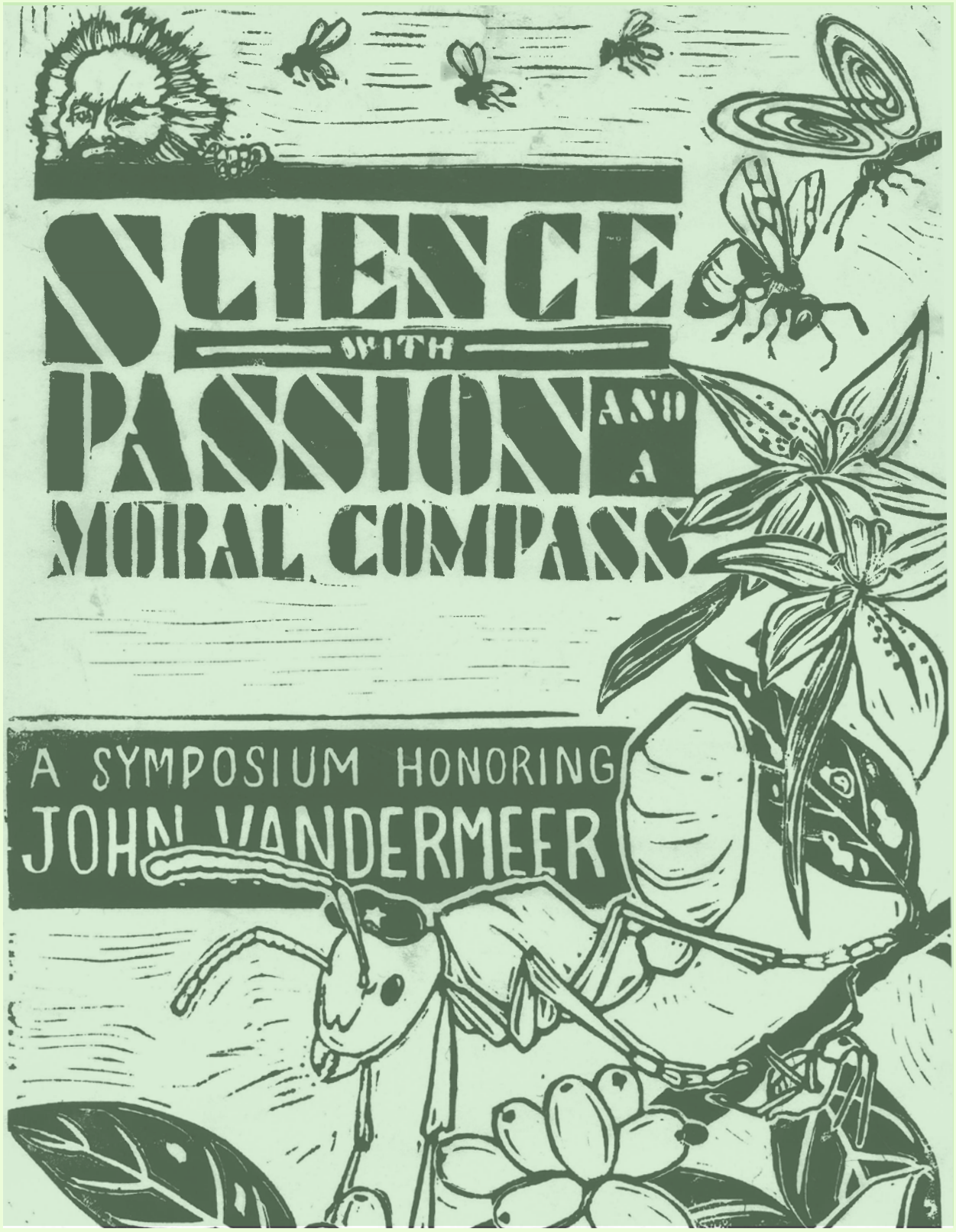

JOHN VANDERMEER – THE DIALECTICS OF ECOLOGY: BIOLOGICAL, HISTORICAL AND POLITICAL INTERSECTIONS

P U B L I C A T I O N S O F
ECOLOGY AND EVOLUTIONARY BIOLOGY, UNIVERSITY OF MICHIGAN
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RECENT *MISCELLANEOUS PUBLICATIONS*

Smith, G. R., and J. Van Tassell. 2019. Keating, Always Welcome Inn, and Imbler Fish Paleofaunas, NE Oregon: Tests of miocene-pliocene drainage connections. pp. 1-34, figs. 20. *In*: Fishes of the Mio-Pliocene Western Snake River Plain and Vicinity. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 204, no. 5.

Smith, G. R., Martin, J.E., and Carpenter, N.E. 2018. Fossil fishes from the miocene Ellensburg formation, South Central Washinton. pp.1-19, figs. 11. *In*: Fishes of the Mio-Pliocene Western Snake River Plain and Vicinity. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 204, no. 4.

Smith, G. R., Zaroban, D. W., High, B., Sigler, J. W., Schilling, J., Krabbenhoft, T. J. and Dowling, T. J. 2018. Introgressive mtDNA Transfer in Hybrid Lake Suckers (Teleostei, Catostomidae) In Western United States. pp. 87-118, figs. 14, 7 tables. *In*: Fishes of the Mio-Pliocene Western Snake River Plain and Vicinity. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 204, no. 3.

Smith, G. R., Chow, J., Unmack, P.J., Markle, D.F. and Dowling, T.E. 2017. Evolution of the Rhinicthys Osculus Complex (Teleostei: Cyprinidae) in Western North America. pp. *i-vi*, 44-83, figs. 17, 4 tables, 1 appendice. *In*: Fishes of the Mio-Pliocene Western Snake River Plain and Vicinity. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 204, no. 2.

Stearley, R. F. and G. R. Smith, 2016. Salmonid fishes from Mio-Pliocene lake sediments in the Western Snake River Plain and the Great Basin. pp. 1-43, 17 figs., 4 tables, 3 maps. *In*: Fishes of the Mio-Pliocene Western Snake River Plain and Vicinity. *Misc. Publ. Mus. Zool., Univ. Michigan*, No. 204.

RECENT *OCCASIONAL PAPERS*

Kraus, Fred. 2015. A new species of the miniaturized frog genus *Paedophryne* (Anura: Microhylidae) from Papua New Guinea. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 745, pp. 1-11, 2 figs., 1 table, 1 map.

Wilkinson, M., A. O'Connor, R.A. Nussbaum. 2013. Taxonomic status of the neotropical Caeciliam genera *Brasilotyphlus* Taylor, 1968, *Microcaeilia* Taylor, 1968 and *Parvicaecilia* Taylor, 1968 (Amphibia: Gymnophiona: Siphonopidae) *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 744, pp. 1-10, 2 figs., 1 table.

Smith, G.R., J.D. Stewart & N.E. Carpenter. 2013. Fossil and Recent mountain suckers, *Pantosteus*, and significance of introgression in catostomin fishes of the western United States. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 743, pp. 1-59, 12 figs., 2 appendices, supplementary material.

Lindsay, A.R. & S.C.G. Haas. 2013. DNA from feces and museum specimens confirms a first state record bird. *Occ. Pap. Mus. Zool., Univ. Michigan,* No. 742, pp. 1-10, 4 figs., 1 table.

Ann Arbor, Michigan 48109-1079, U.S.A.

JOHN VANDERMEER

THE DIALECTICS OF ECOLOGY: BIOLOGICAL, HISTORICAL AND POLITICAL INTERSECTIONS

Ann Arbor, February 21, 2020
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PREFACE

For many years, I have found John Vandermeer's leadership rewarding to study and follow for his commitment to ecology, evolution, social justice, and teaching. This collection of essays and tributes demonstrates these commitments and his breadth of influence over five decades. When we were graduate students, John's analysis of geographic variation in a freshwater fish was so superior to anything that had been done before that many of us were compelled to follow his quantitative perspective. His imagination and productivity as a zoology graduate student at Kansas and Michigan marked him as someone to watch, and followers were immediately attracted to his science and his revolutionary spirit.

Among the scores of essays and tributes here, we see the extent of John's fostering of originality in the pursuit of social justice, agroecology, and ecology. I mention a few of these to illustrate the breadth of his influence.

No action was more exemplary of John's moral compass than his gathering of a group of students to travel to Nicaragua to help the new Sandinista revolution rebuild education after the Samosa dictatorship and later after hurricane Joan, as recounted here by Katherine Yih, one of the 1970s students working with him. Katherine also introduces John to readers of this collection of essays by his students and followers.

"The struggle between those who possess social power and those who do not … is a war fought with many and varied weapons." This paraphrasing of Marx and Engels from Richard Lewontin's: 'Biological Determinism as a Social Weapon,' is quoted here in the essay by Dr. Joseph Graves, an early student of John. Dr. Graves is now a major force in the fight against the misuse of genetics by racists and biological determinists.

Doug Boucher's thoughtful essay on 'theory of change' expands on Einstein's warning that "all of us who are concerned for peace and the triumph of reason and justice must be keenly aware how small an influence reason and honest good-will exert upon events in the political field." Doug presents a refreshing and compelling view of the way ahead.

Helda Morales documents the promise of John's fight against sexism. 'Following his example, we will continue to build an agroecological science that is more consistent with our principles--- a more socially sensitive, diverse, and resilient agroecology.'

In the spirit of the New World Agriculture and Ecology Group (NWAEG), Luis Fernando Chaves describes a model he developed to couple land-use dynamics and land tenure, reproducing the patterns of latifundia formation described by Celli for the Roman Empire. Here, he describes a basic message from the model --- inequities in access to health care can create poverty. Things always become more dynamic, entangled, and full of contradictions, requiring new dialectical synthesis.

A group of John's agroecology activists, Senay Yitbarek, Theresa Ong, Doug Jackson, and Dave Allen, members of the Out-of-the-Box Collective, highlights a fundamental NWAEG theme quoting Chomsky: "citizens in democratic societies should protect themselves from manipulation and control by their leaders." "Chomsky's views are deeply entrenched in the Enlightenment tradition, out of which a humanistic conception of education developed to cultivate creativity, independent inquiry, and solidarity with others."

In his essay "teaching sustainable agriculture," Brian Schultz presents a host of ideas important to agroecology: 'A farm is an ecological system where the crops are part of a dynamic community of living organisms that interact in food webs and evolve, plus nonliving components such as soil, water, air, and energy, all connected to the rest of the world. 'Agriculture teaches lessons about economics and politics in both directions: To do agriculture right we need social change, and sustainable agriculture could then become rather easy; agriculture is a great case study for why we need that larger social change.'

Catherine Badgley casts her hopeful gaze into the future to see where today's exciting trajectory toward agroecology could lead. The coming collision between feed-grain, meat, and dairy industries with shortages of water, fossil fuel, and healthy soil is forecast to favor small, soil-building farms, healthier citizens, and enriched, more just farm employment.

Peter Rossett is always concerned with social movements, agroecology, and food sovereignty. Here he describes John's early guidance and where that path leads: What is the question you are trying to answer? Your questions come from the people that you hang out with. Peter's powerful message is that if we want to do socially relevant research that has the capacity to transform reality, we have to do it together with, and if possible, within, movements that have the confluence of forces and the mobilizing capacity to actually make change. Change doesn't come from scientific papers, it often comes from the number of people that you can put in the streets.

John Soluri documents the migration of agroecology across disciplinary boundaries and into fields of biology, political economy, history, agronomy, forestry, and anthropology, along with his own development across disciplines from NWAEG to history. He describes the critical meeting point between biological evolution and political revolution.

Jahi Chappell came to John as an engineer, attracted to work in agroecology. In his essay he notes the need to bring ideas from the natural and social sciences to the public at large. He proposes application of the extension model from land-grant colleges to the rest of academia to assist groups in civil society to develop the means to advance practical skills combining science, social justice, and democracy in the spirit of Science for the People.

Historian Susan Wright details and compares the suppression of knowledge of environmental impacts by biotech corporations with the generation of knowledge in the practice of agroecology. Her analysis of the development of genetically modified organisms in the food system emphasizes the profound difference in the ethical foundations of these two paradigms of agricultural knowledge.

Stacy Philpott, Shalene Jha, Heidi Liere, and Brenda Lin present an urban perspective on agroecology: "Most of the US population lives in urban areas, yet many residents lack sufficient access to fresh produce and nutrition. In response, urban agriculture has expanded dramatically, especially in under-served communities, and currently provides >15% of the global food supply. Yet, gardeners lack appropriate agricultural knowledge regarding pest control, pollination, water storage, and garden sustainability."

Ivette Perfecto's tribute to John aptly summarizes her observations with a quote from Brecht: 'There are people who fight one day and are good. There are others that fight for a year and are better. Some fight for many years and are very good. But there are those who struggle all their lives, these are the essentials.'

John Vandermeer's response to the scores of tributes is characteristic. Citing the famous phrase by Hegel that "the truth is the whole," John builds on the interconnectedness of all things political and ecological. It is his rallying cry for those who wish to promote a deeper political analysis of ecology, especially in the context of the current environmental crisis. He contrasts R. A. Fisher's view of the influence of 'the environment as a troublesome variable that needs to be factored out of genetic experiments' with Lancelot Hogben's deeper understanding of the additive effects of genetics and environment, and our dialectical concern with understanding their interaction.

The most concise tribute in this collection is from John's most important mentor, Richard Levins, shortly before his death: 'John recognizes that contemporary biology is limited—that it's still fragmented, it's still reductionist, it still looks at the world in pieces. And John has fought vigorously to prevent this from happening— to strengthen the complex view of nature that characterizes the Marxist tradition.'

Gerald Smith, December, 2018

JOHN VANDERMEER

THE DIALECTICS OF ECOLOGY: BIOLOGICAL, HISTORICAL AND POLITICAL INTERSECTIONS

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Brian Schultz
Eduardo Somarriba
Jack Spence
Ann Thrupp
Liz Wason
Jake Weiner
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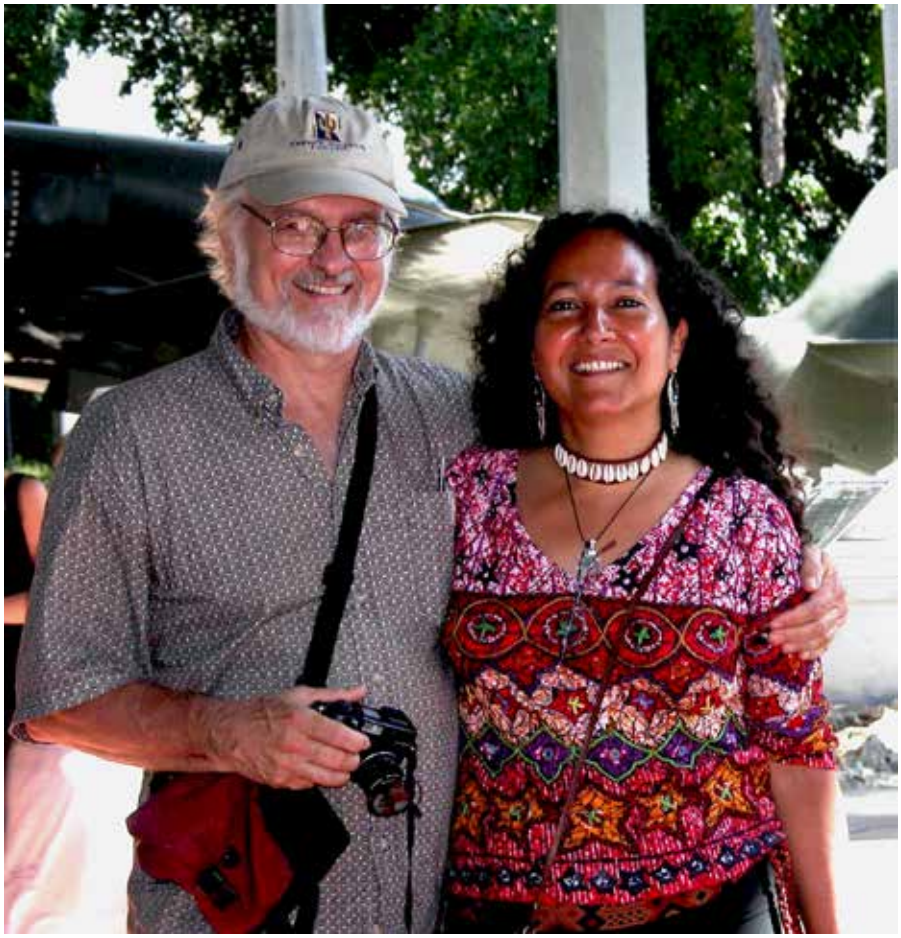
John Vandermeer Response



INTRODUCTION TO JOHN VANDERMEER*

By

Katherine Yih

I'm very happy to have the opportunity to introduce our keynote speaker, my old friend, comrade, and mentor, John Vandermeer. I should probably start by telling you what he does for a living. John teaches at the University of Michigan, where he holds the title of Asa Gray Distinguished University Professor of Ecology and Evolutionary Biology. He's interested in practically everything—including history, philosophy, political economy, you name it—but within the field of ecology, his particular areas of concentration have been theoretical ecology, tropical ecology, and agricultural ecology. He has a sterling set of academic credentials and a long list of publications, including several books co-authored with his partner, Professor Ivette Perfecto, on themes of agriculture, conservation, food sovereignty, and the relationships among those.

John provided continuous leadership and energy to the Ann Arbor chapter of Science for the People, while we students came and went over the years. I was there in the late '70s and early '80s, and in that period, we had subgroups working on critiques of biological determinism, the second Science for the People trip to China, editing the magazine, and such. John was instrumental in forming a couple of subgroups that grew into strong solidarity organizations. One was the Ann Arbor support group for the Midwestern farm workers' union known as FLOC, the Farm Labor Organizing Committee. (I still remember the day that John proposed driving down to Toledo to meet with them to see if there was anything we could offer. This was such a novel thing, to me at least, to break out of the campus bubble and make connections like that. But John was always aware of strikes and other important struggles and movements happening locally as well as nationally and internationally.) FLOC was on strike and undertook an ambitious national consumer boycott against a couple of big vegetable canning corporations, and we were able to provide them with significant support of various kinds over several years.

The other organization that John was a driving force in creating, again out of Science for the People, was NWAEG, the New World Agriculture and Ecology Group. NWAEG's work in Nicaragua is another example in which John said, "Let's see if these people could use any help." This was in the summer of 1979, just after the Sandinistas had ousted Somoza and come to power. So a year and a half later, a group of us went there to meet people and reconnoiter, and ultimately cooperative agreements were established with several Nicaraguan institutions, which established the basis for many years of scientific and political solidarity work.

As a teacher, John has taught and continues to teach "straight" ecology courses, but his biggest course, which he has taught for decades, is a course for undergraduate non-majors that deals with sociopolitical issues in biology. (While I was at Michigan, some of the students used to refer to it as "commie bio," which they probably didn't mean as a compliment, but those of us teaching in the course took it that way!) John is a brilliant and compelling teacher who really challenges his students to think. I don't think it's hyperbole to say that generations of undergrads at Michigan have had their eyes opened through that course to an alternative view of why things are the way they are in our society and world. Of course, they didn't all become leftists, but John used to say he didn't care if they believed everything he said; he just wanted them to learn to question things and to *keep* questioning.

As a mentor, John has been remarkably influential. He has mentored dozens of students who have gone on to successful careers often involving some kind of political activism or work in the public interest. I should say that not all of John's students ended up getting degrees, but he is one of the few mentors you'll ever meet who takes pride in his students dropping out (or at least he used to back in the '70s, anyway)! The ones I knew who dropped out did so to take up occupational health and safety work with unions or to do farmworker organizing.

I was talking about John with Margaret Reeves recently; Margaret is a friend who was also at Michigan and in Science for the People and NWAEG. I asked if she had any ideas of what I should say when I introduced John. Margaret thought about it a bit and then proceeded to tell me about something that had happened at the West Coast regional meeting of NWAEG in February [2014]. Folks were trickling in little by little over a two-hour period, during which time people sat around and shared their stories about what they were working on and how they'd gotten there. After the meeting, a colleague of Margaret's, whose first NWAEG meeting this had been, asked her, "Who is this person *John* that everyone kept referring to?" So, as Margaret concluded, "I think one of John's *hugh* legacies is all the many, many people. . .out there in the world doing good things and who all, in one way or another, point

to John as a key influence in their life and career decisions."

What is his secret? I think it's a combination of several characteristics, but I'll mention two of the big ones: First is his love of biology and ecology, which is so evident to anyone who's ever been in the field with him. Pretty much any field will do, as long as there are a few ants in it! And he transmits that enthusiasm to his students. Second is his politics. And by that, I mean his deep solidarity with the oppressed, his clarity about the structural causes of exploitation and oppression, and the tremendous energy and commitment he brings to the struggle for social justice.

It's the interaction of these two passions that's particularly powerful. One of John's blog posts was a review of a book about Darwin, in which he writes, "Darwin was a passionate advocate of a political position [for the abolition of slavery] and used his science to advance that position. Indeed . . . his political position actually drove his science."

I think that exactly the same can be said of John.

So all of this, plus his unstoppable energy, love of people, and sense of fun, creates a kind of magnetism about John, which draws people into a swirl of exciting ideas and people and collective action. After a few years in that ferment, people end up making big changes in their trajectories and ultimately go out into the world equipped with some solid scientific knowledge, as well as a critical political perspective and a lot of motivation to work and join with others in the struggle. A huge legacy indeed!

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* Keynote speaker at the conference "Science for the People: The 1970s and Today," University of Massachusetts at Amherst, April 12, 2014

2010's

SCIENCE, POLITICS, AND POWER

Fighting the Power: Race and Genomics in the 21st Century, A Paper for "Science With Passion and A Moral Compass: A Symposium in Honor of John Vandermeer"

By

Joseph L. Graves Jr.[1]
Associate Dean for Research and Professor of Biological Sciences

ABSTRACT

Advances in the biological sciences during the twentieth century have provided the intellectual scaffolding to dismiss biological determinist thinking forever. Yet despite this, particularly in arenas associated with biomedical research associated with socially defined race, biological determinism is resurgent. This article examines biological determinism in the age of genomics, particularly as it is associated with racialist understandings of human genetic variation. This is best illustrated with regard to the claims of racial medicine (a modern biological determinist variety). In addition, this article examines the use of genomic data and clustering algorithms (such as STRUCTURE) to claim legitimacy for racial clustering. Finally, the article discusses how biological variation generated by genetic, epigenetic, environmental, and chance effects invalidate biological determinist explanations of the human social condition.

PROLOGUE: BIOLOGY AS A SOCIAL WEAPON

"The struggle between those who possess social power and those who do not, between freeman and slave, patrician and plebeian, lord and serf, guildmaster and journeyman, in a word, oppressor and oppressed is a war fought with many and varied weapons."

This paraphrasing of Marx and Engels appears in the first line of Richard Lewontin's "Biological Determinism as a Social Weapon" in the book Biology as a Social Weapon, by the Ann Arbor Science for the People Editorial Collective, published in 1977. I had no part in the discussions that led to this landmark work, as I was at this time a senior biology major at Oberlin College. The book included essays on the full gambit of biological determinist claims, including Heredity and IQ. Of course, at this time, I had no idea how much my career would be dominated by this discussion, particularly the racial aspects of it. I first came in contact with this book in the office of my new advisor in the "Department of Ecology and Evolutionary Biology", Dr. John Vandermeer, in the fall of 1979. I picked it up and read it voraciously. For the first time in my life, I was being exposed to theoretical arguments that explained the isolation and discrimination I had experienced as an African American attempting to pursue a career in the biological sciences. And for the first time, I was also exposed to a role model in the person of John Vandermeer, who not only was a brilliant scientist, but who applied his science to addressing problems of social significance. My years with the Vandermeer group were transformative. The rest, as they say, is history.

