

THE SENIOR COLLEGE MESSENGER

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This is an organ for members of Senior College to submit short articles that share news, opinions, reactions to the program and anything that they feel will be of general interest. Its regular appearance will allow for an exchange of opinion of topics of interest to the members.

Please submit contributions to the editor, Ed Barbeau at barbeau@math.utoronto.ca

MONOCULTURES

Harold Atwood, Department of Physiology

Visiting Honduras in early April 2018, we were guided through the wooded hills away from the coast most of the time, observing and photographing a host of birds, butterflies and plants. We recorded butterflies and moths not previously reported for Honduras. Truly, a biological wonderland for winter-blasted Torontonians. At trip's end, we descended to the Caribbean coast and travelled many miles along it. Most of the lowlands we traversed had been converted into plantations of oil palm – mile after mile of overwhelming uniformity. Non-oil palm vegetation had been assiduously extirpated; the palm trees were scientifically spaced in regimental order. Not much evidence of birds or butterflies here in this impressive but biologically less interesting monocrop. Later on, I realized we had glimpsed one of the largest of man-made monocultures, which now account for 10 to 20 percent of the world's permanent cropland. Huge areas of Indonesia and Malaya, in particular, are now devoted to oil palm plantations, while clearing and burning of original forests to make room for more proceeds year by year in response to economic forces. Disappearance of original forests leads to disappearance and threatened extinction of many birds and other animals that live there. (Our biological 'relative', the Orangutan, is a case in point.) But palm oil is an essential component of food production and preparation, and is incorporated into a host of other commodities, especially those destined for India, Indonesia, and other Asian countries. Human needs and economic realities relentlessly dominate the approaches to land use in regions where oil palms can be grown.

Many driving trips through the midwestern states of Illinois and Iowa for family visits have cemented out familiarity with another of the great man-made monocultures: the vast corn-growing fields that produce the USA's largest crop. Upwards of 80 million acres of corn generate over \$50 billion in annual sales. One passes through endless fields of it, with fields of soybean interspersed now and then. The soybeans are a rotation crop planted to restore nitrogen to the soil, but also as an intended defence against a major problem for corn growers: attacks from a small beetle known as the Corn Rootworm. The worm-like underground larval stage of the beetle eats the roots of the corn plants, ruining the crop or drastically reducing its yield. Originally, rootworms (four species in the genus *Diabrotica*) were relatively innocuous residents of Central America, but gradually worked their

way northwards. When they invaded the corn monoculture of the Midwest, their populations exploded.

Huge amounts of time and money have been focussed on ways to combat rootworms, but their nimble genomes and the Darwinian evolutionary process of natural selection have allowed them to survive despite successive attempts at their destruction. Initially, various insecticides were applied, but rootworm variants with genetically endowed resistance to each insecticide in turn emerged rapidly. Facilitating this, the corn monoculture permitted very large beetle populations to build up, which in combination with their inherent genetic flexibility, increases the likelihood for selection of mutations that confer resistance. (Similar evolution of genetic resistance to insecticides has often occurred in other insects – for example, cockroaches’ resistance to DDT.) The second line of defence against the invaders is crop rotation. Soybeans are planted after a corn crop has been harvested. Rootworms deposit overwintering eggs in the soil after their summer feast on corn; in a field planted the next spring with soybeans, emerging larvae are confronted with an inedible crop and starve to death. Then, according to the crop-rotation scenario, corn can be safely planted the following year in a field free of rootworm larvae. But here again, natural selection held out a helping hand to the beetles. A variant appeared that could survive by eating the roots of soybean plants. Another variant’s overwintering eggs were able to prolong their dormancy for an extra year, breaking dormancy when corn was replanted after a year of soybeans. These evasive techniques spurred a third move by humans in this evolutionary arms race. Transgenic corn plants were crafted to contain genes for one or more of four toxins produced by a bacterium, *Bacillus thuringiensis* (*Bt*). The Bt toxins, harmless for humans, poke lethal holes in the larva’s digestive tract. For a few years, this method of control was a success – but then, resistant variants began to appear. In desperation, to slow the development of large Bt-toxin resistant populations, growers can plant corn that does not contain transgenic Bt genes next to fields of Bt-containing corn. The purpose of this refuge is to provide a corn crop habitat that allows rootworms to feed and reproduce without being exposed to the Bt toxins. It is clear that rootworms exposed to the Bt toxins each year for many generations will evolve to become Bt-resistant. But when a refuge is present, the beetles that have become resistant will mate with the non-resistant ones from the refuge area. Since resistance is usually a recessive trait, the resulting offspring would not be resistant and dies eating corn roots containing Bt toxins. This prolongs the use of this transgenic technology at the cost of sacrificing some corn plants in the refuge area. Hoping to stay ahead of the beetle’s evolutionary tactics, scientists in the USA are developing additional genetic attacks to combat their enemy; these putative weapons have been under assessment.

