For weapons like tusks, antlers, or beetle horns, one possibility is a tradeoff associated with mechanical levers: as the output arm of the lever system gets longer—the

antler or the beetle horn—it should also get weaker. Emlen and his colleagues test for this tradeoff in the giant Asian rhinoceros beetle Trypoxylus dichotomus, a species where males wield a "pitchfork" shaped head horn that can comprise up to 30% of the weight of the male. Emlen also discusses results from field studies of multiple natural populations of beetles exploring how changes to the mating system contribute to population-differences in the strength of selection acting on male horns, potentially explaining population differences in the length of the horns. The talk ends with a surprise: even after battling to hold a territory, male beetles must perform stridulatory "songs" and trembling "dances" on the backs of the females! Experiments underway are exploring the functional significance of these putative courtship signals, revealing just how much we don't understand about this amazing animal system.

This talk is aimed at academic audiences (biology departments) but is written in a "stand-alone" fashion that works fine with broader audiences. It is a fun story of the detective process so fundamental to basic scientific research, and a healthy reminder of how often our initial ideas turn out to be wrong!

The following two talk options are not based on Emlen's own research, but come from his many years teaching about the excitement and relevance of evolutionary biology. These are stand-alone versions of two of the most popular lectures in his Genetics & Evolution course.

EVOLUTION OF INFLUENZA & COVID

This sweeping narrative digs into what really happened in 1918-19, leading to a pandemic strain of influenza that ultimately claimed the lives of 1 out of every 20 people on the planet. Viewed through the lens of evolutionary biology we see how rival strains of influenza compete, and how shifts in human behavior – crowding and mass movement of troops related to the waging of WWI – created conditions that favored the most virulent viral genotypes, permitting these deadly strains to spread. At the same time this lecture also tells the more familiar story of the rise and spread of COVID-19, with eerily familiar themes. Viewed from the perspective of the virus, how does our modern world

compare to that of 1918-19? We obviously have better medical practices, and we know a lot more about pathogen transmission; but we also have eight billion people on the planet, higher urban densities, and high-speed airline travel mixing populations on an unprecedented scale. We'll see how our modern world works against us by creating opportunities for rapid evolution of virulent pathogens, and how and why public health measures like social distancing, masks, and vaccines can work to counteract these selective pressures. Shocking, full of historical narrative, and touching on politically sensitive issues like masks and vaccines, this talk brings an evolutionary biology perspective to the social upheaval of global pandemics.

EVOLUTION OF CANCER

Insidious and terrifying, cancer will claim a third of us. Most people have either battled with cancer themselves or have had close family members or friends with cancer. What is cancer? And why is it so difficult to defeat? This talk examines cancer through the lens of evolutionary biology, examining the "big picture" – the tenuous détente between the various cells in our bodies and what happens when individual cells turn rogue (we'll see that cancer risk applies to all long-lived multicellular species) – as well as more fine scale perspectives such as why specific populations of cells are more vulnerable (breast, lungs, brain, colon etc.) and what happens to the population of cells within a tumor once cancer has started. We'll see that cancer is a disease that is all about evolution. Battles between rival cells within tumors ("tumor heterogeneity") drive the evolution of cells that better exploit our bodies' resources, racing to divide faster than rival cell lines and ultimately dispersing beyond the tumor to infect other parts of our bodies (metastasis). Even though mutations strike at random, we'll see that the suite of mutated genes that drive cancer is not random at all, and the sequential stages of tumor evolution are highly repeatable. This lecture also delves into exciting modern approaches to fighting cancer (e.g., CRISPR gene editing and CAR-T cell therapy) and explicit uses of evolutionary theory to improve the application of chemotherapeutic and other treatments.

DOUGLAS EMLEN

CLASSROOM DISCUSSION TOPICS

1. COMMUNICATING SCIENCE TO NONACADEMIC AUDIENCES

We live at a time when science is more relevant than ever, yet at the same time science has become dauntingly complex. How do we connect with audiences outside of our disciplines in ways that are impactful and constructive? Emlen has tackled this challenge in many ways, writing a “trade book”; a narrative nonfiction chapter book for middle school readers; and a college sophomore level textbook coauthored with a science writer (Carl Zimmer). He worked with film producers on documentaries for the BBC and Nova, and he has given dozens of interviews for radio, YouTube, and other outlets. Each project brought new challenges – different audiences requiring different approaches – and he readily admits he stumbled repeatedly along the way, making every mistake in the book at one time or another. However, he benefitted from dedicated and talented editors and countless critical reviewers, and he has amassed a wealth of tips and tricks. Many of the rules of trade book writing and journalism conflict starkly with what we are taught in academia, providing ample fodder for debate.

An open discussion on this topic would bring together the experiences of others in the audience, as well as Emlen’s, to discuss topics like finding the narrative, how much information is too much, knowing your audience, the importance of sequence when assembling complex ideas, when and how much to anthropomorphize, active versus passive phrasing, and first versus third-person perspectives. He is also happy to discuss the publishing process – finding an agent and writing book proposals for the trade industry, versus working with an academic press like Oxford or Princeton – and using other media, including working with illustrators and artists, designing exhibits for museums, and collaborating with dancers and composers.