INTRODUCTION: RACIAL BIOLOGICAL DETERMINISM

"Hegel remarks somewhere that all great world-historic facts and personages appear, so to speak, twice. He forgot to add: The first time as tragedy, the second time as farce." —Karl Marx, *The Eighteenth Brumaire of Louis Bonaparte* (1852).

Nowhere is this more apparent than in the case of biological determinism of the racist variety. Today, we have both social movements (the alt-right) based entirely on old racist ideas and ideologues who provide their revitalized theory in the form of neo-racism. This is the farce that Marx is speaking of above. These developments are being driven by the same social dynamics that occurred in and dominated past societies. Racism is a worldwide phenomenon, although it has not always been so (Gossett, 1977; Montagu, 1997; Brace, 2005; Graves, 2005a). Neither is racism the only dynamic of past societies that is with us today. The same can be said of sexism and anti-gay/lesbian/transgender bigotry. That these "isms" still exist is

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a fundamental question that scholars and people of goodwill across the world must address. At the present juncture, if we fail in this enterprise, the world may enter a period of darkness eclipsing those that have come before. Indeed, failure to address these ideologies conclusively now places the danger of human extinction squarely on the table.

To understand why there is nothing new about neo-racism, we must first define the old racism. Racism is defined as racial prejudice combined with political power (Operario and Fiske, 1998). Racialism differs from racism, as this ideology only purports that biological races exist within the human species (Echo-Hawk and Zimmerman, 2006). Racialists need not be racists, but recently, there has been a strong correlation between these two ideologies. Race is itself differentiated as two often conflated concepts: biological race and socially defined race. The former is a concept associated with the biological features of a species (Graves, 2015a). Despite the claims of many modern pundits, e.g., evolutionary biologist Jerry Coyne, the notion of what a biological race is and how one may be defined has been rife with controversy from the very start (Graves, 2005a). The discussion of biological variation within species as a means to define biological races goes back to before Darwin (e.g., the plant variety discussion) (Mayr, 1982), was wrestled with by Darwin without success (Darwin, 1871), and debated within the neo-Darwinian synthesis by Fisher, Wright, Dobzhansky, Mayr, Stebbins without a great deal of resolution (Graves, 2015a). Evolutionary geneticist Richard Lewontin's contribution to this discussion was the observation that the amount of genetic variation within so-called biological races in humans was greater than that between them (Lewontin, 1972). This observation was also recorded by other leading geneticists and anthropologists, such as Masatoshi Nei, Arun Roychoudhury, Luca Cavalli-Sforza, and was generally interpreted as signaling the death knell of claims of biological races within anatomically modern humans, (Templeton, 2001; Graves, 2005b). The modern scientific consensus is that our species—anatomically modern humans—does not have biological races (Montagu, 1997; Graves, 2005a, b; Templeton, 2001; Graves, 2015a, b). This does not mean that our species does not display geographically based genetic variation and that some of this variation is not adaptive (Handley et al., 2007; Fan et al., 2016). However, this does mean that based upon the idea that human biological variation should be viewed in the same way we treat all species (e.g., Darwin, 1871; Templeton, 2001), then our variation does not merit classifying biological races within it. Furthermore, we have had both sufficient theory and observations to understand this point from at least the middle of the neo-Darwinian synthesis (1930s–1940s, described by Montagu, 1997) through that later portion of the twentieth century (described by Brace, 2005 and Graves, 2005), and modern genomics abundantly dismantles this notion (see Graves, 2015a, b; Williams, 2016). However, despite these advances in biological thinking, the socially defined race concept often appropriates the language of the biological concept, but in reality is defined primarily by social and cultural features of individuals and is always associated with a particular social dominance hierarchy (Graves, 2005b). In this way, social racial hierarchy is different according to nation and even by historical periods within nations (Omi and Winant, 2015).

THE PROBLEM OF THE COLOR LINE

It declares, Darwin himself said, that great as is the physical unlikeness of the various races of men are their likenesses are greater, and upon this rests the whole scientific doctrine of human brotherhood.

W.E.B. DuBois, "The Conservation of Races," 1897.

DuBois's statement above is based on chapter seven of Darwin's *The Descent of Man and Selection in Relation to Sex,* originally published in 1871. Few people realize that part of that rationale for "Darwin's Delay" was the implications of common descent for understanding human racial relations (Graves, 2005a; Desmond and Moore, 2009). In counseling Darwin about the implications of the *Origin*, Charles Lyell warned that the idea of shared ancestry with Africans would give shock to nearly all men, and that no university would teach it, ensuring the expulsion of a professor already installed (Desmond and Moore, 1991). Darwin dared not address the implications of human evolution in *Origin*, but by 1871, he had become the leading figure of British science. His book *Descent* was designed to take on the polygenists (those who believed that the human "races" were really separate species) directly (Desmond and Moore, 1991; Graves, 2005a). It would, however, take the developments of the neo-Darwinian synthesis (1900–1940s) to provide the full refutation of the existence of biological races in humans (Graves 2005a).

However, despite the existence of the scientific evidence against the biological existence of race, racism grew and flourished worldwide through the nineteenth and twentieth centuries. This is because racism was never really premised on the reality of biological races, but was driven by social factors that required the differentiation of human beings by supposedly "objective" criteria (Gossett, 1977; Bennett, 1993; Brace, 2005; Graves, 2005a). An excellent example of this was the diversity of laws classifying persons with any detectable African descent to socially defined racial categories. For example, many southern states utilized the principle of "hypodescent," which meant any African ancestry made one a "black" or Negro. Homer Plessy, the plaintiff in the *Plessy v. Ferguson* "separate but equal" decision of 1896 was actually 7/8 European by ancestry and 1/8 African. In 1948, Davis Knight, a descendent of Newton Knight (one of the leaders of the Jones County rebellion against the Confederacy), was sued by the State of Mississippi for "miscegenation." He thought he was "white" and had married a "white" woman by the name of Junie Lee Spradley (Bynum, 1998).

Historically, there have always been scientists and pseudo-scientists willing to lend their expertise to both the racialization of humans and to devising means to hierarchically rank these groups with regard to socially relevant traits, e.g., intelligence, industry, and morality (Gould, 1981; Brace, 2005; Graves, 2005a). In the nineteenth century, this was characterized by the work of the polygenists (separate and inferior human species); Social Darwinists in the later nineteenth and early twentieth century (Herbert Spencer, Lester Ward, and others); the eugenics movement of the mid-twentieth century (Francis Galton, Charles Davenport, R. Ruggles Gates, Alfred Ploetz, Eugen Fischer); post-World War II revival of the 1950s–60s (Carleton Putnam, Henry Garrett, Corrado Gini, Roger Pearson); the race and IQ movement of the 1960s and 1990s (Arthur Jensen, Richard Herrnstein, William Shockley, Hans Eysenck, J. Phillipe Rushton); and, finally, modern neo-racism (Nicholas Wade, Henry Harpending, Razib Khan, and others).

In the eighteenth century, European naturalists were generally not in agreement that racial hierarchy existed, and if it did, what the hierarchy should be (Graves, 2005a, Table 3.1). They differed in which human traits they studied and whether these traits were heritable or environmentally determined, but generally agreed that there was only one human species. By the middle of the ninetheenth century, European and American naturalists had shifted their views of human racial hierarchy. There was uniformity in agreement concerning the inferiority of the Negro (Africans) and general agreement that this inferiority was heritable. The vast majority thought that the supposed races of humankind were, in reality, different species. In hindsight, their errors were not surprising in that the biological principles required to effectively evaluate human biological diversity simply did not exist until well into the twentieth century. However, their determination of African, Amerindian, Arab, Asian, and Pacific Islander inferiority did not rest on biological science at all; rather, it was driven by the centrality of chattel slavery and colonialism to the wealth and well-being of European populations worldwide. Eurocentrism and white supremacy rested upon the assumption of the innate superiority of the European, and by this superiority, the right and responsibility to bring European civilization and advancement to the rest of the world. This assumption supported the enslavement and murder of tens of millions of Africans and Amerindians, along with the conquest and partition of the Americas, Africa, Asia, and the Pacific.

There are numerous historical accounts of the horrific tragedies that were driven and justified by racist ideology. These include the transatlantic slave trade and the genocidal wars carried out against indigenous populations worldwide (particularly in the Western Hemisphere) (Dunbar-Ortiz, 2014). In the twentieth century, racist ideology aligned with state power during the rise of fascism in the 1930s. The definition of fascism has been widely debated (Trotsky, 1933; Griffin, 1991). Leon Trotsky saw fascism as primarily a mass movement of the middle class in response to a deep crisis within capitalism. Fascist movements always contain strong elements of nationalism, which may or may not be united with racism (Griffin, 1991). Conversely, not all racist movements are fascist movements. The Nazi Party took power in Germany behind a mass movement of the middle class aligned with strong racism and anti-Semitism. The American Jim Crow system was driven by race and not so much by class. However, both of these examples of attempting to maintain a totalitarian society required the use of mass terror and military power.

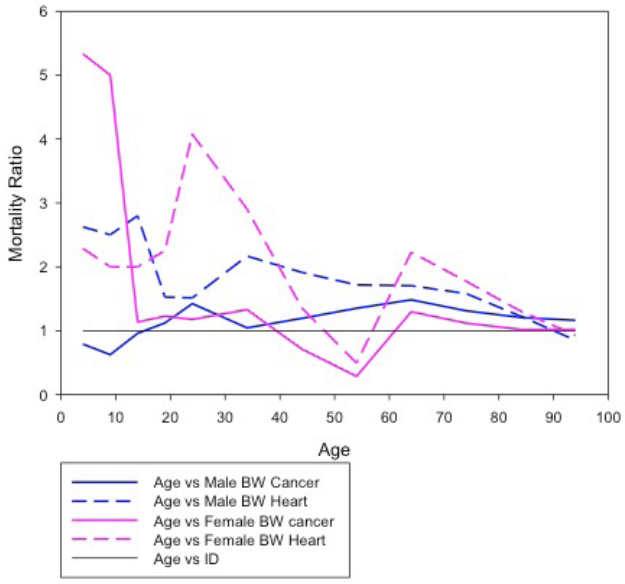

Figure 1.— Mortality Ratios in African American and European American by age in 2010. Source: National Vital Statistics Reports 61(4), May 8, 2013.

The rise of fascism in Europe led to an inevitable clash between the Axis and the Western Democracies. However, this war was not really a clash between governing philosophies, but rather over which set of powers would dominate the world's resources, including rule over the colonized people of Africa, Asia, Pacific Islands, and the Americas. The racial theories of the European fascists and the Empire of Japan were derived from those of the Western democracies (Graves, 2005a; Graves, 2013b). At the same time that Roosevelt decried the treatment of the Jews by the Nazis, the Nazis countered with references of the treatment of the Negro by the United States (Kuhl, 1994; Grodin and Annus, 1992; Graves, 2005a). The U.S. War Department film *The Negro Soldier* (1944), produced by Frank Capra, urged the Negro to join the fight against fascism abroad, but spent no time addressing segregation and institutional racism in the broader U.S. society or in the armed forces themselves. Indeed, the period between World War I and World War II saw thousands of unsolved murders of African Americans at the hands of European American lynch mobs (Dray, 2002).

Institutional Racism in the Twenty-First Century

Even with the election of the first apparently non-European descended president of the United States, Barack Obama, institutional racism was still firmly entrenched in American society. This is illustrated by a number of objective measures of well-being collected on American social conditions in the new millennium. For example, Figure 1 shows the age-specific mortality ratios for African Americans versus European Americans for cancer and heart disease (data from 2010). These data show a general trend of mortality from these two diseases being greater for African Americans until their latest age (> 90 years). Some striking differences can be noted; for example, for African American females, mortality from cancer is more than fivefold that of European American females at an early age (< four years old), and heart disease mortality is more than fourfold that of European American females between 20 and 30 years old. For males, heart disease mortality is from more than 2.5–1.5 from ages four to 75, and cancer mortality is always greater than European Americans after an early age. The mortality from homicide figures are even more striking (Figure 2). The most glaring difference is the mortality ratio for homicide at age 14–19. These show that an African American female has about a 60-fold higher risk of death from homicide compared to a European American female of the same age class! After this age, African American female mortality is three- to fourfold higher until end of life. For males, this risk increases from two- to threefold at the youngest ages to approximately 10-fold from the teen ages to 35 years old.

It's still argued by some that these patterns of mortality are best explained by genetic differences between the populations. That is, if patterns of mortality are significantly impacted by genetic sources, genetic differences between populations could easily explain patterns of mortality. Thus, in this way of thinking, African Americans are not the victims of institutional discrimination; they are simply the losers in evolution's genetic processes. I have dubbed this argument the myth of "the genetically sick African (Graves, 2005b; 2011; 2013)." In actuality, this argument is not supported by what we know about how evolution molds patterns of disease (Graves and Rose, 2006; Graves, 2011; Graves, 2015b; Graves et al., 2016; Stearns and Medzhitov, 2016). First, complex disease and behavior patterns that might contribute to mortality are polygenic. While specific loci might elevate the risk of any particular disease, the expression of that disease is strongly influenced by the overall genetic health of the individual. Thus, we would expect that populations with higher amounts of deleterious mutations (genetic load) should show higher rates of morbidity and mortality under equal environmental conditions. Therefore, under the myth of the genetically sick African, we would expect that African populations should have a greater load of deleterious mutations compared to European populations. However, the exact opposite is true. Loehmueller et al., 2008 showed that there were proportionately more deleterious genetic variants in European than in African populations. Thus, we would predict by a purely genetic argument that the mortality rates of European Americans should be higher than in African Americans. Furthermore, it could be argued that overall genetic composition does not entirely determine the mortality risk by a specific disease, but the particular alleles present in a given population are more important. This has been argued for African Americans and hypertension. Again, examining the hypertension risk alleles and their frequency in African Americans and European Americans, I showed that for 33 such loci, African Americans actually had higher frequencies of the protective alleles (Graves, 2005b). Other studies have shown that when African Americans had higher frequencies of the risk allele, this was only true for persons of African descent in the United States. Persons of African descent with the risk allele living in Western Africa showed no such elevation of risk (Cooper et al.,1997; Kramer et al., 2005). Finally, a series of studies have shown that while persons of African descent not born in the United States initially have a health advantage compared to African Americans, after living in the United States, these groups begin to take on the health profile of African Americans (for general health: Read, Emerson, and Tarlov, 2005; Hamilton and Hummer, 2011; for suicide, Brown, Cohen, and Mezuk, 2015). Read, Emerson, and Tarlov, 2005 showed that this decline was greatest for immigrants from European-majority nations, suggesting that this resulted from their previous experience with racism. This is strong evidence that it is not genetic predisposition that accounts for African American health disparities; it is American institutional racism that

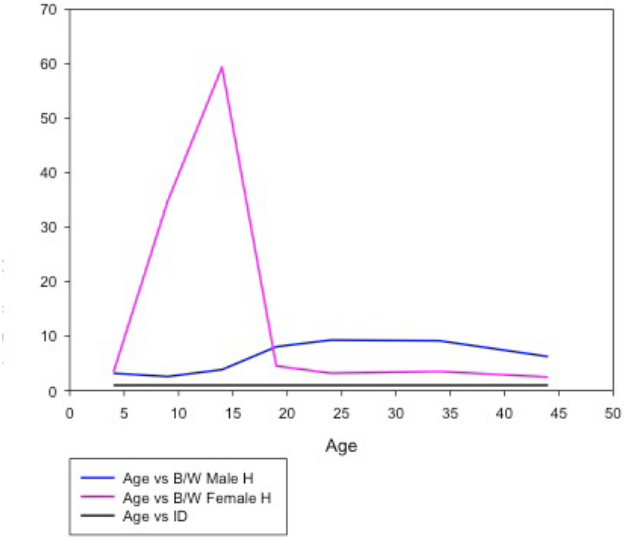

Figure 2.— Mortality ratios in African American and European American due to homicide in 2010, according to age. Source: National Vital Statistics Reports 61(4), May 8, 2013.

produces a toxic environmental effect on otherwise "healthy" genomes.

Figure 3 shows the relationship of the mortality ratio of individuals by income level in the United States in 1993 (based on data given in McDonough et al., 1997). This figure displays a clear negative correlation between mortality ratio and income. It could be argued that this figure results from the fact that African Americans and other genetically inferior groups are those who inhabit the lowest-income groups. For example, in 2012, the median income was $39,460 and $67,892 for African Americans and European Americans respectively. Of these, 27.1% African Americans compared to only 10.1% of European Americans, lived below the poverty line (http://minorityhealth.hhs.gov/templates/browse.aspx?lvl=2&lvlID=51).

However, while African Americans are disproportionately represented in lower-income groups, the vast majority of individuals in these groups are persons of European descent (in the 2014 census, 31,089,000 European Americans compared to 10,735,000 African Americans were below the poverty line). In addition, the relationship between mortality and income is well-established across the world (Kennedy and Kawachi, 2002; Kebede-Francis, 2011).

Finally, one of the most apparent examples of the ongoing racism in the United States is the pattern of mass incarceration, particularly of non-European Americans. The twenty-first century now is experiencing patterns of incarceration never experienced before in American society. The United States leads the world in those incarcerated, and there is a clear and persistent pattern of racial bias in the prison population. For example, in 1933, during Jim Crow, African Americans were incarcerated at a rate of 3:1 compared to European Americans; in 1950, the ratio was 4:1; 1960, 5:1; 1970, 6:1; 1989, 7:1; 2008, 7.07:1 (Pew Report, 2013). This increase in incarceration rates is impossible to explain from differential crime prevalence or from genetic changes in the African American population. Indeed, it is argued that these patterns result from a decision by the segments of the European American ruling class to focus on social control via police occupation of minority communities (Alexander, 2010; Thompson, 2016).

Neo-racism

Neo-racism is the ideology that asserts that the social conditions of racial minorities is not the result of institutional or individual racism, but rather due to nonracial forces, such as market dynamics, naturally occurring phenomena, and the cultural attitudes of minorities themselves. It further asserts that in countries like the United States, where civil rights policies have been implemented, it is now time to treat individuals in a "colorblind" or nonracial way. Indeed, some have gone so far as to marshal the nonexistence of biological races as proof that institutional racism cannot be a factor in the social condition of socially defined racial groups in the United States (Graves, 2015b).

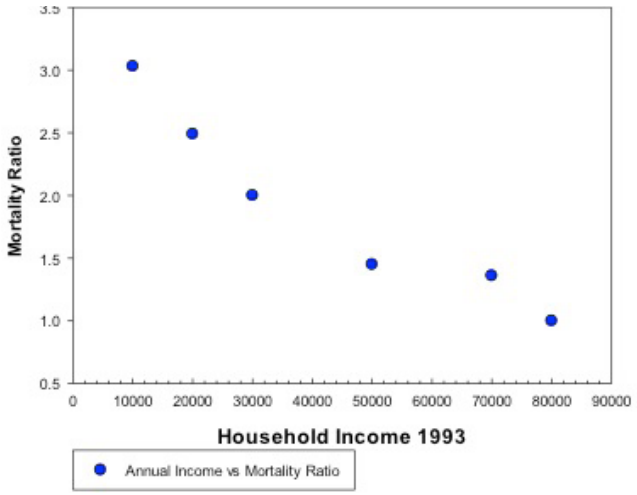

Figure 3.— The mortality ratio as a fuction of household income in the United States in 1993 is shown. The ratio for less than $20,000 per year was 3.03; $20,000 per year was 2.49; $30,000.00 was 2.00; $50,000 was 1.45; $70,000 was 1.36. More than $70,000 per year was considered the reference income for comparison to lower incomes. This figure clearly shows that for all Americans, mortality risk is greatest for low incomes and declines as income increases. Data is from McDonough et al., 1997.

To understand why this is not true, we need to review the process by which the United States began to openly address its institutional racism. This was stimulated by the victories over fascism in World War II that raised immediate contradictions between the stated beliefs of the United States and its racial policies. On one hand, the United States was now the unchallenged leader of the "free" world. On the other hand, the United States now faced a wave of anticolonial revolutions coming in the wake of the weakening of the former colonial rulers of Africa, Asia, and Latin America. Given that most of these people were non-Europeans, it could not continue with a blatant propagation of white supremacy within its own borders, nor appear to support such ideology worldwide. This opened the opportunity for a massive civil rights movement at home, in part fueled by African Americans who fought against fascism in Europe and experienced acceptance by European populations as liberators (Potter, Miles, and Rosenblum, 1992; Klarman, 1994).

In the period leading up to and following the civil rights movement, abundant advances in both the social and biological sciences should have buried racist thought forever. For example, the UNESCO race documents were produced and popularized to repudiate fascist racial thinking. Subsequent generations of development of both population genetic theory and the accumulation of data on human polymorphisms (Roychoudhury and Nei, 1988; Cavalli-Sforza, Menozzi, and Piazza, 1994) should have drowned claims of racial differentiation of our species. Yet the significance of this

basic science never really influenced racism in American social life (Graves, 2005a, b; Omi and Winant, 2015). Genetic essentialism concerning racial belief is still a major misconception both in the American public as well as among scholars (Byrd and Hughey, 2015; Hochschild and Sen, 2015; Hoffman et al., 2016; Williams, 2016). This condition persists because there is not a consistent educational attempt to eradicate this pseudoscientific thinking as well as the consistent action of institutional racist structures (education, employment, wealth, health, athletics) reinforcing the stereotypical beliefs. Indeed, so powerful is the hold of racist ideology in sectors of the American population that racial epithets are still hurled at outstanding African Americans (such as Michelle Obama) whose very existence blatantly defies these stereotypes.

Conclusion: Neo-Racism in the Global Context

While I have focused on examples from the United States, neo-racism is not limited to this nation. This is in part because of the global impact of the nations that originated and perfected the socially defined race concept, the United Kingdom and the United States (Graves, 2005a). One example of this is how the British imported their racial thinking to explain caste formation in India. This is well illustrated by the thinking of the British colonial administrator, H.H. Risley, who believed that the caste system originated in a racial clash. Risley's theory centered on the idea that the fair-skinned and long-headed race of Aryans invaded India and subdued the dark-skinned Dravidians (Risley, 1915). Risley also thought that the Aryans were a European race (Sebastian, 2015). Not surprisingly, given the history of British colonial domination of India, racial theories of caste formation have been resilient to contrary theories. Roychoudhury et al., 2000 reached a very different conclusion on Indian caste origin based on an analysis of mitochondrial DNA of Indian caste groups. However, shortly after this paper was published, Bamshad et al., 2001 collected data from eight groups in Andhra Pradesh. They reported that genetic distances between particular castes was correlated with caste status. Individuals from similarly ranked castes were genetically closer than those of dissimilar castes. This paper also found that genetic distances from European populations decreased as one went up the caste hierarchy (Bamshad, 2001; Sebastian, 2015).

This sort of result could be taken as support for the invading Aryan theory. In the neo-racist paradigm, the ancient Aryans would have achieved their cultural dominance over Indian society due to some genetically prescribed aspects of their intellect or other complex behaviors. However, there is no reason to believe this sort of claim. Even if we were to accept the idea that the Aryans were originally a population from a more northern central west Asian location, and that they did conquer populations from the more southern regions of India, this could have simply been a historical accident, having nothing to do with any particular genetic attribute of the Aryans. Of course, once establishing a male-dominated caste hierarchy, those males could control marriages through time, and over a long enough time, genetic distances would diverge between the higher and lower social castes. Indeed, U.S. history could be viewed through the very same lens. While the genetic distances between European Americans and African Americans are not great, they certainly exceed the differences between the higher and lower castes of India. In U.S. history, marriages within its ruling families have been tightly prescribed to exclude African Americans. The example above helps us to understand how cultural identities, values, and traditions challenged, appropriated, and negotiated by advances in science. In the case of the origins of Indian castes, the British collided with Indian cultural norms and values. The turn-of-the-millennium debate on this question was couched in the terms of modern genomic science (e.g., results like those of L.L. Cavalli-Sforza and Roychoudhury versus those of Bamshad). The remnants of Aryan supremacist ideology still exist in India. Recently, it was reported that a far-right Hindu nationalist group Arogya Bharati was attempting to engineer superior babies. They claimed that their methods would produce fairer complexion, taller stature, and higher IQ (Gowen, 2017).