We can extract general principles on weakness of monocultures from this example. **First**, large monocultures are susceptible to attacks from organisms that prey upon them (and are often introduced). Looking back in history, we may recall another more tragic monoculture episode, the Irish Potato Famine, or Great Famine, of 1845 to 1852, resulting in one million Irish deaths and 2.1 million leaving the country. In this case, the potato monoculture in Ireland was devastated by an introduced fungal organism (*Phytophthora infestans*). **Second**, invaders of monocultures often generate very large populations, and adaptive mutations that occur

randomly by chance are much likelier to arise and take hold. **Third**, brute-force control by lethal chemicals (insecticides in particular) can often be circumvented by natural selection, as mutations arise that endow the targeted organisms with genetic adaptations for survival. Other organisms with smaller populations may be extirpated in treated areas, as detailed in scientist Rachel Carson's seminal book *Silent Spring* (1962) – a devastating exposure of the irresponsibility and harmfulness of an industrial society toward the natural world.

From a biological standpoint, Earth's human population has many attributes of a monoculture, although it is certainly more complex than a corn-field. We are a single species; we occur at high densities in cities; we now encompass the whole planet, and though not uniformly distributed, we interact extensively through modern transportation. We should not be surprised that the principles of weakness that operate in monocultures of other organisms, both plant and animal, apply also to the interactive human population. A current example is the virus outbreak causing Covid-19. The virus entered the human population in China, and spread rapidly to cause infections all over the world. This spread was facilitated by dense populations in cities and by extensive interconnections of separated cities. The virus proliferated by infecting large numbers of people. This in turn created the ideal conditions for adaptive mutations to arise through natural selection, so spawning a host of variants. Some mutations have allowed the virus to partially elude vaccines developed to contain it. (As one colleague put it, we are "seeing evolution in the fast lane"), Methods to contain the virus have included loosening the monocultural features that promote its spread, such as limiting large crowds, interpersonal interactions, and travel.

Another serious threat to the human 'monoculture' is the appearance of drug-resistant bacteria. Unwise use of antibiotics has created conditions that favour natural selection of variants resistant to most of the developed anti-biotics. Once a resistant variant shows up, it can be easily spread from one person to another in a densely packed populations. This has been gradually happening, particularly in hospitals. Given the current difficulties in coming up with new antibiotics to get past the evolution of antibiotic-resistant bacteria, and the likelihood that resistance will develop sooner or later even if a new antibiotic is found, additional measures must be sought for protection. Stricter adherence to public health procedures needs to be promoted. Vaccines, when available, are preferable to anti-biotics for combatting our microscopic enemies. We must keep in mind the weak points of monocultures, and the power of natural selection, as we guard against situations that allow invaders to evolve rapidly.

(*Acknowledgment*: Milton Charlton kindly reviewed this essay and contributed helpful suggestions.)

SENIOR COLLEGE: A Personal Note

**Peter Hajnal, Information Studies, Munk School of
Global Affairs & Public Policy**

Some ten years ago, shortly before RALUT gave birth to Senior College, I had a conversation over lunch with Peter Russell who encouraged me to get involved in that new initiative. He reassured me that I might contribute and play some role, and I became one of the founding Fellows. During the past ten or so years, I have been impressed and inspired by the leadership of Peter Russell, Harold Atwood and Michael Hutcheon in steering the College to widening its scope of activities, outreach and intellectual heft, with the commitment and enthusiasm of chairs and member of the various committees and programs.