This of course is not the only example of modern genomic science being misappropriated to contribute to neo-racist thinking. Nicholas Wade's *Troublesome Inheritance,* published in 2014, includes most of the themes constituting modern neo-racism (see my review, Graves, 2014; and the statement of 143 population geneticists, Coop et al., 2014 published in the *New York Times*). The most pernicious of the neo-racist themes, however, is an old racist theme: race and IQ (Graves, 2013b). It is claimed by some neo-racists that we will soon be able to parse the genomic contributions to intelligence by race. I have consistently argued that such claims are pseudoscientific (Graves, 2013b). First, there is the fact that our species does not have biological races. Second, while geographically based genetic structure does exist within the human species, it does not match the socially defined races that are the cornerstone of racist psychometric arguments. Third, the limitations of genome-wide association (GWAS) techniques to fully associate genomic variants are extremely limited with regard to complex phenotypes. For example, the ability of GWAS to account for genomic contributions to one of the best-studied human complex traits, height, has been disappointing. This results from small effect size, low population frequencies, population size of samples, genomic marker density, and the rate at which linkage disequilibrium diminishes with chromosomal map distance (Yang, 2010). The heritability (degree that offspring resemble their parents, h^2) of height has been reliably measured at 0.80 in various human populations (h^2 ranges from 0.00–1.00). For this trait, 180 single nucleotide polymorphisms have been identified with a p value $< 5 \times 10^{-8}$ together accounting for only 10% of

the variation in the trait (for a study of 180,000 individuals, Hill, 2012).

The A^2 Science for the People treatment of biological determinism, *Biology as a Social Weapon,* included two chapters in which the concept of heritability played a central role (Schwartz, 1977; Woodward, 1977). Schwartz, 1977 focuses on the fallacies of statistical models of the heritability of intelligence, while Woodward, 1977 focuses on the historic link between scientific racism and IQ. At this time, the genomic technologies required to fully investigate the genetic claims of the psychometrists was simply not available. However, today, with these tools in hand, we can evaluate much more powerfully the core basis of these claims: the strong genetic determinism of IQ and the racial differentiation of genetic elements associated with IQ. Applying these new technologies to these questions demonstrates just how appallingly unscientific the claims of psychometry are. For example, GWAS for intelligence has been simply disappointing. Davies et al., 2011, examined 549,692 SNPs from 3,411 unrelated adults (a very small sample) from the United Kingdom and found that none of the individual SNPs showed a replicable genome-wide association. They found one SNP in a formin binding protein 1-like (FNBP1L) associated with fluid intelligence ($p < 9.2 \times 10^{-7}$) but this did not replicate in a Norwegian sample (Davies et al. 2011). They concluded, however, that 0.40–0.50 of the phenotypic variation was accounted for by causal variants linked to their genotyped SNPs (within LD regions). This, they argued, was consistent with prior estimates of 0.40–0.50 h^2 for intelligence. Spain et al., 2015 used GWAS to examine exonic variation associated with extremely high intelligence. High-IQ individuals were selected from the Duke University Talent Identification Program (TIP). This study used the top 1% of this group, displaying IQ scores of ~176. Exome array genotyping was done for 1,759 individuals who reported their ethnicity as "white." The control group was generated from the Minnesota Twin Family Study, 3,253 individuals identified as "white" with IQ scores distributed between 70 and 150 points. This study resulted in one non-synonymous SNP in the PLXNB2 locus, whose gene product has been associated with neuronal migration, explaining 0.16% of the variance in IQ between the controls and the high-IQ group. Finally, Davies et al., 2015, utilizing 54,000 adults, reported a GWAS accounting for 1% of the variance in intelligence in that cohort.

These results clearly show that we are nowhere near the sophistication in genomic techniques required to elucidate the genetic bases to intelligence in humans, let alone to make racialized claims regarding differences in intelligence. Indeed, when I examined the geographic variation of genomic variants which are reputedly associated with high IQ, there was little evidence for association with socially defined racial groups (Graves, 2013c). Yet, we must be concerned that there are those who continue to support this program despite the strong theoretical reasons to doubt its legitimacy (Graves, 2011; Graves, 2013c; Hill, 2012) and the abject failures the program as produced so far. For example, BGI Shenzhen (formerly Beijing Genomics Institute) is sequencing large numbers of genomes from individuals deemed to have high IQ. The consultants for this project include Robert Plomin, a stalwart of IQ genetics research, and Stephen Pinker. Individuals associated with the project have already discussed the possibility of marketing prenatal IQ tests, genetic engineering and selective implantation of high IQ embryos, and genetic IQ testing of existing children to tailor their educational program (Yong, 2013; Richardson, 2015). Worse than this pseudoscientific and unethical program is the fact that there are some Western scholars (e.g., Jeffrey Miller) who are decrying a potential gap in genomic intelligence technology (Ottery, 2014).

It is here where we can more fully appreciate the ideology behind this kind of pseudoscience in the light of current world events. Neo-racism is an ideology that is perfectly adapted for use by proto-fascist movements. We have already observed the carnage that racism can inflict on humanity when it is wielded by state powers intent on preserving the racial status quo (Graves, 2005a; Graves, 2013c). There is danger that this can happen again. Particularly with the ascendance of new genomic technologies wielded by unethical individuals without a deep understanding of quantitative and population genetics theory (as I would argue is presently occurring at BGI Shenzhen). The misappropriation of this type of technology raises the possibility that in the future, we could face the potential for a *Star Trek: Wrath of Khan*-type eugenics movement. These technologies would only be available to the most wealthy nations, and within them the most wealthy individuals. While I argue that the eugenic applications of these technologies are likely to fail, it will be the belief that they work which has the potential to create a new class divide in the future societies of the world: the genetically enhanced versus those naturally born. These developments are even more troubling with the worldwide rise of proto-fascist and fascist movements. For example, Donald Trump has called to his banner neo-racists of all varieties and has appointed them to prominent positions within his administration (Baum, 2017). Worse is the fact that similar racists programs are associated with despotic leaders in Europe, such as Vladimir Putin (Feuer and Higgins, 2016). The confluence of these events suggest that a return to a global racial nightmare is now plausible.

While it is impossible for history to repeat itself, it is possible for similar social forces to create conditions resembling past disasters. Examining why past progressive social movements failed to avert these disasters may provide useful insights for how we should be preparing ourselves today. For example, it was possible that the racist genocide of the World War II could have been avoided. Leon Trotsky, in his essay, "What is National Socialism?" published in 1933, warned the world of what was to come if fascism was not kept in check immediately. Few people listened, and those who could have prevented the catastrophe failed to act. With this essay, I am warning the

world of what can happen if scientists interested in postitive change do not immediately address neo-racism and the social movements associated with this ideology.

To accomplish this, we are going to ask hard questions such as: What is it about global, social, and economic systems that so readily spawn fascist ideology and movements? Wallerstein has argued that these movements are a result of the structural characteristics of capitalism (Curty, 2017). While it is true that there is no necessary relationship between any economic system and racism, there has certainly been an unshakable correlation between racism and capitalism (Sidanius and Pratto, 1993; Wilson, 1996; Bennett, 1993; Davis et al., 2011). Thus, I argue that the global struggle against racism must also be a global struggle against capitalism and imperialism. I am by no means the first person to say this, as even the Reverend Dr. Martin Luther King, Jr. understood this before he died (Joseph, 2000; Waldschmidt-Nelson, 2011). The events of the last few months have made this revelation even clearer.

At the same time, we should not believe that social movements to bring an end to capitalism will necessarily bring an end to racism. For this to happen, there must be an intentional link between anti-racism and anti-capitalism, and those engaged in this struggle must commit to programs that unite these efforts. History again can be illustrative of what can happen if this link is not made. Anti-Semitism in Europe has been likened to modern racism (Gossett, 1977; Graves, 2005a). The original Bolsheviks made it clear that they were opposed to anti-Semitism (Azadovskii and Egorov, 2002; Brandenberger, 2012). Yet the success of Stalinism was partially achieved by playing to cultural features of the old Russia, including anti-Semitism. Deutscher argues quite convincingly that this was partially responsible for Stalin's victory over Trotsky (Deutscher, 1963). Neither did Red China develop a comprehensive or effective understanding of racism and ethnocentricism (Dikotter, 2015). Racial theories became taboo after the victory of the Red Army in China (Kohn, 1995). However, this did not prevent the continued influence of Han chauvinism during the establishment of the revolutionary regime. In addition, while Mao saw China as the leader of the anti-racist, anti-imperialist fight against "white" domination of the world, the Chinese never effectively implemented an anti-racist alliance with African nations fighting for independence against European colonialism (Sullivan, 1994). Furthermore, African students studying in China in this period were often victims of ignorance and racism on the part of the Chinese they interacted with (Hevi, 1963). The failure of this regime to address racist thinking led to the revival of racial science, including polygenism, the belief that modern races are the result of different evolutionary lineages, in China in the post-Mao era (Wu, 1989). Thus, the modern eugenic and biological determinist ideology of BGI Shenzhen in what I dub "post-socialist China" is not at all surprising.

Despite the failure of previous attempts to develop socialism (e.g., the Soviet Union, the People's Republic of China, and others), I would still argue that developing a socialist society is humanity's best option for developing a sustainable future that also respects the rights of nations, cultural groups, and individuals to self-determination. Capitalism works the way it was designed: It benefits the few at the cost of well-being of the many. However, its design features also reveal its inherent instability as a global system. The various ruling factions of the world continue to deploy even more inhuman methods to guarantee their profits. This has produced a historic wealth gap between the ruling and working/unemployed (Baker, 2016); in the United States, the top 1% of American families now own >40% of American wealth. Unfortunately, modern scientists seem to be increasingly buying into this system, and by doing so, developing even greater potential to further compromise the objectivity of their science (Maienschein et al., 2008). However, even if the methods are objective, there is the question of what research questions are being pursued, and for what purpose? For example, it is entirely possible to develop pharmaceutically based treatments that could slow down the damage or anesthetize individuals to lessen the pain caused by institutional racism. Such drugs would immediately generate huge sales in the United States; however, I have argued that a more just scientific research program would actually address the causes of these harms (e.g., institutional racism) and implement programs to eliminate these causes (Graves, 2015a, b).

On the other hand, the core premise of socialism is the idea that the means of production should be engaged in supporting the needs of the vast majority of the world's population. The scientific research program of a truly socialist nation would look very different from our current priorities. It can be argued that under any social system, an emphasis on basic and pure research will be required. What would be most different is the nature of translational research. Translational "science for the people" would not be driven by whether the products of that research would be marketable and generate profits. The evaluation of such research would result from its utility to solve the problems of the world's ever-growing population. We already know what these problems are: anthropogenic climate change, water shortages, food availability, proper nutrition, shelter, infectious diseases like malaria, chronic and age-related disease such as cancer, safe and renewable energy, energy-efficient transportation, etc. Clearly, there would be many more problems for the scientific community to turn its attention to, compared to the scientific research program of capitalism, which really only wanted to make the world better for those who could afford to purchase its products.

EPILOGUE

Above is my vision of science with passion and a moral compass, a vision that was formed through my association with Dr. John Vandermeer. John helped me learn to "fight the power!" It has been my great honor to have called him a mentor and friend.

REFERENCES

Alexander, M., 2010. *The New Jim Crow: Mass Incarceration in the Age of Colorblindness*, (New York, NY: The New Press).

Azadovskii, K. and B. Egorov. 2002. From Anti-Westernism to Anti-Semitism: Stalin and the Impact of the "Anti-Cosmopolitan" Campaigns on Soviet Culture, *Journal of Cold War Studies* 4(1): 66–80. doi: 10.1162/152039702753344834

Baker, D., 2016. Rigged: How Globalization and the Rules of the Modern Economy Were Structured to Make the Rich Richer, (Washington, DC: Center for Economics and Policy Research).

Bamshad, M. et al., 2001. Genetic evidence on the origins of Indian caste populations, *Genome Research* 11: 994–1004.

Baum, B., 2017. Donald Trump's "genius," White "natural aristocracy," and Democratic Equality in America, Theory & Event 20(1): 10–22, Supplement.

Bennett, L., 1993. *The Shaping of Black America,* (New York: Penguin Books).

Brace, C.L. 2005.*"Race" is a Four Letter Word: Genesis of the Concept*, (New York, NY: Oxford University Press).

Brandenberger, D., 2012 "Simplistic, Pseudosocialist Racism": Debates over the Direction of Soviet Ideology within Stalin's Creative Intelligentsia, 1936–39, *Kritika:Explorations in Russian and Eurasian History*, 13(2): 365–393.

Brown, M.J., Cohen, S.A., and Mezuk, B., Duration of U.S. residence and suicidality among racial/ethnic minority immigrants, Soc. Psychiatry Psychiatr. Epidemiol. 50(2):257-67. doi: 10.1007/s00127-014-0947-4, 2015.

Bynum, V.E., 1998. "White Negroes" in Segregated Mississippi: Miscegenation, Racial Identity, and the Law, *The Journal of Southern History* 64(2): 247–276.

Byrd, W.C. and Hughey, M.W., 2015. Biological determinism and racial essentialism: The ideological double helix of racial inequality, *The Annals of the American Academy of Political and Social Science* 661: 8–23.

Cavalli-Sforza, L.L., Menozzi, P., and Piazza, A., 1994. *The History and Geography of Human Genes*, (Princeton, NJ: Princeton University Press).

Cooper R., Rotimi C., Ataman S., McGee D., Osotimehin B., Kadiri S., Muna W., Kingue S., Fraser H., Forrester T., Bennett F., Wilks R. 1997. The prevalence of hypertension in seven populations of west African origin, *Am. J. Public Health* 87(2):160–8.

Curty, G., 2017. Capitalism, structural crisis, and contemporary social movements: An interview with Immanuel Wallerstein, *Critical Sociology* 1–5.

Davis, P. E., 2010. Racism, Capitalism, and Predatory Lending: How the U.S. Government's Failure to Regulate the Disproportionate Negative Effects of Payday Lending in Black Communities Violates the International Convention on the Elimination of All Forms of Racial Discrimination, *Human Rights & Globalization Law Review* 4 (2010-2011): 61–86.

Davies G. et al., 2011. Genome-wide association studies establish that human intelligence is highly heritable and polygenic. *Mol. Psychiatry* 16(10): 996–1005.

Davies G. et al., 2015 Genetic contributions to variation in general cognitive function: a meta-analysis of genome-wide association studies in the CHARGE consortium (N=53, 949), *Mol. Psychiatry* 20: 183–192.

Desmond, A. and Moore, J. 1991. *Darwin: The Life of a Tortured Evolutionist*, (New York & London: Norton & Co.).

Desmond, A. and Moore, J. 2009. *Darwin's Sacred Cause: How a Hatred of Slavery Shaped Darwin's Views on Human Evolution*, (Boston & New York: Houghton, Mifflin, Harcourt).

Deutscher, I., 1963. *The Prophet Outcast: Trotsky, 1929–1940*, New York, NY: Oxford University Press.

Dikotter, F., 2015. *The Discourse of Race in Modern China*, New York, NY: Oxford University Press.

Dray, P., 2002. *At the Hands of Persons Unknown: The Lynching of Black America*, New York, NY: Random House.

Echo-Hawk, R. and Zimmerman, L.J. 2006. Beyond Racism: Some Opinions about Racialism and American Archaeology, *American Indian Quarterly*, 30(3-4); 461-485.

Fan S., Hansen M.E., Lo Y., and Tishkoff, S.A., 2016. Going global by adapting local: A review of recent human adaptation, *Science* 354 (6308): 54–59.

Feuer, A. and Higgins, A., 2016. Extremists turn to a leader to protect Western values: Valdimir Putin, The New York Times, December 2016. http://nyti.ms/2gZm7n9.

Gossett, T.F., 1977. *Race: The History of an Idea in America*, New York, NY: Schocken Books.

Gould, S.J., 1981. *The Mismeasure of Man*, (New York: Norton & Co.).

Gowen, A., 2017. Straight out of the Nazi playbook': Hindu nationalists try to engineer 'genius' babies in India, The Washington Post, May 8, 2017. https://www.washingtonpost.com/news/worldviews/wp/2017/05/08/straight-out-of-the-nazi-playbook-hindu-nationalists-try-to-engineer-genius-babies-in-india/?utm_term=.92dca8f3d86d .

Graves, J.L. 2005a. *The Emperor's New Clothes: Biological Theories of Race at the Millennium*, soft cover edition, 2nd printing with a new preface by the author, Rutgers University Press.

Graves, J.L., 2005b. *The Race Myth: Why We Pretend Race Exists in America,* soft cover edition with a new preface by the author. New York, NY: Dutton Books.

Graves, J.L. and Rose, M.R. (2006) Against Racial Medicine, *Patterns of Prejudice* vol. 40 (4-5): 481-493, Sander Gilman editor.

Graves, J.L., 2009. Biological V. Social Definitions of Race: Implications for Modern Biomedical Research, *Review of Black Political Economy*, DOI: 10.1007/s12114-009-9053-3

Graves, J.L., 2011. Evolutionary versus Racial Medicine: Why it Matters? In *Race and the Genetic Revolution: Science, Myth and Culture*, edited by Sheldon Krimsky and Kathleen Sloan, Columbia University Press.

Graves, J.L, 2013a. Looking at the World through 'Race' Colored Glasses: The Influence of Ascertainment Bias on Biomedical Research and Practice, in Laura Gomez and Nancy Lopez, eds. Mapping "Race": A Critical Reader on Health Disparities Research, Rutgers University Press.

Graves, J.L, 2013b. Genocide (Japanese Occupation), in *Encyclopedia of Race and Racism*, 2nd Edition, Gale-Cengage Learning.

Graves, J.L, 2013c. Race, Genomics, and IQ: Slight Return in *Intelligence Quotient: Testing, Role of Genetics and the Environment and Social Outcomes*, Ed. Joseph Kush, Nova Scientific Publishers, pp. 69–86.

Graves, J.L., 2014. Why this book on race and genetics is a problem, *This View of Life*, 2014. https://evolution-institute.org/article/book-review-great-are-wades-errors-in-a-troublesome-inheritance-genes-race/

Graves, J.L., 2015a. Why the non-existence of biological races, does not mean the non-existence of racism, in: "The Mechanisms of Color-Blind Racism," Special Issue of *American Behavioral Scientist,* DOI: 10.1177/0002764215588810, 2015a

Graves, J.L., 2015b. Great is their sin: Biological Determinism in the Age of Genomics, *The Annals of the American Academy of Political and Social Science* DOI: 10.1177/0002716215586558

Graves J.L, Reiber, C., Hurtado, M., Thanukos, A., and Wolpaw, T. 2016. Evolutionary Science as a method to facilitate higher level thinking and reasoning in medical training, *Evolution, Medicine, & Public Health* doi: 10.1093/emph/eow029.

Grodin, M. and Annus, G., 1992. *The Nazi Doctors and the Nuremberg Code*, Oxford: Oxford University Press.

Griffin, R., 1991. *The Nature of Fascism*, New York and London: Routledge Press.

Hamilton, T.G. and Hummer, R.A., 2011. Immigration and the health of U.S. black adults: does country of origin matter? *Soc. Science Med.* 73(10): 1551-60. doi: 10.1016/j.socscimed.2011.07.026

Handley L.J., Manica A., Goudet J., Balloux F., 2007. Going the distance: human population genetics in a clinal world, *Trends Genet.* (9): 432–9.

Hevi, E., 1963. *An African Student in China*, London: Pall Mall Press.

Hill, W.G., 2012. Quantitative genetics in the genomics era, *Curr. Genomics* 13(3) :196-206. doi: 10.2174/138920212800543110.

Hochschild, J. and Sen, M., 2015. Genetic determinism, technology optimism, and race: Views of the American Public, *The Annals of the American Academy of Political and Social Science* 661: 160–180.

Hoffman, K.M., Trawalter, S., Axt, J.R., Oliver, M.N. 2016. Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proc. Nat. Acad. Sci. USA* 113(16):4296-301. doi:10.1073/pnas.1516047113

Joseph, P.E., 2000. Waiting till the midnight hour: Reconceptualizing the heroic period of the civil rights movement, 1954–1965, *Souls*: (2): 2, 6–17, DOI: 10.1080/10999940009362207.

Kennedy, B.P., and Kawachi, I. 2002. *The Health of Nations: Why Inequality is Harmful to Your Health*, New York, NY: The New Press.

Kedebe-Francis, E., 2011. *Global Health Disparities: Closing the Gap Through Good Governance,* Sudbury, MA: Jones & Bartlett Publishing.

Klarman, M.J. 1994. Brown, Racial Change, and the Civil Rights Movement, *Virginia Law Review, 80 (1): Twentieth-Century Constitutional History*, pp. 7–150.

Kohn, M., 1995. *The Race Gallery: The Return of Racial Science*, London, UK: Jonathan Cape.

Kuhl, S., 1994. *The Nazi Connection: Eugenics, American Racism, and German National Socialism*, Oxford: Oxford University Press.

Kramer, H., Wu, X., Kan, D., Luke, A., Zhu, X., Adeyemo, A., McKenzie, C., Cooper, R. 2005. Angiotensin-converting enzyme gene polymorphisms and obesity: an examination of three black populations, *Obes. Res.* 13(5):823–8.

Loehmueller et al., 2008. Proportionately more deleterious genetic variation in European than African populations, *Nature* 451: 994–998.

Lewontin, R.C., 1972. The apportionment of human diversity, in Evolutionary Biology Vol. 6, (Dobzhansky, T.H., Heckt, M.K., and Steele, W.C., Eds.), (New York: Appleton-Century-Crofts), pp: 331–398.

Maienschein, J., Sunderland, M., Ankeny, R.A., and Robert, J.S., 2008. The ethos and ethics of translational research, *The American Journal of Bioethics*, 8:3, 43–51, DOI: 10.1080/15265160802109314.

McDonough, P., Duncan, G. J., Williams, D., House, J., 1997. Income dynamics and adult mortality in the United States, 1972 through 1989. *Am. J. Public Health* 87: 1476–83, 1997. doi: 10.2105/AJPH.87.9.1476

Montagu, A., 1997. *Man's Most Dangerous Myth: The Fallacy of Race*, (Walnut Creek, CA: Altamira Press).

Operario, D. and Fiske, S.T., 1998. Racism equals power plus prejudice: A social psychological equation for racial oppression, in Eberhardt, J.L. and Fiske, S.T. (Eds.), *Confronting Racism: The Problem and the Response*, (Thousand Oaks, CA: Sage Publications).

Pew Research Center, 2013. King's Dream Remains an Elusive Goal; Many Americans See Racial Disparities. April 22nd. http://www.pewsocialtrends.org/2013/08/22/kings-dream-remains-an-elusive-goal-many-americans-see-racial-disparities/

Potter, L., Miles, W., and Rosenblum, N., 1992. *Liberators: Fighting Racism on Two Fronts in WWII*, New York, NY: Harcourt Mitiland.

Richardson, S.S. 2015. "The Trustworthiness Deficit in Postgenomic Research on Human Intelligence," The Genetics of Intelligence: Ethics and the Conduct of Trustworthy Research, special report, Hastings Center Report 45, no. S15–S20.
DOI: 10.1002/hast.493.

Read, J.G., Emerson, M.O., and Tarlov, A. 2005. Implications of black immigrant health for U.S. racial disparities in health, J. Immigr. Health 7(3):205–12.

Risley, H., 1915. *The People of India* 2nd Ed., London: W. Thacker.

Roychoudhury, S. et al. Fundamental genomic unity of ethnic India is revealed by analysis mitochondrial DNA, *Current Science* 79(9): 1182–92, 2000.

Roychoudhury, A.K. and Nei, M., 1988. *Human Polymorphic Genes: World Distribution*, New York, NY: Oxford University Press.

Schwartz, A.J., 1977. The politics of statistics: Heredity and IQ, in *Biology as a Social Weapon*, (Minneapolis, MN: Burgess Publishing Co.).

Sebastian, T., 2015. Science and theories of caste origins: From colonial anthropometry to contemporary genetics, *Economics and Political Weekly* 37: 42–49.

Sidanius, J. and Pratto, F., 1993. Racism and support of free-market capitalism: A cross-cultural analysis, *Political Psychology* 14(3): 381–401.

Spain S.L. et al., 2015. A genome-wide analysis of putative functional and exonic variation associated with extremely high intelligence, *Mol. Psychiatry* 1–7.

Stearns, S. and Medzhitov, R., 2016. *Evolutionary Medicine*, (Sunderland, MA: Sinauer and Associates).

Sullivan, M.J., 1994. The 1988—89 Nanjing anti-African protests: Racial nationalism or national racism? *China Quarterly* 138: pg. 144.

Templeton, A.R., 2001. The genetic and evolutionary significance of human races, in *Race and Intelligence: Separating Science from Myth*, ed. J. Fish (Mahwah, NJ: Laurence Earlbaum).

Thompson, H.A., 2016. *Blood in the Water: The Attica Uprising of 1971 and Its Legacy*, New York, NY: Pantheon.

Trotsky, L. 1933. What is National Socialism? In *The Modern Thinker*. https://www.marxists.org/archive/trotsky/germany/1933/330610.htm.

Waldschmidt-Nelson, B., 2011. *Dreams and Nightmares: Martin Luther King Jr., Malcolm X, and the Struggle for Black Equality in America.* Gainesville: University Press of Florida.

Williams, J.E., 2016. Decoding Racial Ideology in Genomics, foreword by Joseph L. Graves Jr., Lanham, MD: Lexington Books.

Wilson, C.A., 1996. *Racism: From Slavery to Advanced Capitalism* (SAGE Series on Race and Ethnic Relations), 1st Ed., (Thousand Oaks, CA: Sage Publishers).

Woodward, V., 1977. IQ and scientific racism, in *Biology as a Social Weapon*, (Minneapolis, MN: Burgess Publishing Co.).

Wu, R., 1989. *Paleoanthropology*, Beijing, Ch: Wenwu chubanshe.

Yong, E., 2013. Chinese project probes the genetics of genius, *Nature* 497(7449): 297—299.

2000's

Sciences (Natural and Social) and Progressive Change

By

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BY WAY OF INTRODUCTION

This paper is a tribute to John Vandermeer, featuring three of his intellectual passions: science, theory, and progressive change. It's written by a natural scientist but mostly based on social science, which should immediately raise doubts in the mind of a skeptical reader as to whether the author really understands what he's talking about.

Skeptical Reader would be right. Author has various excuses, but probably the best is that he's imitating the eclectic style of intellectual work that he learned from John Vandermeer. In any case, I'll try to provide the normal kinds of scholarly signposts to where I learned about this social science—i.e., citations, parentheticals, and asides of various lengths—as well as to maintain the appropriate (i.e., large) amount of humility in how I interpret it. One recurrent theme of this paper is that we should be judging statements by their content rather than by who says them. Applied to me and to this writing, that would imply that even a superficial generalist might manage to get it right. Ojalá…

THEORIES OF CHANGE

When I started working at the Union of Concerned Scientists in 2007, one of my first tasks was to write grant proposals to get funding for the Tropical Forest and Climate Initiative, of which I was not only the director, but also the only full-time employee. Those proposals, unlike those for research grants that I had written in my previous career as a scientist, frequently were supposed to include a summary of my Theory of Change. This was a problem, as I had never thought that I had a Theory of Change, and in fact, I wasn't quite clear what it meant.

However, necessity being ancestral to invention, I talked with friends and colleagues and developed a minimally sufficient understanding of what a Theory of Change was. It was a series of events, causally linked, of the form:

a) You'll give us the money…
b) Which we'll use to do A, B, and C…
c) Which will result in further changes D, E, and F…
d) Which will eventually—hopefully sooner—result in changes X, Y, and Z

Or, more briefly, it described in detail the causal chain of how, if you give us the money, this is the way we'll change the world.

Initially, I was not at all happy at having to describe my Theory of Change. I considered it a superfluous part of the grant proposal, no doubt inserted by social scientists as an obstacle to weed out applicants who weren't inventive enough to tell a fanciful story. Nonetheless, I came up with something to say, and apparently it was at least adequate—we got some money and were able to hire some more people and do some work that contributed, at least somewhat, to reducing global deforestation.

That success (or perhaps, when you get down to it, that money) has changed my opinion of the Theory of Change concept. I now realize that, whether we acknowledge it or even understand it, we all have one or more Theories of Change (Figure 1). And making them clear, not only to those whom we're begging for money, but also to our friends, our colleagues, and even ourselves, is useful in figuring out whether we are going to be effective in changing the world. If our Theory of Change is based on false or dubious premises, we're not going to be successful in changing the world, no matter how much money we get, or how big our project grows, or how hard we work. So, it's worth some effort, and some research into how social change happens, to get our Theory of Change right.

For progressives, finding out how to change the world is vital, but there are some additional, more specific questions that flow from our being on the Left. They include:

a) How do we build a movement?
b) How do we organize people?
c) How do we motivate people not just to agree, but to act?

That is, a key element of Theories of Change for progressives is that they're democratic and inclusive. They need not only to change the world—as if that weren't enough—but to do it in a way that empowers people. For conservative Theories

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Figure 1.— What to do about global warming. Source: *First Dog on the Moon*, 16 March 2010, www.firstdogonthemoon.com.au and https://www.pinterest.com/pin/213921051025000080/

of Change, using money or power to change the world can be acceptable, and there's no doubt that sometimes—indeed, all too often—that works. But for progressives, that's not real success. For us, it's not only the change, but also how we make it happen, that matters.

So, here are some Theories of Change, as one-word titles and one-sentence summaries. That is, vastly oversimplified:

a) **Education**.— Teach people what's wrong with the world, and they'll act together to change it.
b) **Publication**.— Spread the word not just by speaking, but by writing, and when they read your analysis of what needs to be done, they'll do it.
c) **Demonstration**.— Create living examples of how things could be better, and when they see and understand them, people will imitate them.
d) **Fear**.— Show how bad things are and how they're going to get worse, and people will act to prevent them from happening.
e) **Hope**.— Show how the world could be better, and people will be inspired to make it happen.
f) **Money**.— Incentivize people with the prospect of material gain.
g) **Threats**.— Menace people with harm or the loss of something they deeply care about, and they'll act to keep it.
h) **Violence**.— Use force to make the changes you want to see.

These are the crude short versions of theories, and real ones have a lot more complexity and often involve combinations and intersections. For example, clearly educating the general public will require us to learn to speak differently from the way we're used to doing it in our classrooms and journals (Figure 2). But the underlying assumptions are still the same. And one can see these assumptions underlying many of the strategies—and the slogans—that have been used in recent decades. Keep hope alive; Be the change you want to see; Each one teach one; Prolonged people's war; Occupy; There is no planet B; Because science; Never doubt that a small group of thoughtful, committed people can change the world. All these phrases, slogans, and strategies are implicitly based on Theories of Change.

Natural scientists' theory of change, and what's wrong with it

I would argue that scientists, particularly environmental scientists, have a "default" Theories of Change, and that it's a combination of the first three elements above (Education, Publication, and Demonstration) with an excessive amount of the fourth (Fear) and not enough of the fifth (Hope).

Education and Publication, for most scientists, is our everyday job. It's what we do for a living. It's why they pay us the only-moderately-big bucks. So, when you hear scientists say that the fundamental solution is education, or conversely, that the fundamental problem is ignorance/stupidity/anti-scientific thinking—it's sort of like barbers saying that what America really needs is better haircuts.

It may well be true, but we ought to at least realize how self-interested it sounds. It's telling ordinary people that they have an enormous problem, and we scientists happen to have—indeed, to be—the solution to it. So, the way to make the changes we need is: hire more of us, pay us better, and give us more and bigger grants.

Demonstration is in many ways just another way to do teaching and publication, by showing rather than telling. More effective but sometimes costlier, it has a long history of being used in agricultural extension, and by some measures very effectively. It's based on the principle of Show, don't tell, and is reflected in pieces of left-wing history ranging from utopian communities and hippie communes to Bernie Sanders's $27. But we've learned by experience that it's hard to scale up; changing a whole society is qualitatively different from establishing a niche community within it.

I'd argue that Money, Threats, and Violence, though incredibly powerful in modern and most past societies, are

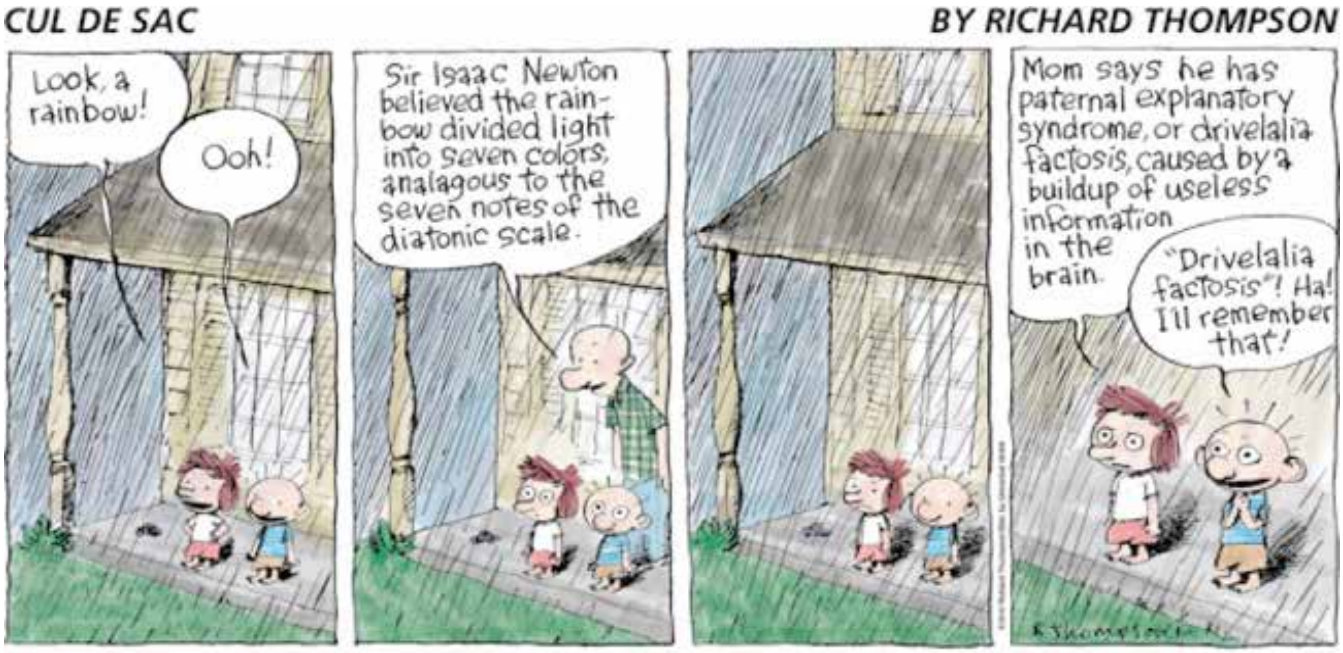

Figure 2.— Drivelalia Factosis. Source: *Cul de Sac* by Richard Thompson, 18 July 2010.

incompatible with a *progressive* theory of change. And I'll come back to Fear and Hope later, because there's actually a lot of social science research that tells us about their effects as well as their effectiveness. But right now, let's look at the assumptions that underlie a Theory of Change based on Education, Publication, and Demonstration.

What unifies this combination of elements is the assumption that if you show people what reality is and what they should do about it, they will. If they only understood, they'd Do the Right Thing. This is an idea deeply rooted in modern Western society. It's based on rationalism, positivism, and ultimately on Kant's categorical imperative. It views human beings as rational actors who can understand what's in their long-term interest and make it into reality.

Unfortunately, there's pretty good evidence that it's wrong.

The evidence comes from a field of research now about half a century old that is usually called behavioral economics, although its origins are actually in psychology (Lewis, 2017). This sub- (or cross-) discipline, associated with such figures as Kahneman, Tversky, Ariely, Thaler, and Sunstein, has accumulated overwhelming evidence that people do not perceive, think, or act in the way that positivist rationality says they should (Ariely, 2009; Kahneman, 2003, 2011; Lewis, 2017; Thaler and Sunstein, 2003, 2008). Our species is not *Homo economicus*; we do not maximize, or even perceive, our interests in a way that obeys the most fundamental rules of logic. We are "humans" rather than "econs" (Kahneman, 2011).

And this is true not only of ignorant people, but as much or even more of the highly educated and the experts. In fact, some of the most convincing evidence on this point comes from giving the same experimental problems not only to students, but also to economists and psychologists at the professional society meetings, and seeing them give the same, logically erroneous answers (Lewis, 2017).

One of the most important points about these findings is that we not only make mistakes and act irrationally, but we do it in quite predictable ways. We use simple heuristics—confirmation bias, anchoring, representativeness, loss aversion—that lead us astray from what a rational econ would do e.g.,

a) Confirmation bias: We seek out evidence that confirms what we already believed and ignore that which contradicts it.
b) Anchoring: If we hear a high number mentioned in passing, that makes us more likely to guess a higher answer to the next question we're asked—even if that question is totally unrelated to the mention of the number.
c) Representativeness: We think that people are more likely to be described by detailed stereotypes (e.g., "Linda is a librarian and wears glasses") than by a more general, non-stereotypical description ("Linda is a librarian").
d) Loss aversion: We are willing to pay considerably more to avoid "losing" something than we are to obtain it, even if we didn't really own it in the first place.

These are just a few of the kinds of cases in which, even if we understand what we rationally should do, we don't act that way. Just as young children's mistakes tell us about the rules by which our knowledge of language develops (e.g., my granddaughters saying "eated" and "telled"), so the consistency of mistakes shows us how people think and act—and it's not

rationally. Rather, it's what Kahneman and Tversky have called "bounded rationality" (Kahneman, 2003).

It's now widely realized that behavioral economics undercuts the rational humans/rational markets paradigm on which neoclassical economics is based (Ariely, 2009; Brooks, 2010). But it goes further than that. Indeed, one of Kahneman and Tversky's most vociferous (though ultimately unsuccessful) critics was the evolutionary psychologist Gerd Gigerenzer (1993, 1996), who realized that evolutionary psychology (the latter-day incarnation of what used to be called sociobiology) is based on the same principle as neoclassical economics. Both see humans as behaving to maximize a key variable. Economists call it "utility" and measure it in dollars, while evolutionary psychologists call it "fitness" and measure it in terms of the representation of one's genes in future generations. But in both cases, the bounds on rationality (not just in how we think, but in how we act) deals a fatal blow to the model.

With these kinds of results, you'd think that behavioral economics would have been greeted warmly by progressives and incorporated into our theories of change. But there has been a problem for those on the Left, and it's worth facing it head-on. It's that the leading figures in behavioral economics aren't progressives themselves, or at least, they don't seem to be progressive enough. They have worked with, in, and for the Israeli military. They give advice to Wall Street firms. They talk about ways to make markets work better (Thaler and Sunstein, 2008; Lewis, 2017). While in the American context, their political ideas would best be categorized as liberal, calling them progressives would be a disservice to both progressive thought and theirs.

There are two responses to this, besides the clear contribution that behavioral economics has made to discrediting conservative paradigms such as neoclassical economics and evolutionary psychology. The first is that evaluating scientific results by the politics of their discoverers, rather than by their content and the evidence for them, is ultimately just a form of guilt by association. That's neither very scientific nor very progressive as a standard of judgement. The history of science is replete with examples of important advances made by scholars with conservative (or worse) political ideas. And we also have many examples of the Left using the findings of the Right for its own purposes—the classical case being the thousands of hours that Marx spent reading classical economists and parliamentary reports in the British Museum. We should assess new ideas by their content, their logic, and their evidence. Who first developed them is, in the long run, irrelevant.

The second response is that the amount of evidence for behavioral economics is now enormous. I've cited several books and papers as guides to this literature, but they're just a few of its less technical presentations. It's perhaps not quite as massive as the evidence for climate change, but it's getting there.

A caveat would be helpful here in avoiding going completely overboard. The message is not that economics is irrelevant, or that prices, incomes, wealth, and markets don't affect human behavior. It's that we don't respond to economics *alone,* and that we don't respond to it by maximizing either our utility or our fitness.

So far, so good. But I really should admit the unease I feel, and that I think most natural scientists feel, at the idea that humans are not rational. Isn't rationality a critical component of science? Shouldn't it be given more weight than people just making things up (Figure 3)? If we give up have rationality, why should we keep on doing science? Is it only to justify our existence and our livelihoods? Are we just the same as barbers promoting haircut improvement?

I don't think so, and in fact, I think we can develop a better, and more progressive, theory of change by admitting the limits of rationality. Here are some preliminary thoughts, derived mostly from climate change, an area that I've been working in for the last decade.

Using social science to modify our theory of change

One of the most active areas of social science in recent years has been around climate communication, which deals with a source of increasing anxiety in the twenty-first century. It's the question that, given that the evidence for human-caused climate change and its damaging effects is so overwhelming, why don't people accept it? And why haven't our political systems done anything about it?

One answer is simple but unsatisfying—hasn't behavioral economics taught us that humans aren't rational? So why should we be surprised when they don't respond, even to a threat of their own creation that endangers their entire planet? This is unsatisfying partly because it doesn't seem to offer any solution, but it's also contrary to evidence. As I'll show below, a substantial majority of people, not only globally but also in the United States, do in fact accept the evidence and, furthermore, want their governments to act on it. Scientists' lament that no one is listening to them may be a widespread feeling, but it's wrong.

The second question—Why hasn't anything been done?—is also somewhat wrong, in that things have been done (mostly in other countries), although clearly, they haven't been enough. However, framing this second question in contrast to the erroneous answer to the first question (that people don't believe the science) is helpful in revealing another assumption of many natural scientists. It's that we live in a democracy where what the people want, gets done. That is indeed a naïve theory of change. Progressives know better. Can they develop a theory of change to match?

I think we can, if we base it on some more science—social science, that is.

There has been a lot of research on climate communication, and it's quite relevant to the critical issues for progressives that

I raised at the beginning—how to build movements? how to organize? how to motivate people not just to agree, but to act? Some of its findings include the following:

a) A **substantial majority**, including of Americans, agree that:
   Global warming is happening
   Humans are causing it, and
   We should do something about it

Furthermore, this has been the case for more than a decade (Leiserowitz, 2017).

b) This is **not a question of education**. In fact, the minority of climate denialists tend to know *more* about it than the population at large (McCright and Dunlap, 2011).

c) The **perception that there is a strong scientific consensus**—e.g., the fact that 97% of scientists believe in global warming (Cook et al., 2013)—tends to make people more likely to accept it (Myers et al., 2015).

d) This is at least in part due to the **high regard that people have for scientists**. We are one of the most respected occupational groups in society. Politicians and journalists, on the other hand, are among the least respected.

e) The high level of support for climate change science exists **even though few people are able to explain it**—including many who strongly believe in it. Here's a test: Can you explain the mechanism of global warming in three non-technical sentences? (Read on for an answer.)

f) **Incorrect understandings are quite common**, e.g., the atmosphere acts like the roof of a greenhouse to keep warm air in; it's because of the destruction of the ozone layer; air pollution blocks out sunlight; etc.

g) However, **hearing a short explanation of the mechanism** of climate change does make people more likely to believe in it and to support climate action. Here's a good one from McCuin et al. (2014), who also present evidence of its effectiveness: The earth absorbs visible light from the sun and emits infrared light back out. Greenhouse gases like CO_2 absorb some of this infrared light, so less escapes from the earth. This warms up the earth.

h) **Pre-existing beliefs** strongly affect how people hear the science and whether they accept it (Hoffman, 2012). For example, "just world" beliefs—that ultimately, good behavior is rewarded, and the guilty are punished—tend to make people more likely to reject climate science. Liberals and conservatives respond positively to different framings of the issue: liberals to concepts like equality, care for others, and moral obligations, and conservatives to stewardship, sanctity, and purity.

i) **Apparently irrational impacts are common**. For example, the **backfire effect** (repeating and correcting scientific mistakes can actually reinforce them in listeners' minds) and the **seepage effect** (scientists' own belief in science and their commitment to action is weakened by hearing climate denial, even when they know it's incorrect) (Lewandosky

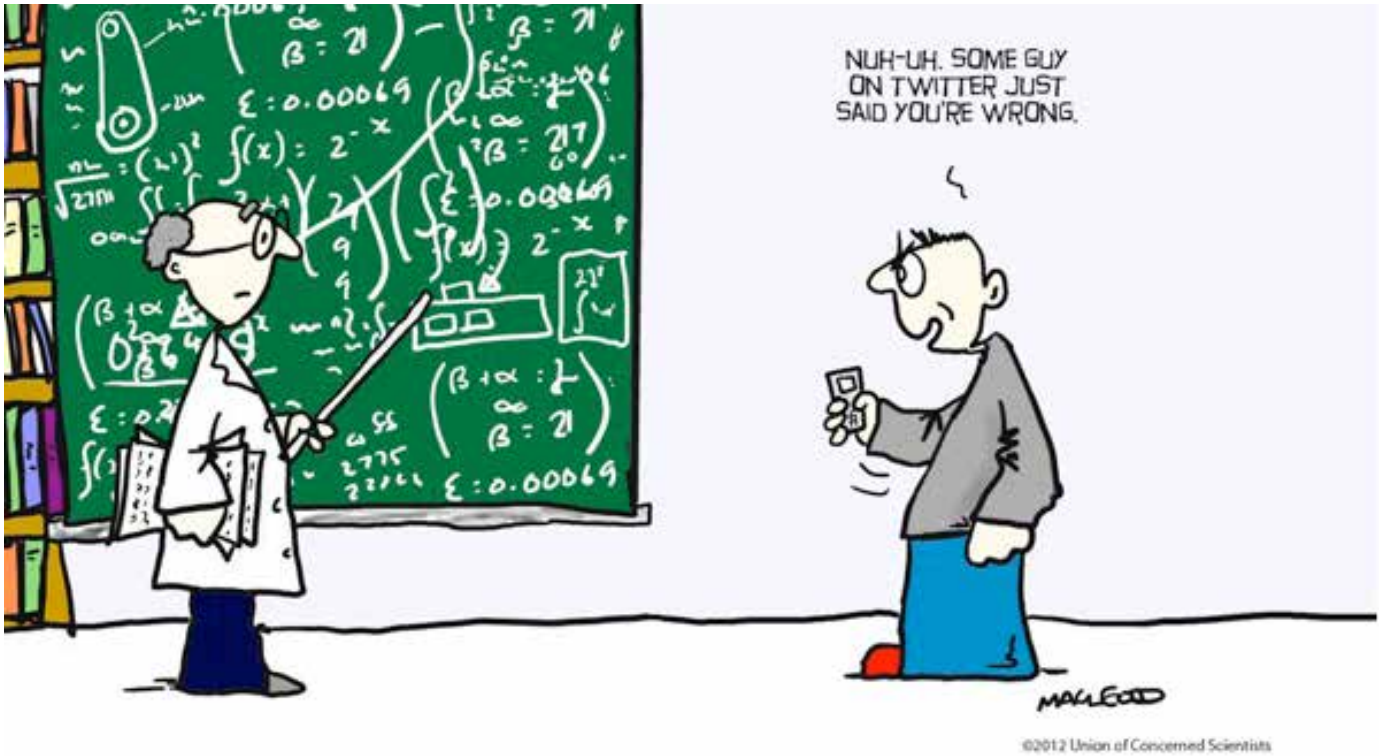

Figure 3.— Some guy on Twitter just said you're wrong. Source: James MacLeod, http://macleodcartoons.blogspot.com/2012/08/union-of-concerned-scientists-cartoon.html (Cartoon in the 2012 Union of Concerned Scientists Scientific Integrity program calendar).