Over the years I served as a member of several committees: first, the Membership and Recruitment Committee (as it then was) and the Colloquium Committee (of which I was interim chair for a term, taking over from Betty Roots); co-chairing the Excursion Subcommittee for a while; and I have been active in our informal refugee support group (which, under the name of Scholars Giving Sanctuary, was mostly the brainchild of our late colleague Joe Whitney). That group kept up its work and pressure, overcame considerable bureaucratic obstacles and sponsored a Pakistani refugee family; as well, interested individual Fellows and their families have continued to help refugees in various ways.

I received two research grants from the College. These helped fund my research first of reforming the G7 and G20, then of the role of information technology in the functioning of these two informal institutions of global governance. The reform piece became a chapter in the second edition of my book *The G20: Evolution, Interrelationship, Documentation* (Routledge, 2019), and a spinoff article, “Whither the G7 and the G20?” about to be published in *Canadian Foreign Policy Journal*. A third result, an article on the two “Gs”, co-written with my research assistant Gillian Clinton, is being submitted to another journal.

Being a Fellow of Senior College has been a rewarding experience. Intellectual stimulation and collegiality have been constants. More recently, the College met successfully the new challenge of finding an appropriate technological response to the Covid-19 pandemic: meetings on Zoom. May the College continue to flourish!

ATTENTION BOOK ENTHUSIASTS!

Many of you have enjoyed the rewards of taking part in the Senior College Book Club experience. Now we need **your** recommendations of outstanding books for the upcoming year. The more we have, the better we will be able to achieve an interesting, varied and above all, first-class program.

The Book Club committee welcomes fiction of all genres and non-fiction that explores issues and developments in all fields. In particular, two slots are reserved for classic books, such as *Frankenstein* and those dealing with the arts, such as *In Montmartre: Picasso, Matisse and the Birth of Modernist Art*, to give examples from this year's schedule. Books should be accessible to colleagues from diverse disciplines.

The nomination process is simple. Just give the name of the book and its author, along with a brief reason for your nomination if you wish. Send your suggestions for as many books as you wish to seniorcollege@utoronto.ca no later than **March 15**.

CALENDAR OF COMING EVENTS

Events marked with **F** are for fellows and external fellows. Register through the weekly email notifications or by going on line at <https://seniorcollege.utoronto.ca> and clicking on *Events*.

Seventeenth Annual Symposium

Wednesday, April 20: all day

What have we learned from the pandemic?

Weekly Talks: Wednesdays, 2-4 pm

March 2: **Nicholas Gunz** (History)

Observations on analytic naval intelligence

March 9: **Mark Lautens** (Chemistry)

Advocating for science

March 16: **Lynn Hasher** (Psychology)

Aging and memory: some surprises

March 23: **Joel Faflak** (English)

Getting happy: learning to love musicals

May 4: **David Moffett**, Criminology, University of Ottawa

Immigration and criminalization in Canada.

May 11: **Tom Tiekou**, Political Science, Western U, London

The African Union.

May 18: **Carl James**, Chair in Education, Community & Diaspora, York U.

How did we get to now? Systemic inequality, racism and the culture of exclusion in Canada.

May 25: **Barrington Walker**, History, Wilfrid Laurier University

Blackness, violence and modern Canada.

June 1: **Brendon Gurd**, Kinesiology & Health Studies, Queen's University

Can exercise be bad for you? The facts about exercise non-responders.

June 8: **Keith Baar**, Molecular Biology, UC Davis

Molecular biology and living longer, healthier lives.

Colloquia: Thursdays, 2-4 pm (F)

March 17: Chair - Martin Klein

Should we reform the police in Canada?

April 28: Chairs - Daphne and Charles Maurer

Is a post-racial society possible?

May 19: Chairs - Phil Sullivan, John Yeomans

Are there threats to academic freedom from within the university?

Book Club: Mondays, 2-4 pm (F)

March 7 (Chair: Marty Klein)

Caste: The origins of our discontent (by Isabel Wilkerson)

April 4 (Chair: Meg Fox)

In Montmartre - Picasso, Matisse, and the birth of modern art (by Sue Roe)

May 2 (Chair: Sara Shettleworth)

Fundamentals - the key to reality (by Frank Wilczek)

June 6 (Chair: Maggie Redekop)

Who do you think you are? (by Alice Munro)

July 4 (Chair: Linda Hutcheon & David Milne)

Lampedusa (by Steve Price)

Coffee hours: Thursday, 2-3 pm

March 10; March 24