Figure 4.— It's like the sun shines brighter when you're around. Source: *Boondocks* by Aaron McGruder, 11 October 2005.

et al., 2015). These effects can be successfully countered, however (Lewandosky et al., 2012).

j) **Fear is counterproductive**. Dire warnings and predictions, and the use of alarming words (Figure 4), tend to discourage people into thinking that the future is hopeless, which they are not willing to accept (O'Neill and Nicholson-Cole, 2009).

k) **Motivated reasoning is common**. That is, rejecting science because we don't like its implications for action and policies (Kahneman, 2011). Separating "What are the facts?" from "What is to be done about them?" may be logical, but we humans find it hard to do. Thus, arguments about whether humans are changing the climate are also arguments about whether we need to phase out coal, develop renewable energy, and transform our social metabolism (Fischer-Kowalski and Haberl, 2007).

On this last point, I want to emphasize that motivated reasoning is not just a feature of our opponents. We progressives do it, too. You see it, for example, among supporters of grass-fed beef who, upon hearing that it's worse for the climate compared to more nutritious diets for cattle or compared to other meats, start to question whether climate change is really that overwhelmingly important an issue. Conversely, we accept and publicize new scientific findings that show that things are even more awful than we thought, because of the (mistaken but common) belief that this will raise the sense of urgency for radical and immediate action. This happens even when the "new science" is uncertain, or based on a single study, or dependent on a model with many assumptions, or has similar weaknesses that would justly make us skeptical if the results were the opposite.

Simply put, we're motivated, too—to create a more just, peaceful, and sustainable future. That's a good motivation, but it's a motivation nonetheless, and it affects our thinking about science, just as it does with other people. We shouldn't pretend that these kinds of irrationality apply only to the Right.

Another aside: I've found that scientists often dislike the phrase, "belief in climate change," as I've used above. They insist that climate change is a matter of science, not faith and belief. I disagree, because I think that creates a false opposition between science and religion, as well as between rational, intelligent scientists and irrational, stupid believers. We all have beliefs, and we all have bounded rationalities.

Some tentative conclusions

So, what to make of all this? I'd be the first to admit that some of the findings about human irrationality are discouraging (e.g., b, f, h, i and k in the list in the last section). Others make me more optimistic about climate action but seem to suggest that people support it for what are not really the best reasons (e.g., c, d and e). If support for change depends on the perception of scientific consensus and the respect for science as an endeavor, it's really just a sort of "innocence by association"—judging results to be true based on who says them, rather than by their substance.

Perhaps a quote from Einstein (1950) is relevant here, though not exactly for the reasons he said it: "For all of us who are concerned for peace and the triumph of reason and justice must be keenly aware how small an influence reason and honest goodwill exert upon events in the political field."

Nonetheless, I'm hopeful, and as a progressive and as a scientist, hope is part of my theory of change (Figure 5). Not just because it's more effective, but also because fear is fundamentally a weapon used by the powerful to divide and repress us. It's not the kind of tactic that progressives should use, even if it did work.

Humans' rationality is limited, and that goes for me, too. But even so, talking with people in a simple, honest, non-elitist way—that is, organizing—can succeed. And anyhow, it's the right thing to do. It's how we keep the hope alive that we can change the world.

Figure 5.— Science, Senator. It's called science. Source: Mark Hicks, http://www.markix.net/awards.html (Cover cartoon for the 2014 Union of Concerned Scientists Scientific Integrity program calendar).

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REFERENCES

Ariely, D. 2009. *Predictably Irrational: The Hidden Forces That Shape Our Decisions*. New York: Harper Collins.

Brooks, D. 2010. The return of history. *New York Times*, 26 March 2010.

Cook, J., Nuccitelli, D., Green, S.A., Richardson, M., Winkler, B., Painting, R., Way, R., Jacobs, P. and Skuce, A. 2013. Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters* 8: 024024.

Einstein, A. 1950. On receiving the One World award. In: *Out of My Later Years*. New York: Philosophical Library.

Fischer-Kowalski, M. and Haberl, H. eds., 2007. *Socioecological transitions and global change: trajectories of social metabolism and land use*. Northampton, MA: Edward Elgar Publishing.

Gigerenzer, G. 1993. The bounded rationality of probabilistic mental models. In *Rationality: Psychological and Philosophical Perspectives*. Eds.: K. Manktelow and D. Over., pp. 284–313. London: Routledge.

Gigerenzer, G. 1996. On narrow norms and vague heuristics: a reply to Kahneman and Tversky. *Pschological Review* 103: 592–596

Hoffman, A. 2012. Climate science as culture war. *Stanford Social Innovation Review* Fall 2013: 30–37

Kahneman, D. 2003. Maps of bounded rationality: psychology for behavioral economics. *American Economic Review* 93: 1449–1475

Kahneman, D. 2011. *Thinking, Fast and Slow.* New York: Farrar, Strauss and Giroux.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Rosenthal, S., Cutler, M., and Kotcher, J. 2017. *Climate change in the American mind: October 2017*. Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication

Lewis, M. 2017. *The Undoing Project.* New York: W.W. Norton and Company.

Lewandosky, S., Ecker, U.K.H., Seifert, C.M., Schwarz, N. and Cook, J. 2012. Misinformation and its correction: continued influence and successful debiasing. *Psychological Science in the Public Interest* 13: 106–131

Lewandosky, S., Oreskes, N., Risbey, J.S., Newell, B.R. and Smithson, N. 2015. Seepage: climate change denial and its effect on the scientific community. *Global Environmental Change* 33:1–13

McCright, A.M. and Dunlap, R.E. 2011. Cool dudes: the denial of climate change among conservative white males in the United States. *Global Environmental Change* 21: 1163–1172

McCuin, J.L., Hayhoe, K. and Hayhoe, D. 2014. Comparing the effects of traditional vs. misconceptions-based instruction on student understanding of the greenhouse effect. *Journal of Geoscience Education* 62: 445–459

Myers, T.A., Maibach, E., Peters, E. and Leiserowitz, A. 2015. Simple messages help set the record straight about scientific agreement on human-caused climate change: the results of two experiments. *PLoS ONE* 10: e0120985

O'Neill, S. and Nicholson-Cole, S. 2009. "Fear won't do it": promoting positive engagement with climate change through visual and iconic representations. *Science Communication* 30: 355–379

Thaler, R.H. and Sunstein, C.R. 2003. Who's on first. *New Republic*, August 31, 2003. Online at: https://newrepublic.com/article/61123/whos-first

Thaler, R.H. and Sunstein, C.R. 2008. *Nudge: Improving Decisions about Health, Wealth and Happiness*. New Haven: Yale University Press.

1990's

HOW JOHN VANDERMEER HELPED ME BECOME AN AGROECO-FEMINIST

By

Helda Morales

ABSTRACT

Here, I present a preliminary diagnosis of women in agroecology academic programs, as well as the achievements attained by the equity committee at my research institution and by the Alliance of Women in Agroecology (AMA-AWA) to increase diversity in academia. I discuss how John Vandermeer's ideas, recommendations, and example deeply influenced our work.

INTRODUCTION

As a student, I never felt discriminated against for being a woman or a Guatemalan getting a Ph.D. at a American university. I thought that success was the result of one's own effort. After obtaining my Ph.D., I landed a position as a professor in a research center in Mexico. Soon, I started to notice that other colleagues did not listen to me, my work was unconstructively criticized, the head of the department wanted to talk to me through another man, I was told how to conduct seminars and what questions were not appropriate to ask. I thought that these attitudes had to do with the fact that I was young and a foreigner. For months, or maybe years, I suffered but remained silent.

One day, John Vandermeer, one of my dissertation committee members and longtime advisor, asked me how I was doing in my new position. When I recounted the situation, he first asked me a series of questions: "Have you thought that [your colleagues] are acting like that because you are a woman? Have you noticed if they act the same way with new male faculty members?" He then gave me a talk about women in academia, introducing me to the term "glass ceiling" and to the work of Scott Page (2008) on the importance on diversity in work groups. I then realized that my colleagues were treating me poorly because I am a woman. It really hit me. I was upset, but I was inspired to learn more about women in academia, to start the discussion in my research center with my agroecology colleagues, and to create a better environment for my students. In what follows, I present a preliminary diagnosis of women in agroecology academic programs and the achievements attained by the equity committee that was formed at my research institution and by the Alliance of Women in Agroecology (AMA-AWA) to increase diversity in academia.

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Agronomy: A man's world

Agronomy has long been a man's world. The Agronomic Society of America, a scientific and professional agronomist society, was founded in the United States in 1907. For 30 years, it was exclusively male, and it was not easy for the few women who were accepted to participate. In 1939, Ralph John Garber, the president of the society, said, "If our paternal ancestor had given us an X chromosome instead of a Y chromosome, we would have been more likely to become an agronomist's helpmate than an agronomist" (McIntosh and Simmons, 2008).

In Mexico, women became involved in agronomy even later. It was not until 1971 that the first woman graduated from the ENA (Escuela Nacional de Agronomía, today the University of Chapingo) (Zapata, López, and Galindo, 2000), where most of my colleagues graduated.

Today, many women are agronomists, but the earlier ideas that agronomy is a man's world still permeate the minds of many.

Is agroecology any better?

Since the 1980s, agroecology programs have sprung up in higher education and research centers around the world (Gliessman, 2014). We celebrate biodiversity at the farm and at the landscape level, we celebrate traditional and indigenous knowledge, and we promote socially just food systems (Altieri and Toledo, 2011; Altieri, 2015). Are we also working as hard to create a diverse and equitable environment in our academic institutions?

From 2011 to 2016, I asked for students' gender statistics from graduate programs in Latin America and Spain, and three

heads of graduate programs responded. These programs are attracting many women, and I believe this is also occurring in other agroecology programs. Two of these programs have more women students than men. The doctoral program in agroecology and society at El Colegio de la Frontera Sur in Mexico is 54% women. The master's program in agroecology at the Universidad de Córdoba in Spain is 69% women. The graduate program in agroecology at Brazil's Institutos Federais de Educação, Ciência e Tecnologia, Sudeste de Minas, Rio Pomba Campus, is 45% women.

Nevertheless, the rate of women professors in agroecology programs in Latin America is less than 27%, according to the information that was available on their respective webpages between 2011 and 2016 (Table 1). This is lower than the 29% international average for women in academia, or the average of 42% for women professors at the National Autonomous University of Mexico (Ordorika, 2015).

Is this a sign of discrimination against women in agroecology? Or have we lacked sufficient effort to encourage women to participate? In 2011, I interviewed 18 women academics working in agroecology at universities in Argentina, Brazil, Cuba, Guatemala, Mexico, Venezuela, Spain, and the United States. Sixty percent of the professors said that they have felt discrimination at work. Some are unsure if they are discriminated against because of their gender, ethnic group, political ideas, age, or because they are agroecologists. As one female academic said, "It is difficult to separate the behavior related to gender from the rest of what we are in this complex plot of evaluative perceptions." Nevertheless, 47% are sure that they are discriminated for being a woman by their colleagues, by the academic structure, and even by the law.

Here are some of their comments:

"On some occasions, [my male colleagues] have said openly that they do not want more women because they get pregnant."

"They do not understand that I have schedule restrictions. I am a professor, but I am also a mother."

"Most of my male colleagues have wives who take care of their children and domestic issues. Obviously, if women didn't need to spend so much time on those activities, they would dedicate more time to their work and would stand out in their academic career."

"For that same reason, my career has been affected: It has been slower than for my male colleagues, my graduate studies were much slower, I was always late to everything, and I was not able to get a postdoctoral scholarship because I was older than 35."

"In the doctoral program, to be a woman and get pregnant put me in a more difficult situation than my male classmates. The fact that we do not have any affirmative action (in this case, some support or extension, or at least a caring attitude from the graduate program), is an act of discrimination. Not directly, but by omission."

"They think that the countryside is not a place for women, even though they deny that sexism still exists. They do not realize or they do not care that their sexist jokes or the naked lady in their screen saver make us feel uncomfortable."

Table 1. Percentage of women professors in agroecology programs in Latin America. Information gathered from program webpages between 2011 and 2016.

Academic Program	Percentage of Women Faculty
El Colegio de la Frontera Sur, Mexico	33
Universidad de Chapingo, Mexico	20
Universidad Autónoma de Yucatán, Mexico	38
Universidad Benemérita de Puebla, Mexico	1
Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica	44
Universidad de Caldas, Colombia	0
Universidad Nacional de Colombia	30
Universidad de la Habana, Cuba	13
Universidad Bolivariana, Venezuela	50
IFET, Brazil	37
Universidad de Córdoba, Spain	33
Average	27

Thirty percent of the women academics I interviewed mentioned that their colleagues do not listen to them and that their work is not recognized: "I did the work behind the curtain. I coordinated, organized, and controlled when the director and the head of the graduate program was not there, and that was most of the time. I was the one who did all the coordination activities without being a member of the academic committee."

Thirty-five percent of the women interviewed said that working with farmers is hard, because many farmers do not listen to them. "When he [a male colleague] said the same thing that I was saying, farmers paid attention and his recommendations were followed; we agreed that I would tell him what to say (he was a veterinarian and did not have knowledge of agroecology)."

Fifty-nine percent said that it is difficult to be a field agroecologist in countries with so many violent assaults against women:

"I was very aware about being in the field by myself; I knew that a student had been assaulted and almost raped during the field course."

Twenty-three percent felt that occasionally some students do not respect them because of their gender:

"Because I am young and a woman, students think that I do not have a Ph.D. They call my male colleagues 'doctor' and call me 'miss'."

"Women in my department are assigned the most difficult courses in terms of logistics."

"Students respect the time of male professors; ours, not so much. Several students with male advisors have asked me for a letter of recommendation because their advisors are too busy, and they do not want to bother them."

Most interviewees think that their agroecological and academic perspectives are not different from those of their male colleagues. Yet, 24% agree that their vision is different because they place gender on the agenda, they look for horizontal relationships, and because they are more sensitive to social problems.

They admit to having maternal attitudes and spending more time with students; that is why students approach them, even to talk about personal problems:

"I have spent many hours in individual meetings and, according to students' evaluations, my time helped them in their academic pursuits."

"I look forward to cultivating a less hierarchical environment in my department, an environment centered on exchange and critical thinking, and not on reproducing empty and authoritative structures."

"We tend to emphasize the data and to be more conservative in our analysis. Rarely have I seen papers by women scientists that deal mainly in 'speculation' or just crazy ideas. Nevertheless, there are a lot of them written by male scientists. I think this is because male ideas are taken more seriously by the scientific community and because we want to maintain our reputation that has been so hard to cultivate. Unfortunately, I believe that this behavior works against us and against science in general. Because most of us were raised differently, we may have different ideas than men. The scientific community is not getting any benefit from our ideas because we do not publish them, out of fear."

Even though 6% said that it is an advantage to be a woman in the agroecological academic world because we listen, are empathetic and more sensitive, and value group wellbeing, the underrepresentation of women in agroecology academic positions and the testimonies of the professors I interviewed is a call for change. I have no knowledge of other studies on underrepresented groups in agroecology, such as people of color or members of the LGBTQIA community, but I am sure that their participation and conditions are worse than women's are. In our battle for more diverse and resilient agroecological studies, we should encourage women to participate.

Taking action

John Vandermeer spoke to me about his involvement in STRIDE (Strategies and Tactics for Recruiting to Improve Diversity and Excellence) at the University of Michigan. Thanks to John, I learned the value of raising awareness about how stereotypes affect evaluations, the need to recruit for excellence and diversity, active recruitment, and how to create a friendly environment for women and other underrepresented groups.

The ECOSUR Committee against Discrimination and for Equity

We should work to determine how female and male researchers use their time, what their academic productivity is like, and how satisfied they are with work and domestic life. The survey did not show significant differences in academic productivity between men and women, yet the latter spent more time on housework and childcare (Morales, 2007). In part because of the study, the discussion it generated, and the openness of our director, a committee against discrimination and in favor of equity was officially established in 2006. We invited John to talk about how prejudices or stereotypes affect the recruitment for excellence, surveyed our institution for discriminatory practices, organized seminars to address the problem, and planned ways to achieve diverse critical mass and equity. Ten years later, the battle continues: Some still deny discrimination exists and argue against recruiting based solely on excellence. Yet we were the first Mexican institution to grant paternity leave for male employees. We give a one-year extension for doctoral students who have a child during their studies, and some groups have made efforts to recruit women faculty. Last year, John returned to talk further about the scientific evidence in favor of recruiting for diversity. On a personal level, I no longer remain silent.

AMA-AWA

In 2013, Ivette Perfecto, Stacy Philpott, and I organized a workshop for women agroecologists in academia. Ten professors participated from various countries, including Colombia, Guatemala, Mexico, Puerto Rico, and the United States. One of the main results of the workshop was the founding of the Alliance for Women in Agroecology, AMA-AWA (http://scelysan.wixsite.com/ama-awa/us?).

The Alliance's objectives are to contribute to the development of future generations of women in agroecology and establish alliances with women involved in agroecological farming and their organizations. Since then, we have organized two seminars to address women's issues in agroecology during the SOCLA meetings (Latin America Scientific Society of Agroecological) in Lima, Peru (2013) and Buenos Aires, Argentina (2015), where we exhibited posters of women working in agroecology and pressed our demand that keynote speakers also include women. We have a closed Facebook group, where we exchange information with more than 300 members. We attended a second workshop in Puerto Rico in 2016. Our main achievement has been to build a sisterhood network of professors, students, and farmers.

John's actions for diversity

Besides giving talks and discussing the importance of increased diversity in academia, John Vandermeer practices what he preaches. During last year's symposium, "Science with Passion and a Moral Compass," which celebrated John's academic career, most of the women and other underrepresented academics who were speakers cited anecdotes on how John helped them become scientists and find jobs. In addition, John has also encouraged us, cited our research in his talks and publications, and remained a constant mentor and friend.

With his example, we will continue to build an agroecological science that is more consistent with our principles, i.e., a more socially sensitive, diverse, and resilient agroecology (Hecht, 1999). Furthermore, following his example, we will keep asking questions: Are our departments working actively to take advantage of diversity? Do the journals where we publish promote diversity? Does our scientific society do the same? What is my role in promoting diversity?

On our behalf and on behalf of our current students and future generations of women in agroecology, we sincerely thank you, John Vandermeer, for your passion for science and your moral compass. Thank you for showing us the way.

REFERENCES

Altieri, M.; Toledo, V. 2011. The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants. *The Journal of Peasants Studies* 38 (3):587–612.

Altieri, M. 2015. Breve reseña sobre los orígenes y evolución de la agroecología en América Latina. Agroecología 10(2):7–8.

Gliessman, S. 2014. Agroecology, the ecology of food systems. CRC Press.

Hecht, S. 1999. La evolución del pensamiento agroecológico. *Agroecología: bases científicas para una agricultura sustentable*, *4*, 15–30.

McIntosh, M. and Simmons, S. 2008. A Century of Women in Agronomy: Lessons from Diverse Life Stories. *Agronomy Journal*

Morales, H. 2007. Between academic life and family life: challenges and strategies of researchers in Southern Mexico. *Interciencia* 32(11):786–790.

Ordorika, I. 2015. Equidad de género en la educación superior. *Revista de la educación superior* 44(174).

Page, S. E. 2008. The difference. Page, S. E. *The difference: How the power of diversity creates better groups, firms, schools, and societies*. Princeton University Press.

Zapata, E., López, J., Galindo, R. 2000. Las agrónomas y el mercado. *Revistas Géneros* 20.

1980's

A CONTAGIOUS LOVE FOR NATURE

By
Luis Fernando Chaves

What I admire the most about John Vandermeer is his contagious love of nature. John's beloved nature is not a fenced forest, or any other artificial construct where humans are not part of the fauna, or where humans are simple background decoration in a landscape. It is something that more closely resembles the feeling of finding something you like, be it a colorful bamboo mosquito or a quetzal in a forest. It is that subtle moment when you somehow realize your amusement comes from your own humanity. I think John's love for nature emerges from the many ways in which he tries to understand things and the interpenetration of his action and intellect. So, from being an ecologist developing theory and models for what he observes in nature, his love for nature also shapes his political action and stance for humanity. In this sense, I think the most integral John one will ever get to know is the one resonating with his coupled oscillator, Ivette Perfecto, and synchronizing the phase with the many comrades, most notably Jerry Smith and Catherine Badgley, when sharing all the dimensions of a common love for nature in the New World Agriculture and Ecology Group (NWAEG).

I was one of the many oscillators synchronizing my phase with John's in NWAEG between 2005 and 2008. During this time, I was a Ph.D. student in Ecology and Evolutionary Biology at the University of Michigan and regularly attended weekly NWAEG meetings. NWAEG was an intellectual and activist community that did not separate politics from science. In NWAEG, it was not a sin to question the "other" underpinnings of different approaches to interacting with nature or to modifying the environment. In this community, it was possible to think and act around the principle that the whole is the truth.

I think the interactions with John and other NWAEG members helped me to question the role of forests in the transmission of parasites that cause cutaneous leishmaniasis in Latin America. Traditionally, the dogma was that cutaneous leishmaniasis was a disease that was going to disappear with the primary forests. A large share of the forest was destroyed in the 1970s, when the prophecy was that deforestation would liberate us from leishmaniasis. To the contrary, this disease has become more common and widespread (Alvar et. al, 2012). What I found during my Ph.D. research was that communities in areas where forests were more abundant were less likely to be affected by the disease, and that more deforested areas not only had more leishmaniasis, but were more sensitive to climatic changes triggered by El Niño. Beyond that, I found that in Costa Rica, the disease didn't map well along any specific climatic or environmental gradient, but it followed patterns of poverty and socioeconomic inequality (Chaves et al., 2008).

Following this work, my collaborators and I tried to understand how poverty alters the ecology of insect vectors of disease in a way that leads to different patterns of infection in populations. For example, we looked at how housing quality can lead to important differences in the number of vectors that people live near, or how likely it is that insecticides can have an impact in reducing their abundance (Chaves et al., 2013), which is associated with the probability of infection (Saldaña et al., 2013; Chaves et al., 2014; Yamada et al., 2016). We also looked at the impacts of land-use change on vector infection (Gottdenker et al., 2012), the impacts of poverty on the health of other animals with which we interact and share parasites (Fung et al., 2014; Calzada et al., 2015; Saldaña et al., 2015), and ultimately on the role of poverty in the ecology of disease transmission. This integral view of things was made possible under the influence of John and NWAEG.

From the time of my Ph.D. research and my interaction with John, I wanted to model the dynamics of latifundia formation as influenced by the presence of disease. John was among the few people that also found this idea exciting, and he encouraged me to pursue its mathematical modeling. The idea that latifundia[1] formation was partially driven by disease transmission was cleverly proposed by Angelo Celli in his study about the historical dynamics of malaria transmission in the Roman Campagna (Celli, 1933). I hesitated, concerned that the problem was historical and local in nature. But after the discovery that inequities in land tenure, not the beauty of Yang Guifei[2], were to be blamed for the collapse of the T'ang dynasty in China, I developed a model that coupled land-use dynamics and land tenure that reproduced the patterns of latifundia formation described by Celli (Chaves, 2013). This was interesting, because a basic message from the model was that inequities in access to health care can create poverty. Yet, things can always be more dynamic, entangled, and full of contradictions, requiring new synthesis. But as a starting point, and as a first abstraction of a complex phenomenon, I presented this study (Chaves, 2013) during John's celebratory symposium, and highlight it in this Festschrift, because it owes much to John's influence.

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[1] Accumulation of land ownership by a small fraction of the people working the land.

[2] One of the four classical Chinese beauties, so beautiful that all flowers will be put to shame.

On a more human side, I also got valuable advice from John. The most important advice was for me to seek the truths in the words of colleagues that, purposefully or inadvertently, may hurt. Also, by following John's example, I am now able to do simple things that reduce gender, race, and artificial barriers in society, to make our environment more inclusive and enjoyable.

Finally, I want to thank John and his coupled oscillator, Ivette, for being such great friends and mentors. I probably will never be able to exhibit John's contagious enthusiasm about things, but I am thankful that after meeting him, I feel more comfortable about the ways in which I love nature—its wholeness and contradictions—and our power to change things and move forward to a new stage, where science is not used to justify atrocities, but where science helps to improve the lives of people without compromising our unity with nature.

REFERENCES

Alvar, J., Vélez, ID., Bern, C., Herrero, M., Desjeux, P., Cano, J., Jannin, J., Boer, Md. 2012. the WHOLCT: Leishmaniasis Worldwide and Global Estimates of Its Incidence. *PLoS One* **7**(5):e35671.

Calzada, J.E., Saldaña, A., González, K., Rigg, C., Pineda, V., Santamaría, A.M., Rodriguez, I., Gottdenker, N., Laurenti, M.D., Chaves, L.F. 2015. Cutaneous Leishmaniasis in dogs: is high seroprevalence indicative of a reservoir role? *Parasitology*, 142(9):1202–1214.

Celli, A. 1933. The history of malaria in the roman campagna from ancient times. London: John Bale, Sons & Danielsson, Ltd.

Chaves, LF., Cohen, JM., Pascual, M., Wilson, ML. 2008. Social Exclusion Modifies Climate and Deforestation Impacts on a Vector-Borne Disease. *Plos Neglect Trop Dis* **2**(2):e176.

Chaves, L.F. 2013. The Dynamics of Latifundia Formation. *PLoS One*, 8(12):e82863.

Chaves, L.F., Calzada, J.E., Rigg, C.E., Valderrama, A., Gottdenker, N., Saldaña, A. 2013. Leishmaniasis sand fly vector density reduction is less marked in destitute housing after insecticide thermal fogging. *Parasites & Vectors* **6**(1):164.

Chaves, L.F., Calzada, J.E., Valderama, A., Saldaña, A. 2014. Cutaneous Leishmaniasis and Sand Fly fluctuations are associated with El Niño in Panamá. *Plos Neglect Trop Dis,* 8:e3210.

Fung, H.L., Calzada, J., Saldaña, A., Santamaria, A.M., Pineda, V., Gonzalez, K., Chaves, L.F., Garner, B., Gottdenker, N. 2014. Domestic dog health worsens with socio-economic deprivation of their home communities. *Acta Tropica*, 135(0):67–74.

Gottdenker, N.L., Chaves, L.F., Calzada, J.E., Saldana, A., Carroll, C.R. 2012. Host life history strategy, species diversity, and habitat influence Trypanosoma cruzi vector infection in Changing landscapes. *PLoS Negl Trop Dis*, 6(11):e1884.

Nagasaki University Institute of Tropical Medicine (NEKKEN), Nagasaki 852–8523 Sakamoto 1-12-4 Japan & Programa de Investigación en Enfermedades Tropicales (PIET), Escuela de Medicina Veterinaria, Universidad Nacional, Heredia, Costa Rica. Email: lchaves@nagasaki-u.ac.jp

Saldaña, A., Chaves, L.F., Rigg, C.A., Wald, C., Smucker, J.E., Calzada, J.E. 2013. Clinical Cutaneous Leishmaniasis Rates Are Associated with Household *Lutzomyia gomezi, Lu. panamensis, and Lu. trapidoi* Abundance in Trinidad de Las Minas, Western Panama. *The American Journal of Tropical Medicine and Hygiene* 2013, 88(3):572–574.

Saldaña, A., Calzada, J.E., Pineda, V., Perea, M., Rigg, C., González, K., Santamaria, A.M., Gottdenker, N.L., Chaves, L.F. 2015. Risk factors associated with Trypanosoma cruzi exposure in domestic dogs from a rural community in Panama. *Memórias do Instituto Oswaldo Cruz*, 110(7):936–944.

Yamada, K., Valderrama, A., Gottdenker, N., Cerezo, L., Minakawa, N., Saldaña, A., Calzada, J.E., Chaves, L.F. 2016. Macroecological patterns of American Cutaneous Leishmaniasis transmission across the health areas of Panamá (1980–2012). *Parasite Epidemiology and Control,* 1(2):42–55.

AN INSATIABLE CURIOSITY: A CELEBRATION OF "OUTSIDE OF THE BOX" IN HONOR OF JOHN VANDERMEER

By

Senay Yitbarek*, Theresa Ong, Doug Jackson*, and Dave Allen*

During a Dutch televised debate in 1988, MIT professor Noam Chomsky was asked to explain intellectual self-defense:

> *"Intellectual self-defense means you have to develop an independent mind—and work on it. Now that's extremely hard to do alone. The beauty of our system is that it isolates everybody—each person is sitting alone in front of the tube. Now, it's very hard to have ideas or thoughts under those circumstances. Some people can, but it's pretty rare. The way to do it is through organization."*

At the core of Chomsky's analysis is the notion that citizens in democratic societies should protect themselves from manipulation and control by their leaders. Chomsky's views are deeply entrenched in the Enlightenment tradition, out of which a humanistic conception of education developed that cultivated creativity, independent inquiry, and solidarity with others. However, developing an independent frame of mind is no easy task. The ultimate goal of the educator, in Chomsky's view, is to lay out a string and nothing more. Part of the success of the educator is when the student follows that string in her own time and of her own volition. Too often, modern education is based on the metaphor of filling a leaky vessel with water. Those leaky vessels eventually develop into leaky pitchers, adults who have been molded since youth to be passive consumers, not active participants, neither as creators of knowledge nor as citizens in society. It is therefore critical that intellectuals use their privileged access to knowledge to develop avenues of intellectual self-defense for others.

With these considerations in mind, for a number of years, a small group of renegade ecologists met weekly to discuss issues of an arbitrary nature. The group, named "Outside of the Box" (OOTB), follows in the footsteps of the Enlightenment tradition, the goal being to equip these ordinary people with a kind of intellectual self-defense. The aim was not simply to cover material presented by the priesthood, but rather to discover new principles and insights that could yield new theories from which to build a future society.

Yet to think outside of the box, one must first recognize it, this "box." To those whose every day is pervaded by the awareness of boxes, who can no more fail to see them than cease being, this may seem like a superfluous statement. But the most cursory contemplation of human behaviors and beliefs is sufficient to see that the unconscious (though sometimes intentional) lack of awareness of these boxes is as much a characteristic of *Homo sapiens* as language and sociality. It is present in the dogmatist, certain in his beliefs though they contradict perceived reality; in the warrior and his eulogist, who inflict and invite death in the glorification of imagined personal and tribal identities; in the unenlightened worker, who willingly exchanges the most precious of assets—labor, health, life itself—in pursuit of the very excess production that enables her enslavement; and in the basic impulse that propels us from one generation to the next. These attitudes and behaviors are alike in that they are only tenable in the context of underlying premises and beliefs that form conceptual frameworks, i.e., rationalizing paradigms.

OOTB arose from a desire to escape, at least temporarily, from the particular boxes experienced by us as graduate students in the Department of Ecology and Evolutionary Biology. Although there are many intradisciplinary boxes that merit transcending—conceptual frameworks, favorite models, self-identities as theoretician or empiricist—these were not the boxes that we were aiming to elude in OOTB. What we wanted to temporarily escape was the box imposed by the field of ecology itself.

We say temporarily because enlightenment does not lie in simply recognizing and then permanently casting aside all boxes. An inability to move beyond a reflexive shedding of these constructed boundaries is the mark of many a tormented mind. We have all seen those anguished souls who roam the streets in constant internal battle against the arbitrary constraints that have been imposed upon them throughout life: the strictures of the classroom, the tyranny of the time card, the subtle violence of conformity. For these unfortunates who can see the boxes and their artificiality so clearly but cannot reconcile themselves to their ubiquity, the keen awareness of these boxes is ruinous. Like any structure, boxes may often be constraining; but, like models, they are also essential crutches that allow finite minds to cope with an infinite world. The truth is the whole, but only an infinitesimal fragment of the whole can reside in a human mind at any one time.

The preceding statement is an admonition of human fallacy: the idea that there exists a fundamental limit to our knowledge of the universe and its secrets. This betrays our very human tendency to believe in essential truths—the belief that for every question there exists some definite, no matter

*co-first authors from the OOTB Collective

how obscure, answer. As a first exercise in transcending our existential boxes, let us examine the assumption of essential truths. Consider the Cantor set. Take a line segment, split it into thirds, and remove the middle third. Repeat this process an infinite number of times and what results is a paradox: an infinite number of points existing within an infinite amount of empty space. Here is an example of duality in nature. If it is true that a line segment can be both finite and infinite, that light can be both particle and wave, can it be that the universe as a whole is simultaneously determinate and indeterminate?

The magic of OOTB lies in a similar duality: in its dynamic and simultaneous alternation between the worlds of box-building and box-escaping, its interplay between the necessary but dangerously seductive boxes of the scientist and the unstructured wanderings of the intellectual itinerant. Data and theory; baseball and soccer; Shostakovich and jazz; deadlines and dancing.

OOTB was not intended to be an ideas incubator, or to generate concrete deliverables, such as project plans or grant proposals. Instead, it was meant to help educate our intuitions, both intellectual and moral. To truly appreciate the experience would require a couple of hours and a few beers at Silvio's, but two memorable examples of material we grappled with may give a sense of the wide-ranging and stimulating discussions of OOTB.

The first example is *A Mathematician's Apology*, an essay written by G.H. Hardy, of Hardy-Weinberg fame. In it, Hardy justifies a life devoted to mathematics strictly on the grounds that "serious," or "real," mathematics can be aesthetically beautiful, akin to painting with ideas, and that mathematics can be an expression of elite mathematicians' extraordinary talent—talent most people, who never do anything truly great (in Hardy's opinion), do not possess. Most provocatively, he cites pure mathematics's lack of utility as one of its main virtues: "…science works for evil as well as for good (and particularly, of course, in time of war); and both Gauss and lesser mathematicians may be justified in rejoicing that there is one science at any rate, and that their own, whose very remoteness from ordinary human activities should keep it gentle and clean."

Not only does Hardy contend that a life's work need not be justified by its utility, he claims that consciously focusing on making the world a better place is counterproductive, and anyway almost all of the best work of the world has been driven primarily by ambition (he claims), not by any noble purpose: "…surely, there is nothing of which any decent man need be ashamed" if his dominant motives have been intellectual curiosity, professional pride, or desire for reputation.

What was valuable about the OOTB discussion of this essay was not that it allowed us to reach consensus on whether Hardy was right or wrong, but rather that it forced us outside the confines of our comfortable box: It unsettled our minds about an issue that many of us had taken for granted. Of course we should consciously seek to improve the world through our science! Of course our work should have some relevance to the real world and practical application, however indirectly! These convictions seemed much less self-evident, but perhaps even more deeply true, after being challenged by Hardy's bold assertions. Was Hardy onto some profound truths about human motivations, abilities, and virtue, or was he a myopic sapling in the moral forest, content in being taller than the surrounding seedlings but tragically unaware of the towering giants in the canopy above? By confronting a viewpoint so foreign to many of us, we were forced from our own intellectual complacency, and our own philosophical frameworks were strengthened, expanded, and enriched.

Defining one's personal philosophy is in many ways a lost art. Troubled by the toil and drudgery of daily life, most people have little time for introspection. We confronted this problem when reading David Foster Wallace's essay *This is Water*. Here, Wallace asks how we can maintain our humanity in the face of "day-to-day trenches of adult existence." We interpreted this as: How can we continue to apply what we have learned in our OOTB experience in a world that continues to enforce boxes on us? How can we apply what we have learned during everyday life? Wallace gives an example of shopping after a long, tiring, stressful day, "a crowded, loud, slow, consumer-hell-type situation." Here, he says we can fall into a "default setting" of judgement and self-centeredness. This self-centeredness is hard to avoid because "everything in [our] own immediate experience supports the deep belief that [we are] the absolute center of the universe, the realest, most vivid and important person in existence."

So what does he suggest we can do to avoid this? What does he suggest we can do to live the insights we have learned from OOTB? Unfortunately, Wallace finds no magic formula. Instead, he says that we first must be aware that we have the choice of how we are going to view this world. "[The] capital-T Truth is that you get to *decide* how you're going to try to see [the world]. You get to consciously decide what has meaning and what doesn't." Wallace suggests that we need to confront the world knowing that we have that choice—we have the choice to take our OOTB insights into the world. From there, the hard part is the daily "attention, and awareness, and discipline, and effort" to apply these insights.

Some of the OOTBers found this view of the world oversimplified and even, as Wallace warned that we might, a "banal platitude." But others found this very explicit statement of choice and call to daily discipline and awareness inspiring.

Confronted with the task of simultaneously defending and developing our personal philosophies, OOTB created in us a spirit of discovery that may resemble something of what Darwin felt on the helm of the HMS *Beagle*. In the end, we discovered one basic truth: We are the architects of our own boxes. Their walls and dimensions are built from our personal biases and predilections. Only when we acknowledge this do we begin to emerge from its confines, only to arrive in new boxes that will require further dismantling.

EPILOGUE:

The original OOTB group consisted of graduate students in John Vandermeer's lab, as well as Ivette Perfecto and John himself, which is no coincidence. John lives the principles that engendered OOTB. As an educator, John certainly fosters the development of intellectual self-defense in his students. But focusing solely on his work as an educator would vastly underestimate the centrality of this philosophy to his work and his life. Spend time with John, whether in his office, in the classroom, or in the restaurants and coffee shops of Ann Arbor, and you will witness interactions between him and a complete cross section of the local community—young children, students, professors, restaurant owners, janitors, socialists, capitalist apologists. And without exception, you will see him exhibit an intellectual curiosity, a keen interest in what the other person is thinking, and a tangible sense of mutual respect and genuine engagement that dissolves the isolating influences of age, class, gender, ideology, or clique. In short, you will see a deep love of humanity coupled with an absolute disregard for fettering boxes, whether social or intellectual. John is the key intellectual driving force behind "Outside of the Box."

Thank you, John, for your tireless passion and companionship as we continue to traverse this world of endless boxes.

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TOWARD SUSTAINABLE AND JUST FOOD SYSTEMS

HUMAN FOOD WEBS, CYCLES, AND TOOLS: TEACHING SUSTAINABLE AGRICULTURE IN A LIBERAL ARTS CONTEXT

By

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Summary. Sustainable here simply means methods that can be carried on indefinitely, with a decent quality of life for all involved. Agriculture is a diverse and complex set of ecological food webs in agroecosystems, social food chains and webs of power relationships. If we include a full range of conventional, organic, and agroecological methods, as well as social means and change beyond producing food for profit, finding the solutions for sustainability may be rather easy. For example, since we need to move to sustainable energy in general, energy becomes largely moot as a sustainable agriculture issue. Even chemical nitrogen and rock nutrient fertilizers can both be sustainably produced, and soil erosion can be countered. Any increased infrastructure, labor costs, and prices are modest and should be easy as well as essential for society to share. Farmers and farm workers can bypass power bottlenecks to obtain more of the value of production. Regional sharing combined with local production can help with pest control and climate change. To do it right, sustainable agriculture needs to use both ecosystem and social services, and in turn is a case study for the need for social change in general.

INTRODUCTION

This paper stems from a brief talk for the May 2016 Festschrift for John Vandermeer, entitled "Teaching Sustainable Agriculture in a Liberal Arts Context." Here I present more fully some ideas that I noted there for talking about sustainability (in courses, etc.), moving from the problems of conventional agriculture to more ecological alternatives, including social as well as technical issues, and then suggest some solutions for common problems using all of these methods and ideas as tools.

I naturally start with more technical aspects on ecological understandings (e.g., food webs) and solutions (e.g., biological control) for agriculture, from the more local and small-scale sense of farms as agroecosystems, to the larger scale of ecological and environmental impacts, such as pesticide drift or global warming. One can look at agriculture more as properly being a branch or peer field of ecology, rather than what now often seems to be more of a division of chemical and mechanical engineering. But conventional agriculture of course involves social and political problems (e.g., farmers and farm workers can barely make a living). It should be clear that "sustainability" must also necessarily mean a decent quality of life, including social justice and democratic self-determination, for everyone in the food system, not just a lucky or powerful few. After all, a system that is sustainable but unpleasant would be a pretty good definition of hell.

Gliessman (2009) noted four technical and social steps to sustainability, with various degrees of overlap, including: (1) more rational use of resources, such as reduced pesticide spraying using economic thresholds; (2) input substitution, such as organic farmers using organic sprays like Bt instead of DDT, but otherwise similar methods, etc.; (3) more ecological methods that are more truly sustainable, such as greater crop diversification that promotes natural enemies for lasting control, concepts more promoted as agroecology; (4) social connections to support better farming, such as CSAs to buy from farmers up front and directly. One can suggest higher levels for more general social change.

Others (e.g., Altieri, 1995, 2010; Gliessman, 2014; Magdoff and Tokar, 2010; Magdoff, 2015; Reganold and Wachter, 2016) also of course note technical methods beyond organic, and key social components for sustainability. Agroecology (Altieri, 1995, 2010; Gliessman, 2014; Rosset and Altieri, 2017; www.agroecology.org), in addition to indeed invoking more fully ecological solutions, explicitly embraces as a field and a movement emphasizing local knowledge and really working with and within communities (e.g., La Via Campesina) (viacampesina.org; Altieri, 2010; Magdoff and Tokar, 2010; Rosset, 2010, 2011). Various authors (Lewontin, 1982, 2000; Patel, 2012; Perfecto et al., 2009; Shiming and Gliessman, 2016) also note the existence of power relationships in agriculture, including the idea of "bottlenecks," where a few large producers of farm inputs and buyers have more control than the many farmers and consumers. There is also the role for good or ill of governments and other social structures.

I like to combine the methods and relationships and look at the full range of "human food webs," from insects in the

crops to farmers enmeshed in society. Looking at the whole picture of agricultural relationships helps to see solutions. On the one hand, we properly try to develop more sustainable technologies for agriculture, like diversification for biological controls, but at some point, one may find that the best available alternative method simply does not do as well in the short term compared to, say, a synthetic chemical insecticide. At that point, we may find yourself saying that the economic rules should be changed, rather than us trying to beat conventional methods at their own game. Externalities should be charged to producers. Very harmful materials should sometimes just be banned. Farmers and farm workers should have safe working conditions, as well as decent pay, land, etc. If food is truly more expensive as a result, it means that it should be subsidized by society, and/or that consumers should be paid higher wages. I often find myself saying that one of my jobs as a scientist is to help others see the value of science, but one of my responsibilities is to help people see when science reaches its limits and policy and social change are needed.

Human Food Webs from Small to Large

The problems with conventional agriculture may arise in part from some tendency for reductionism (e.g., Norberg-Hodge et al., 2001). It is easy to see a farm problem in isolation, such as a farmer growing a crop with an insect pest, so we seek a pesticide that kills the pest in a petri dish in the lab. But of course a farm is not a Petri dish or a test tube. A farm is an ecological system where the crops are part of a dynamic community of living organisms, which interact in food webs and evolve, plus nonliving components such as soil, water, air, and energy, all connected to the rest of the world (Figure 1). Thus, we often talk about farms as "agroecosystems." And when we spray pests, we may also impact their predators, pollinators, wildlife, workers in the field, people living downwind, and consumers that receive the produce. Pesticide resistance and the pesticide treadmill (e.g., Flint and van den Bosch, 1981; Hajek, 2004; Vandermeer, 2011) is a classic example: Predators are killed, too, so that pests, and new species of resistant herbivores or secondary pests, resurge in greater numbers than before. I like to call it the *pesticide spiral*. And when we apply chemical fertilizers, some of it ends up in ground and surface waters as pollutants. And so on, with a real emphasis on the "and so on" here: What we do has many effects, often unforeseen, and often not realized until much later.

On a larger level, we can define whole regions as biomes and keep in mind that farms and natural systems are not isolated from each other, but are linked together in functional ways. Farms are next to, and also themselves may serve as, wildlife habitats, which in turn provide "ecosystem services" like insect predators (Cross et al., 2015; Vandermeer et al., 2010), and which should be studied and managed together with the farms that are "nature's matrix" (Perfecto et al., 2009). And we recognize that these all are linked together worldwide as the biosphere, and that what you do on a farm can literally impact the whole world (e.g., pesticide residues are found in arctic animals, farming contributes to global climate change, and so on).

One major theme then becomes to encourage more fully ecological approaches to agriculture (Figure 2). Agricultural food webs are not just a source of complications but also a toolbox of possible solutions. The need for more ecological approaches is also of course well known now, and some such methods are already mainstream, such as using crop rotations and cover crops to help deter pests and hold the soil instead of excessive tillage, using predators of pests for biological control, and the use of more diverse planting systems like polycultures or mixtures of crops in the same field (especially in less industrialized regions of the world) (e.g., Altieri, 1995; Gliessman, 2009, 2014; Sullivan, 2003; Vandermeer, 1989).

This is where I like to talk about favorite examples of complexity as a source of understanding and tools. The pesticide treadmill noted above is an obvious starting point. All the research (!) by Vandermeer et al. (e.g., Perfecto et al., 2009; Vandermeer, 2011; Vandermeer et al., 2010, 2014) provides great recent examples of food webs and ecosystem services, such as how a keystone ant species in coffee farms

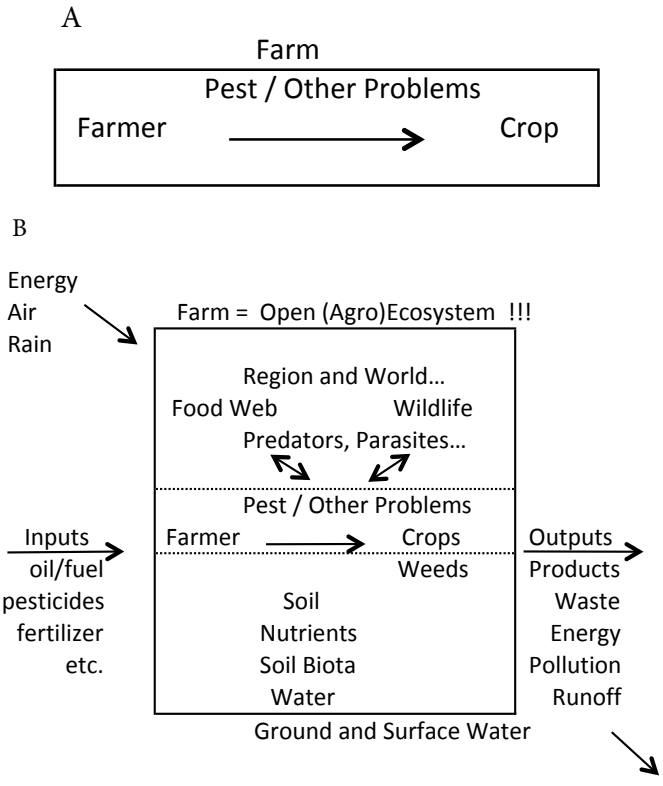

Figure 1.— A, A reductionist view of a farm with a pest problem on a crop, which should be seen instead inside of and as part of: B, a farm agroecosystem, with complex food web relationships and inputs and outputs.

brings in an erstwhile pest that carries a fungus that attacks another pest fungus, the coffee rust, so the ant does much more good than harm (among many other stories, including a parasitoid fly that essentially eats the heads off of ants while it regulates their numbers) (Vandermeer et al., 2010, 2014). Polycultures, like the familiar three sisters (corn, beans, and squash) and more, are of course obvious cases, too, as are the Mexican Chinampas systems and simply diverse land plans around homes and farms around the world (e.g., Altieri, 1995; Gliessman, 2014; Sullivan, 2003; Vandermeer, 1989). Despite some problems with it as currently promoted, the idea of permaculture (e.g., localumass.com/permaculture.html) is useful to talk about (albeit critically), given its popularity with students. I also like the story of how blackberries and plum trees grown near grapes provide an alternative leafhopper species host for a parasitoid wasp that attacks grape leafhopper in the western United States (Wilson et al., 1989; Douglas et al., 2000).

And consider the impressive push-pull system for corn that is commonly used in Kenya: polyculture with a local forage legume, along with surrounding grass trap crops, which controls not only moth pests but also a plant parasite of the corn (e.g., Pickett et al., 2014). For push-pull corn we can also start to add social background notes and questions: about why are they growing so much corn in Africa, not to mention without rotations, and also how corn is an "invasive" that in this case encountered fiercer enemies to which it is not adapted instead of escaping enemies, so that this polyculture may be so amazingly successful because it started from a deep, human-created hole, so to speak.

However, it is also always important to note that while we need to understand the ecology of agriculture, there are also key differences between natural ecosystems and current agroecosystems. Perhaps the most critical is that natural ecosystems are relatively "closed" systems, while agroecosystems are now much more "open" (e.g., Flint and van den Bosch, 1981; Gliessman, 2014). In a closed system, there is no net gain or loss of components. Natural ecosystems are not completely closed, but relatively closed compared to farms, in that little enters or leaves, such as the nutrients that enter a forest watershed in rain and rivers and leaves by rivers and groundwater, and of course energy that enters as sunlight and leaves as heat or chemical bonds. In agroecosystems, unless a farm (even an organic/agroeocological one) is truly a subsistence farm, where the farmers consume all the products and leave all their waste on site, then there is always a large net loss in materials in the form of food and other products that leave the farm.

Thus, farms start out as inherently unsustainable enterprises unless and until renewable inputs to replace all those materials (e.g., compost) are brought back to the farm, which may then actually indeed bring us back to systems more like nature, where nutrients mainly flow in cycles within natural systems, rather than in and out as part of a food "chain."

In addition, evolution usually selects for organisms that put their resources into ways to maximize their own survival and reproduction, not necessarily to produce food for us, and evolution will always tend to counter our measures to control pests and diseases—even alternative methods (e.g., organic as well as synthetic pesticides, and even cultural controls like crop rotation, in the case of corn rootworm evolving to eat rotated soybeans; Thomas, 1998).

We should thus be a bit careful when we say that agriculture should use nature as a model, or that all we need to do is mimic nature to produce a more rational agriculture. Understanding and working with the ecology of crops and farms and the wider world, too, is an essential part of understanding and finding better tools for agriculture, but it may not always be sufficient by itself as a model. Nature is indeed filled with checks and balances, with mutualistic collaborations, including many vital for agriculture (e.g., *Rhizobia*; mycorrhizae). And ecologists actually sometimes neglect mutualisms too much (Boucher, 1985; Vandermeer et al., 2010). But still, nature can be nasty: trying to poison you or eat you, rather than feed you (e.g., many plants are already full of natural pesticides). And last but not least, our understanding of nature is still imperfect, so we must be wary of our own conclusions when we speak of what is "natural," such as how we think evolution produced the world we see, or how the bewildering number of parts in a real ecosystem actually interact.

Still, we should approach agriculture first and foremost as a properly ecological topic, both in the smaller sense of the ecological interactions and the larger sense of ecological and environmental issues, and so on. We should minimize outside inputs and waste, and also indeed learn from and connect to natural systems, work with nature rather than against it as much as feasible, embrace its complexity rather than try to reduce it with overly simple models and solutions, emphasize biodiversity over monoculture and cycles over chains, and seek to make evolution work more with us instead of against us.

Politics, Profits, and Power: The Broader Context

It is also essential to understand farms in their social, economic, and political contexts. First of all, again except for subsistence farmers growing all their own food and keeping all of it, farms produce crops for exchange, which means we buy and sell food products in markets. There is economic reductionism involved here. Food becomes mainly reduced to a set of commodities valued by their prices, and its production and distribution then often become controlled by large corporations, whose natural goal is to maximize profits, often for shareholders who are not so interested in sustainability when they can just move their investment money when better options appear elsewhere.

One can then step back a bit and see the farm, agroecosystems and all, embedded in another system of what is often called the

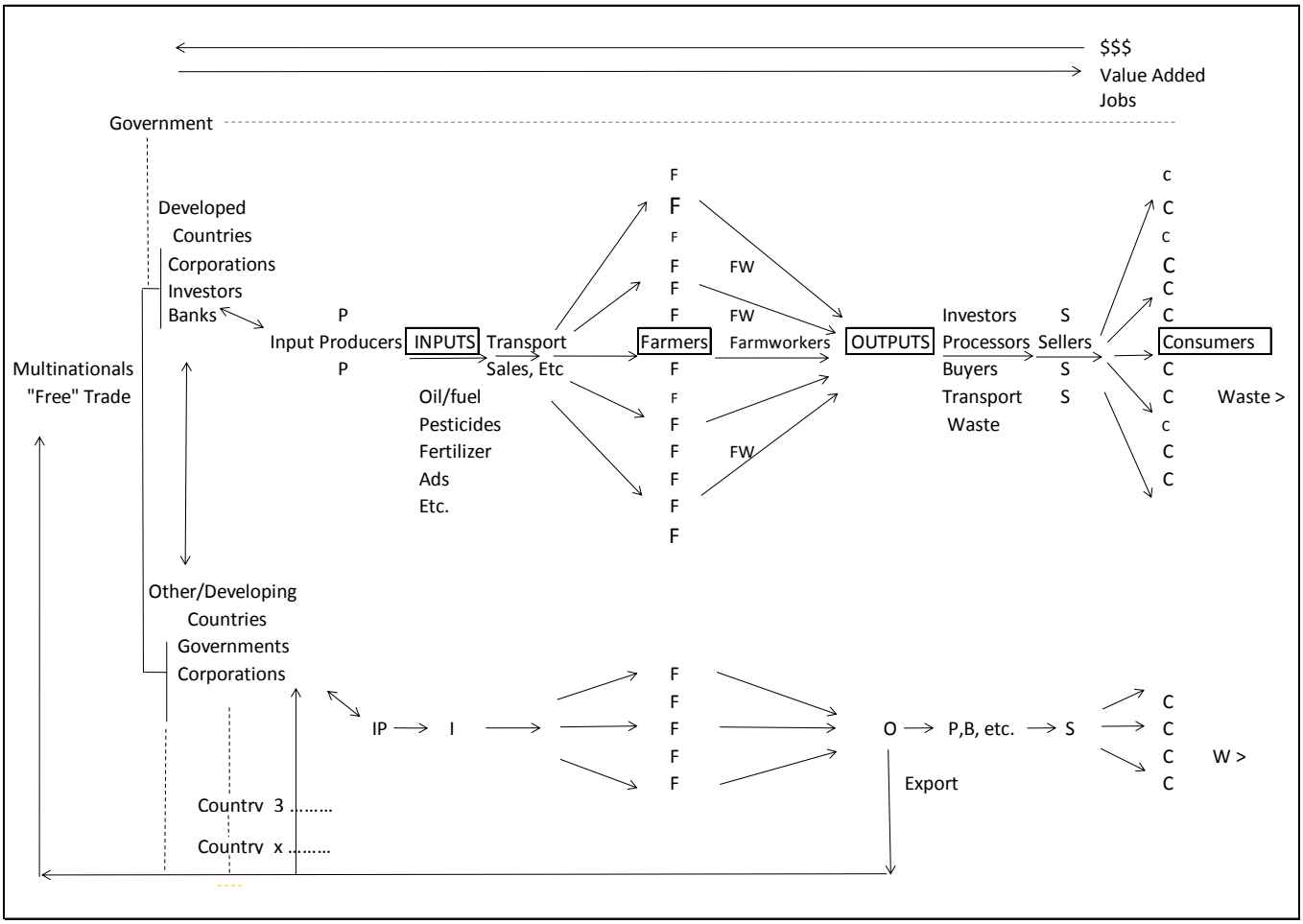

Figure 2a.— The full farm food web, or the food chain of inputs to outputs (petroleum to peanut butter, and waste beyond, too), along with the power bottlenecks that come from many farmers and consumers dealing with a few input suppliers and output buyers, transnational companies spanning the many countries, government and others involved.

industrial food chain (e.g., Pollan, 2006). Farms grow food and fiber to sell to buyers and consumers, and in turn buy inputs, such as fuel and fertilizer, from input suppliers. In past eras, by comparison, chemical pesticides were relatively unknown, and farmers produced much of their own seed, "machines" (i.e., draft animals), and "fuel" (animal feed). In "modern" agriculture (conventional and organic, too), the farms may actually be a relatively small part of the whole food and fiber production process, such that they actually get only a small percentage of the price or value of the food we eat as payment for their crops, and keep little enough of that after paying for the inputs (e.g., perhaps nine cents on the food dollar in the United States; USDA, 2017). As Richard Lewontin (1982) famously noted: "Farming is growing peanuts. Agriculture is turning petroleum into peanut butter."

This human food chain actually really tends to be a more complex food web of power relationships. Historically, industries that grew around agriculture have tended not to take over farms, which have so many risks involved, but prefer to make their profits buying and selling to the farmers, and there tends to be a relatively small number of large companies that make and sell inputs such as fuel and chemicals to a much greater number of farmers, who in turn sell their products to a small number of processors or buyers (e.g., grain buyers, canneries, or supermarkets) (Lewontin, 1982, 2000). Thus, there are the bottlenecks (e.g., Patel, 2012; Perfecto et al., 2009) in the food chain, or web, really (Figure 2a), who thus have much more power in setting prices and take most of the value added. Contracts with buyers are often used by the buyers to dictate details of production that the farmers must use (contracts can benefit farmers, too, but the details matter, as does who gets to determine the terms). If one farmer doesn't like a price or the terms of a contract, another one probably will accept it. As another bottleneck, the buyers also then tend

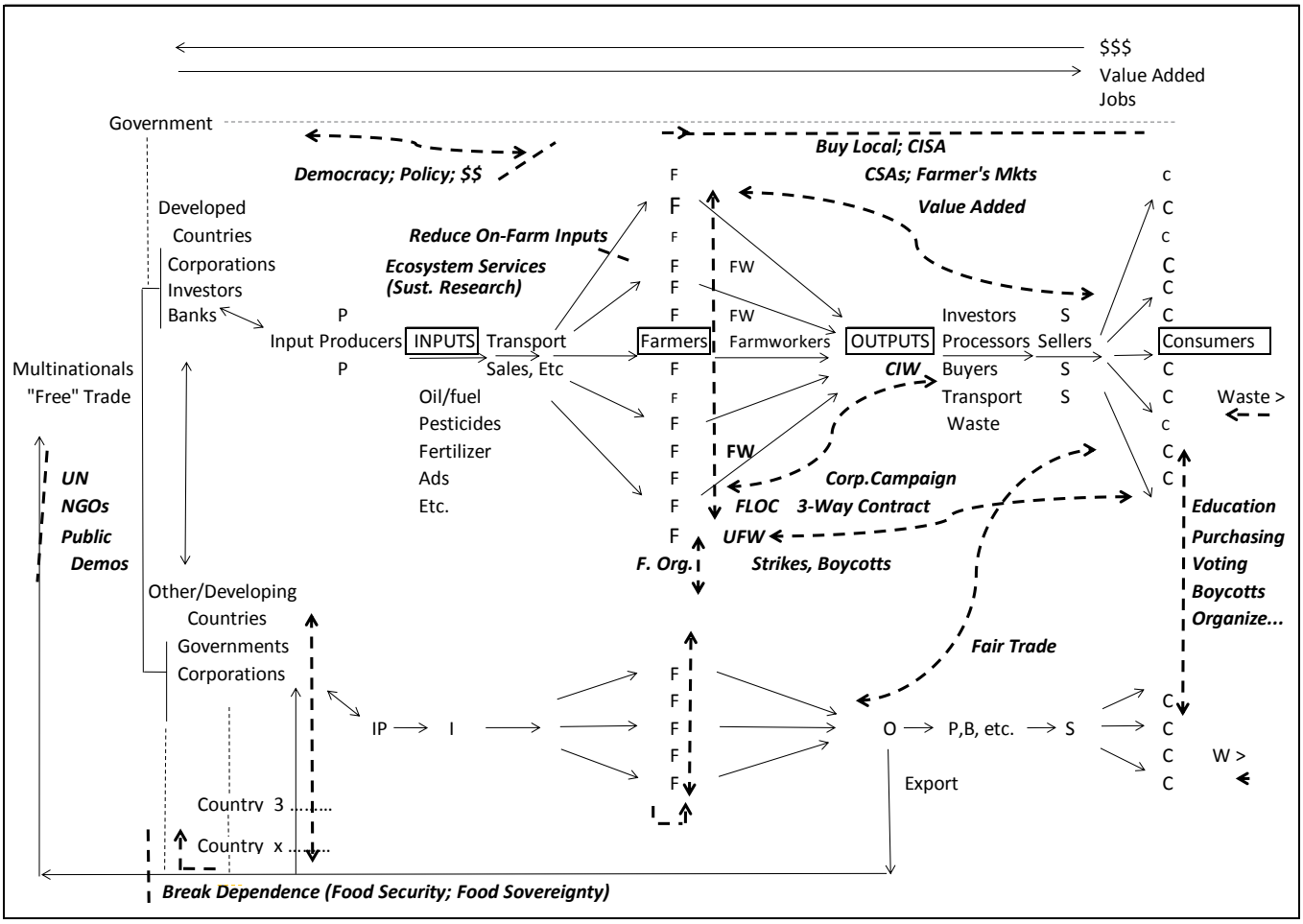

Figure 2b.— The nature of solutions for sustainability are then suggested (added dashed lines), such as breaking the dependence on off-farm inputs as much as possible, as well as recycling or producing sustainable inputs—but also going around or confronting power bottlenecks, such as direct farmer-to-consumer sales, consumer boycotts, action against the power centers by farmers and workers, farmer and farmworker organizing within and between countries, breaking dependence on trade and trade agreements, etc.

to sell to a large number of consumers (the rest of us), who again have little power as individuals to control what is sold to them or what they pay to the supermarkets where they shop.

On the international level, a few large multinationals, such as grain companies, coffee buyers, etc., control trade among the many nations of the world (along with elites and officials within countries), producing yet another set of power bottlenecks. So-called free trade often only adds to the advantage of the larger players to set terms of trade such as prices and quotas. A lack of regulations usually favors the powerful more than the powerless. In the law of the jungle—that is, little or no law—the big cats tend to win.

Seeing the Sustainable Solutions

Contemplating the full range of the ecological and economic relationships should actually help us to see more and easier solutions to find and adopt more sustainable methods of agriculture (Figure 2b). On a more technical level, we can try to help farmers reduce the dependence on outside inputs by producing more sustainable methods on the farm, such as using legume crops and cover crops that fix nitrogen from the air, or using diverse cropping systems that discourage pests without sprays, or tillage by supporting natural enemies with diverse alternative food sources. They can also try to produce more finished products to capture more of the value added (e.g., cider instead of apples).

If technical/agroecological solutions solve the problems and meet our needs, then great (and we should be seeing more truly agroecological farms tried everywhere); but if not, we should insist on social fixes that will put us over the top. On a more economic and political level, we can bypass or attack some of the bottlenecks in the larger human food webs of farm inputs and outputs, so that farmers get a bigger slice of the

value or value added of food production. For example, farmer's markets and direct-to-consumer programs like Community Supported Agriculture (CSA) farms bypass food processors and supermarkets. Buy-local campaigns (e.g., the Community Involved in Sustainable Agriculture, or CISA: buylocalfood.org) also enlist consumers to shorten or bypass the food chains and webs and buy more directly from farmers. Farm workers can organize and focus on corporations that actually have the power to respond to demands for better working conditions, rather than just the farmers, and the workers can enlist consumers to help them.

It is no accident in Figure 2 that some letters for farmers (F) and consumers (C) differ in size from each other. The variation in farm size affects what we do. Big farms use different technologies than small farms, have more power, and receive more subsidies already. Farm worker organizing and activism has varied by farm size: The United Farm Workers (UFW: www.ufw.org) could strike against and deal with the very large farms of California, while the Farm Labor Organizing Committee (FLOC: www.floc.com) found that strikes against the smaller farms in the Midwest could just drive the farms out of business. But FLOC succeeded by going after the bottlenecks of corporate buyers of produce and their shareholders. Current initiatives like those of the Coalition of Immokalee Workers (CIW: www.ciw-online.org) and the Pesticide Action Network (PAN: www.panna.org/our-campaigns/fair-harvest) tend to involve much of the food web from buyer-farmer contracts to consumers. Wealthier or more engaged consumers can help support progressive products or prime the market for organic products by affording the higher prices, at least at first. I heard Cesar Chavez in a talk once note that it is much easier to change a company policy by affecting their sales by a few points than to get a majority of some bloc of voters. Boycotts mean bad publicity and nervous shareholders (Surowiecki, 2017).

Farmers can cooperate among themselves both within and between countries. (Obvious/classic examples include farmer/populist organizations past and present, FLOC organizing across the border with Mexico, La Via Campesina, and more.) We can recognize and try to use the power of governments, as well as NGOs and/or social movements, and use/support them again to make policies that favor sustainable methods (e.g., redirect subsidies from large, conventional farms to more sustainable operations) and support social changes that correct power imbalances (e.g., support unions, oppose WTO). On a more international level, we can make use of ideas of fair trade rather than free trade to support international producer-to-consumer policies and businesses. Consumers can buy more directly from small farmers abroad through fair trade marketers (e.g., coffee is a well-known example now). Countries and communities around the world can embrace "food sovereignty" (e.g., Altieri, 2010; NFFC, 2018; Rosset, 2006, 2010, 2011) or insist that agricultural policies feed their people and support their farmers first, or at least arrive at their own ideas about food vs cash crops, land reform, labor, social needs, and social organization, resisting the influence of large companies or countries who seek to dictate policies in their own interests.

More Specific Examples and Issues in Sustainability

So, one can see all the agricultural stages and the overall ecological and social complexities as tools in a toolbox, with biodiversity as a source of ecosystem services, and the human diversity of economic and political webs as a source of social services. Sustainability should be the overall goal, simply because in the end, nothing else matters. Not every organic or ecological method as currently defined is sustainable, and some sustainable methods may arise from industrial agricultural tools. I can illustrate all this by now suggesting some solutions to other more specific common problems, which I hope will at least be reasonable enough to consider in spite of, and all the more because of, the fact that they are not restricted to only conventional or organic agriculture, nor to just either production or social approaches. In the end, using all the tools should make it all much easier to attain real sustainability.

The Nitrogen Problem.— Nitrogen (N) is generally seen as a big problem for agriculture, because synthetic chemical N fertilizer is so central to conventional production, but uses a "lot" of energy from fossil fuels for farms to produce and tends to be polluting as it leaches through soil into groundwater or converts to N_2O, and it takes the place of sources that would include organic matter and other nutrients, etc. But first of all, N fertilizer production is less than 1% of the total energy budget of the Uunited States (Vitosh et al., 2012) and about 2% for the world (Ritter, 2008). So, given the importance of food, N should probably never have been that big an energy concern in the short run. And we need to convert to sustainable energy sources sooner or later for all things, anyway (more below). But more interestingly, remember that one can run the Haber-Bosch process for making N fertilizer by using H_2 instead of CH_4 as a hydrogen source, with the H_2 made by electrolysis using sustainable electricity sources (e.g., CFANS, 2017; Cobb, 2014; Zhang, 2016). "Green ammonia" may also be made other ways, has other uses as fuel and energy storage, and may not even cost that much more (e.g., Licht et al., 2014). Thus, even if chemical N is not organic, it can be a sustainable input.

Chemical N could then still be a bad competitor with organic N, but it could also be useful for sustainability if properly used. Sustainable chemical N may be more expensive, but so may be all sustainable energy uses, and that will be part of the larger social change. We should of course use a lot less chemical N, and ideally none at all, for the other reasons noted above, some of the N for agriculture (though not too much, actually; see below) should come from manure, compost, and human waste, to add and recycle organic matter, and minimize pollution, along with legume (and free-living microbial) N. Still, having

chemical N as a backup can reassure the critics of sustainable agriculture who argue/fear that organic N can be too difficult or unreliable on a large scale (e.g., Hurst, 2009). It also helps simplify the problem of how to feed the world sustainably, which often seems to default to how to feed it using organic agriculture (Badgley et al., 2007; Kniss et al., 2016; Pretty, 2010; Reganold and Wachter, 2016; Seufert et al., 2012) with a more limited set of methods. It is also of course possible to synthesize less labile forms of N fertilizer, like urea (though urea has problems, too) and beyond, such as glycine (UPM, 2014), or perhaps other N compounds.

Peak Phosphorus and Other Non-atmospheric Nutrients.—Farmers ultimately get N, CO_2, O_2, and water from the air, but phosphorus (P) and other nutrients are from bedrock and subsoil, and when they are exported in food from the farm ecosystem, they must be physically returned, or else sooner or later, fertility must be lost. This is a long-term threat to sustainability for all methods of production, conventional, organic, and agroecological. (No amount of biodiversity creates new P, though diversification may allow more soil volume to be better used and topsoil to be generated and nutrients released from subsoil/rock more quickly given more agroforestry and microbial diversity.) The term "peak phosphorus" refers to people noticing that conventional agriculture replaces P with mined ores that have a high percentage of P, and these mines may run out in a matter of decades, though some say hundreds of years (Childers et al., 2011; Clabby, 2010; Elser and White, 2010; Gilbert, 2009; Gliessman, 2014; Kuntz, 2010).

So what to do about P, etc.? Obvious solutions are to bring back manure from animals fed from the fields, at least, and compost from crop and food wastes, and not let it go into landfills and the oceans. More controversial but probably necessary is to bring back human wastes—urine and sewage sludge, too, since that is also where P goes (e.g., Gliessman, 2014; Heckman et al., 2009). This is an example of where society must help, since currently the waste stream combines industrial wastes that contaminate sewage, etc. with heavy metals. Separate waste streams are needed. Some nutrients could be recaptured from ocean sources, as long as this does not mean environmental devastation (e.g., use seawater filtration, guano, and limited fish bycatch, perhaps, but not massive dredging).

There still would be a "leakage" problem, in that not all the P or other rock nutrients will be returned with 100% efficiency. One additional source of nutrients could be low-level rock sources or "rock dust" (e.g., Manning, 2004; Leonardos et al., 2000; Li and Dong, 2013; remineralize.org). Rock dust attracts some magical claims, but the basic chemistry of low-grade rock may actually be feasible for wider use. For example, grain may have 0.3% of P (Mallarino et al., 2011), while the average P content of all rock is 0.1% (ptable.org), so to sustain 2 T of yield/ac you would (only?) need to add 6 T/ac of average rock for P per year, etc., and this is ignoring manure P, etc. This example is also actually quite high in that a higher % P in rock is common, and really much less P may be needed if you are just making up leakage. If farmers are already exporting tons of grain yields per acre and dozens of tons of vegetables per acre, and organic farmers may bring in tons (ca 5–20 tons) of manure/compost per acre, then bringing in up to a few tons of rock dust tons/ac, perhaps instead of empty harvesting trucks, is not too hard to imagine. (And again, society could help with subsidies.) With larger amounts, you may actually offset modest soil erosion this way, too (more below on that). One of course still adds cover crops, limited manure and other sustainable N for the organic matter and N. There could be a lot of rock excavation and hauling involved, but energy and dollar cost estimates are not excessive (EERE, 2002; Isleib, 2012). Recall that farmers may already add limestone to fields in tons per acre for pH adjustment!

Another, perhaps even easier, way to replace some lost soil nutrients, or soil itself lost to erosion, may be to dredge sediment from behind dams and return it to farm fields (Fonseca et al., 1998). After all, this is where much of the soil from fields goes—into rivers that are dammed. Estimates vary, but one (Kondolf et al., 2014) is that, worldwide, about 4–5 billion tons of sediment is trapped in reservoirs behind dams each year (coming from many upland sources, not just agriculture), or a bit more than a ton per crop acre worldwide. Other estimates could be much higher (Mahmood, 1987). And this is just the replacement rate; there is much more sediment accumulated behind dams that could be used to restore already eroded soils. Using sediments for soil improvement would also add incentives to remove that unwanted sediment from reservoirs. The costs of dredging may not be that high in terms of agricultural inputs—less than $10 per ton per acre—based on the costs of dredging per ton (Kondolf et al., 2014). When dredging is considered costly, it is usually being compared to the cost of water capacity restored behind dams, but water is not as costly as fertilizers, etc., although there will also be transport costs. Of course, dams are a big set of issues in their own right, and the use of sediment in agriculture assumes that at least some dams should remain. Some sediment should also really be released below the dam to support river nutrient needs. And this all assumes that sediment can be found that is not too full of toxins that may also be dumped in the rivers; another overall social need here may be cleaner rivers for this use of sediment as soil to work.

The peak phosphorus issue may largely/just be that conventional farmers and input suppliers want rock that is about 10–20% P or more, so they can use just on the order of a hundred lbs of fertilizer per acre for the usual goals of low labor and "cheap" food, rather than a ton(s) or so. So the P issue is perhaps partly a capitalist market concern, as well as understandable convenience. In some ways, it is comparable to high-N chemical vs bulky low-N organic fertilizers. Also, if you focus on sustainability more than organic, then a little acid treatment for rock P should be fine—not too much, perhaps, so that P is more available but not leaching/eroding. P can thus

be similar to N as noted above—sustainable, even if it isn't organic.

But all of these latter bulk methods may have one remaining problem. You can't just replace one nutrient in these natural forms, but will get them all and more (e.g., toxins) in ratios that are different in new soil and in rocks from what crops remove. This is a problem that nature does not often face in relatively closed systems. Wild plants can evolve to take whatever ratio they need, because they die and recycle it and so do not actually use up any nutrients in most soils (or else that is what will limit them). But farms export lots of stuff, and generating new soil, or bringing in any old rock dust or sediments at a rate that replaces exported crop P, say, will also bring in more or less of some other stuff (e.g., Fe and Mg) than the crop needs every year, not to mention possible toxins in rock and soil like Cd, and these could build up eventually. This is already a real issue. Some farmers actually have too much P in their soil because they keep bringing manure to give them enough N (but of course, they are also just mining P from a pasture somewhere else), and Cd can come in with inorganic P fertilizer (Sharpley, 2001; Roberts, 2014).

A general solution may be to look for many different sources of rock/sediment with low concentrations of most elements overall (because then they will be so abundant that supply doesn't matter, like half of the planet's rock, not just a few rich mines), but still just a bit higher for a few others, so that blends can be produced with the proper ratio for crops, and/or we may need to use (nonorganic) methods to extract P and other nutrients to make nonorganic fertilizer even from low grade rock, to make such proper-ratio blends, but again in relatively quite low and feasible quantities to offset leakage.

And then here is a strange related point for all of the above: Some soil erosion/loss could then be tolerated, or even be a good thing, if it removes spent soil (cf. Pimentel and Burgess, 2013; Tan et al., 2005), so that you can then actually replace it with underlying bedrock conversion as well as added rock dust or whatever. We can also then tolerate the occasional tillage that may be helpful for pest control or soil tilth, perhaps, and light cultivation for weeds. Although you may not "need" erosion if you are using very small amounts of added fertilizer blends that just meet and replace exported plant needs that are not recovered from wastes otherwise.

In summary, sustainable soil and nutrient management could be relatively easy. Farmers should bring back manure, compost, and human wastes to help replace exported rock nutrients, but not apply too much in an effort to supply all of their N. They then add more N with legumes/microbes. If any N is still truly needed, sustainable chemical N is available as a carefully limited and even useful backup (e.g., it is easier to apply during late crop growth). Even low-grade rock or reservoir sediments can also supply any rock nutrients that can't be found again in the proper proportions from food wastes. Rock nutrient and N sources can even replace reasonable amounts of soil erosion, where not too many tons per acre are comparable to what farmers already remove, as harvests and may add as nutrient supplements already. The costs may need social support to compete with conventional methods and markets but are not excessive for these potential solutions. And soil should be seen as a national treasure, anyway.

Water.— Water is more problematic where it is being essentially mined from aquifers for irrigation, and either crop production must be cut to meet sustainable water supplies, along with technologies to increase efficiency (e.g., more soil organic matter), or water brought in from elsewhere (e.g., aqueducts). Producing fresh water from sea/salt water actually turns out to be within reasonable costs and is done in some countries (Gleick, 2008; Zhou and Tol, 2005), though transporting it long distances (e.g., from coasts to distant and higher inland sites) could be difficult/prohibitive. But for water needs, regional cooperation may be key, too. Rain will always fall somewhere, and global warming should mean more water in the atmosphere overall, actually, but where it will fall is less predictable, so plans should be made to move production and share food as needed (see local vs trade, below).

Energy.— One overall problem with conventional (and organic) agriculture is its reliance on fossil fuels for machinery and the production of some inputs like fertilizer, but again, if we recognize that all of our energy uses must soon shift to sustainable sources, this concern about conventional methods will largely disappear as moot, although the cost of energy may well increase and replace sustainability as a focus, so using less energy in agriculture will still be a practical goal, especially if energy supplies actually become more limited. But as noted above, N need then no longer be such an issue for sustainability per se. Labor can be still reduced by machinery to the extent that it is really helpful and needed (though more use of perennial plantings should help, too), and local production vs trade will be less of a resource issue.

Biofuels are an agricultural issue as one way to replace fossil fuels and to help now to reduce CO_2 accumulation. Most critics of these (e.g., Pimentel and Patzek, 2005; Tokar, 2010) focus on the current production of ethanol, which indeed seems to be a very inefficient use of crops (and the more efficient production of cellulosic ethanol, rather than just sugar fermentation, is still problematic), along with the very valid concerns about using land and resources that would otherwise be useful for food crops, and/or clearing new "marginal" lands or forests. However, most comments seem to give less attention to using biomass to replace coal, rather than to replace gasoline. Since this would use the whole plant and is easy to do (i.e., burn it instead of coal; it is furnace science, not rocket science), it is many times more efficient. For example, the classic analysis by Pimentel and Patzek (2005), which suggests that making ethanol from corn actually uses more energy that it contains, also concludes that corn plants at common yields as a whole contain 3.84 times more energy than they need to grow (and switchgrass about 14 times).

Most plants are not very efficient at turning sunlight into

energy, but high-energy crops like *Miscanthus* (Heaton, 2016; USDA, 2011) could in theory actually replace coal using a relatively small percentage of land area (assuming concerns like potential invasiveness can be addressed, such as with sterile-pollen varieties). Burning anything solid produces air pollution, though biomass ashes and particulates should be recovered from furnaces and smokestacks and returned to the source soil. And we tend to argue in other contexts that the world can produce enough food already without straining our resources (e.g., Badgley et al., 2007; Pretty, 2010; Reganold and Wachter, 2016; Rosset, 2011). A bit more arithmetic: If 10% of the earth's land area is cropland and can produce grains at an average of 1 T/ac (easy for some like corn and rice, which could then compensate for lower-yield and nonfood crops, fallow periods, or bad seasons on some land), that is enough calories to feed about 14 billion people (as long as we don't waste so much and/or feed so much to animals). Whether we accept or reject the use of energy crops, solid biomass could for now be the focus of the decisions, rather than ethanol.

Using Evolution (e.g., Biocontrol and Seed Saving).— I have heard it said that we need more general principles of agroecology (biodiversity over monoculture already seems to be one), and I would again suggest that one should be that we should indeed seek to make evolution work for us rather than against us. That means favoring augmenting or establishing natural enemies more than mass release (or organic sprays), because established enemies can coevolve with pests (cf. Perfecto et al., 2009; Vandermeer, 2011), and ideally favoring the natural enemy methods over cultural controls that repel pests directly (i.e., natural enemy more than resource concentration mechanisms), since pests will try to evolve over any static system, organic or not (again, a classic example being how corn rootworm evolved to eat rotated soybeans).

Seed saving is a norm for developing countries and should be for more "high-tech" growers, too (and not just a curiosity even for organic growers while seed is cheap to buy), since it is a way to coevolve with pests as well as reduce dependence on outside inputs. Heirloom animals, too (e.g., that use grass well and resist drought). And nutrition should be on the agenda for seed selection, as well. Are wild weeds like dandelion and purslane so nutritious (Rodale, 2017) because they are special, or is it because (like sweet corn and apples?) we have done a dubious job of selecting vegetable varieties? And we can eat some weeds, too. (If you can't beat 'em, eat 'em.)

GMOs.— Like most critics of conventional agriculture, I think genetically modified organisms (GMOs) in agriculture so far have been a mistaken direction for sustainability. They are mainly promoted by companies because they are another input farmers must buy, like hybrid seeds before them (Lewontin, 1982, 2000), and are part of overall packages for conventional methods that allow relatively quick sales and integration with other products. Flagship examples include Bt- and Roundup-ready crops, which include the otherwise organic Bt toxins in plants as a systemic insecticide, and/or resistance to the herbicide Roundup, so that farmer can spray weeds at will without killing the crop. And of course, these crops (predictably!) jumped into a pesticide treadmill/spiral, where Bt crops and Bt itself, as well as Roundup, are losing effectiveness, so that now they want to make GMOs that will need 2,4-D or other more dangerous herbicides.

But I suggest that GMOs might yet play a role in sustainability and that it is the business model that concerns me more than the technology per se. GMO developments could be redirected to benefit farmers and the environment more truly than they are now. The usual very valid arguments against GMO crops of course still apply (e.g., Norberg-Hodge et al., 2001; Hakim, 2016): (1) that they really do not increase yields, so far; (2) possible health effects from unexpected protein products in the crop plants; (3) environmental side effects (e.g., pollen toxicity and host-weed reduction for bees and butterflies; (4) the necessity argument, that they just are not needed, given organic/agroecological alternatives like existing crop genetic diversity and diversified farming techniques. But to be fair, farmers aren't always concerned about only yields, but about costs in time and labor, and even the environment: Bt crops at first saved effort in spraying Bt or other nastier insecticides, while Roundup-ready crops increased the use of Roundup, but decreased the use of other herbicides that may also be more harmful, and facilitated reduced tillage that reduces soil erosion (e.g., Hakim, 2016; Hurst, 2009). Some GMOs, such as papayas that resist an otherwise devastating virus, have been embraced by some critics (Little, 2014). A common comment in my area is that if a GMO tomato that resisted late blight was produced, a lot of organic farmers in the northeast United States might become GMO converts. We can perhaps imagine other GMOs that could be useful even now, such as drought resistance in non-food crops (still with due testing for safety, such as for novel skin allergens in cotton clothes).

Note, too, that new "wild" or "traditional" crop varieties may also include hidden toxins.

If we can ever solve the problems and accept GMOs on some technical level (still a big if), might there be a GMO for the people? The GMO technology is getting more precise and easier, so that one can imagine GMOs being produced mainly by small local businesses and/or not for profit by academic, NGO, or government institutions (cf. the small IPM labs that Cuba developed; Nicholls et al., 2003), or even by farmers themselves. What if, instead of big corporations displacing local varieties with their few patented seeds, farmers have genes that might actually be useful if shared with others and their own favorite varieties for free? These then become part of the general crop population that can coevolve along with other traits in seed-saving programs. Of course, the same vigilance about evolution, safety, and real need should remain, and GMOs should not be a crutch that replace other more agroecological alternatives, such as biodiversity and even regional crop rotations to control difficult diseases, too.

Animals.— Everyone seems to agree that we should eat less

meat at least, and produce what we want in more diversified animal farms in combination with and/or close to crops. One awkward issue concerns pastured ruminants, and the fact that despite their many advantages over corn-fed CAFOs, etc., grass fed ruminants, may release more methane into the air due to less efficient weight gain, though better pasture management may offset this where grass can sequester carbon more than corn (Gurian-Sherman, 2011). But here again, since our overall energy production must move away from fossil fuels, and we can eat fewer ruminants too, it will be much easier to accept a little extra residual methane in the long run to take advantage of the benefits of grass-fed animals.

Labor.— So much attention is given to yields in various modes of production that labor seems to be relatively forgotten. But agroecological/sustainable methods may not catch on if/where it means that, say, >50% of the population has to return to the farms. Fortunately, sustainable methods may increase labor per acre, at least for now (although perhaps a fully functional agroecology may change this), but apparently in the range of providing more jobs as a benefit—perhaps a 7–13% increase in labor costs for organic agriculture overall (Crowder and Reganold, 2015). Weed control is often a main concern, where tillage or herbicides seem to be the choices for the large acreages, and hand weeding with hoes seems unacceptable now, but there have been advances in *other* choices for weed control, such as with cover crops and ridge tillage (e.g., Gliessman, 2014; Liebman and Davis, 2009), and the clever roller-crimper for organic no-till developed by Rodale (2018). And again, we will be able to eventually use sustainable energy to replace labor with machines where truly useful, and may even replace some soil where limited tillage and cultivation are still useful for now (e.g., organic vegetables).

People leave farms, or else stay or return to them, for various reasons, from being driven off the land by low prices or hostile takeovers (and then people may want to return), to the lure of city life (then they may not want to go back to farms). Part of the social and cultural discussion of sustainable agriculture and food sovereignty needs to include the proper distribution of labor and the rates of change, and include such too-often-forgotten tools as shortening work weeks and worker management, rather than just laying off "surplus" labor, as well as paying more, etc. (e.g., I have met farm workers who said they would not mind harvesting machines as a long as they got the jobs on them, and their children then did not have to work).

Price.— At least for now, sustainable methods usually make food cost more, and this especially affects the poor, which is often used as a criticism of organic agriculture. The most obvious response should be that while we can work to make all food less expensive, still, food should cost what it really costs, and what we need is to pay everyone high enough salaries to afford a decent diet. And the good news is also that this should not be that hard. In the United States, for example (USDA, 2017), if it is true that farm production only gets about 9% of the food dollar, then even if farm costs/incomes double (and the disadvantages of organic/sustainable agriculture in terms of cost, labor, yields, etc. rarely seem close to twofold), the price of food only rises by 9%. And then even if the poor spend 33% of their income on food, their overall cost of living then only goes up 3%. Surely, that much can easily be diverted to their income from the wealthy, from foolish spending on a bloated military, etc.

Local vs Trade: Regions and Distance.— There is an admirable tendency to promote local agriculture now to save energy, support local communities and farmland, etc., and reduce trade in favor of food sovereignty, even as the value of fair trade is recognized in some cases (comparative advantage that is not exaggerated by free traders, like coffee). Home and urban gardens can actually supply useful amounts of vegetables for peoples' diets (Ciulla, 2015; Rabin et al., 2012; Rodale, 2017; Royte, 2015). But there should be a more complete analysis of how local production and trade are balanced and integrated. Again, sustainable energy will reduce the urgency of local production to save energy. But given the unpredictability of climate change, especially with respect to rain, everyone should produce much of their own crops, not only to avoid putting all our eggs (so to speak) in one region that could have a drought (e.g., California), but also so that we can help each other out when droughts appear here or there (a food matrix?). Storage can also help, of course (but not hoarding for speculation). Similarly, countries with small land areas should perhaps seek fair trade deals, too, and not just plan on growing their own food. Regional crop rotations could also help break the cycles of some difficult pests that can otherwise travel short-moderate distances and/or persist in the soil for a long time, though of course trade should also avoid transporting pests as hitchhikers.

And we should look more carefully at free trade and globalization issues, especially since the topic is being questioned more openly by Donald Trump et al., and probably co-opted. For example, he may mean tariffs against China, but will he be against, say, dumping cheap grain on Mexico, especially since that "encourages" immigration, or will he "put American farmers first" and count on a border wall or police to protect the United States from the consequences of Mexican farmers losing their livelihoods? Some globalization is not just a race to the bottom, but a race to equity. There is a huge disparity among nations in wealth, and rich countries are not likely to just give much money outright to poor ones, but the richer ones already are in effect transferring wealth through the cheap prices associated with (free) trade from moving production to use/exploit low paid labor and cheap transport. But fair trade should also mean that such practices are humanely regulated and that more of any money saved should be diverted from CEOs and shareholders to workers in all countries, instead.

Social Change.— Finally, in all of these examples, note again that I am mainly assuming that the lowest cost and

price of food at the highest profit cannot be such an overriding driving force in agriculture, and that a just sustainability is important enough of a goal that changes and increases in costs should be shared by the larger society. This should be part of the meaning of "food for people, not for profit" (Magdoff, 2015). Agriculture teaches lessons about economics and politics in both directions: To do agriculture right, we need social change, and in fact, sustainable agriculture could then become rather easy; in turn, agriculture is a great case study for why we need that larger social change, in general.

REFERENCES

Altieri, M. A. 1995. Agroecology: The Science of Sustainable Agriculture, 2nd Ed. Westview Press, Boulder, CO.

Altieri, M. A. 2010. Agroecology, small farms, and food sovereignty. Pgs 253–266 in F. Magdoff and B. Tokar. Eds. 2010. Agriculture and Food in Crisis: Conflict, Resistance, and Renewal. Monthly Review Press. New York.

Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M., Avilés-Vázquez, K., Samulon, A. and I. Perfecto. 2007. Organic agriculture and the global food supply. Renewable Agriculture and Food Systems, 22: 86–108.

Boucher, D. H. 1985. The Biology of Mutualism. Oxford, NY.

Childers, D. L., J. Corman, M. Edwards, and J. J Elser. 2011. Sustainability challenges of phosphorus and food: solutions from closing the human phosphorus cycle. BioScience 61: 117–124.

Ciulla, R. 2015. A Taste of Urban Agriculture. Rodale Institute, May 11, 2015. https://rodaleinstitute.org/a-taste-of-urban-agriculture/

Clabby, C. 2010. Does peak phosphorus loom? Scientists make the case that easily accessible supplies of an essential element are being depleted. American Scientist 98: 29–292.

Cobb, K. 2014. Is ammonia the holy grail for renewable energy storage? Resource Insights. http://resourceinsights.blogspot.com/2014/02/is-ammonia-holy-grail-for-renewable.html

Cross, J., M. Fountain., V. Marko, and C. Nagy. 2015. Arthropod ecosystem services in apple orchards and their economic benefits. Ecological Entomology 40 (suppl. 1): 82–96.

Crowder, D.W. and J. P. Reganold. 2015. Financial competitiveness of organic agriculture on a global scale. Proceedings of the National Academy of Sciences (PNAS) 112 (24): 7611–7616. http://www.pnas.org/content/112/24/7611.short

EERE. 2002. ITP Mining: Energy and Environmental Profile of the U.S. Mining Industry. Office of Energy Efficiency and Renewable Energy, U.S. Dept. of Energy. Ch. 9 - Limestone and Crushed Rock. https://energy.gov/eere/amo/downloads/itp-mining-energy-and-environmental-profile-us-mining-industry-december-2002

Elser, J. and S. White. 2010. Peak Phosphorus. Foreign Policy. http://foreignpolicy.com/2010/04/20/peak-phosphorus/

Flint, M. L. and R.van den Bosch. 1981. Introduction to Integrated Pest Management. Plenum, NY.

Fonseca, R., F.J.A.S. Barriga, and W.S. Fyfe. 1998. Reversing desertification by using dam reservoir sediments as agriculture soils. Episodes 21: 218–224.

Gilbert, N. 2009. The disappearing nutrient. Nature 461: 716–718.

Gleick, P. 2008. Why don't we get our drinking water from the ocean by taking the salt out of seawater? Scientific American. July 23, 2008. https://www.scientificamerican.com/article/why-dont-we-get-our-drinking-water-from-the-ocean/

Gliessman, S.R. 2009. The framework for conversion. Pgs 3–14 in S.R. Gliessman and M. Rosemeyer, Eds. The Conversion to Sustainable Agriculture: Principles, Processes, and Practices. CRC Press. Boca Raton, FL.

Gliessman S. R. Agroecology: 2014. The Ecology of Sustainable Food Systems. 3rd Ed. CRC Press, Boca Raton FL.

Gurian-Sherman, D. 2011. Raising the Steaks: Global Warming and Pasture-Raised Beef Production in the United States. Union of Concerned Scientists. USC Publications, Cambridge, MA. http://www.ucsusa.org/food_and_agriculture/solutions/advance-sustainable-agriculture/global-warming-and-beef-production.html

Hajek, A. E. 2004. Natural Enemies: An Introduction to Biological Control. Cambridge University Press.

Hakim, D. 2016. Doubts about the promised bounty of genetically modified crops. New York Times 29 October 2016. http://www.nytimes.com/2016/10/30/business/gmo-promise-falls-short.html

Heaton, E. A., N. Boersma, J. D. Caveny, T. B. Voigt, F. G. Dohleman. 2016. Miscanthus (Miscanthus x giganteus) for Biofuel Production. eXtension. October 24, 2016 https://articles.extension.org/pages/26625/miscanthus-miscanthus-x-giganteus-for-biofuel-production

Heckman, J. R., R. Well, and F. Magdoff. 2009. Practical steps to soil fertility for organic agriculture. Pgs 139–172 in C. Francis, Ed. 2009. Organic Farming: The Ecological Systems. Agronomy Monograph 54. American Society of Agronomy, Madison, WI.

Hurst, B. 2009. The omnivore's delusion: against the agri-intellectuals. The American Journal of the American Enterprise Institute.

Isleib, J. 2012. Liming hay ground….Will it Pay? Michigan State University Extension msue.anr.msu.edu/uploads/236/38960/Liming_hay_ground_will_it_pay.pdf

Kniss, A. R., S. D. Savage, and R. Jabbour. 2016. Commercial crop yields reveal strengths and weaknesses for organic agriculture in the United States. PLOS ONE, August 23, 2016. http://dx.doi.org/10.1371/journal.pone.0161673

Kondolf, G. M., Y. Gao, G. W. Annandale, G. L. Morris, E. Jiang, J. Zhang, Y. Cao, P. Carling, K. Fu, Q. Guo, R. Hotchkiss, C. Peteuil, T. Sumi, H.-W. Wang, Z. Wang, Z. Wei, B. Wu, C. Wu, and C. T. Yang. 2014. Sustainable sediment management in reservoirs and regulated rivers: experiences from five continents. Earth's Future, 2:256–280. doi:10.1002/2013EF000184

Kuntz, T. 2014. Peak phosphorus. New York Times, April 27, 2014. http://ideas.blogs.nytimes.com/2010/04/27/peak-phosphorus/

Leonardos, O.H., S.H. Theodoro, and M.L. Assad. 2000. Remineralization for sustainable agriculture: a tropical perspective from a Brazilian viewpoint. Nutrient Cycling in Agroecosystems 56: 3–9.

Lewontin, R. C. 1982. Agricultural research and the penetration of capital. Science for the People 14 (1): 12–17. science-for-the-people.org/wp-content/uploads/2015/07/SftPv14n1s.pdf.

Lewontin, R.C. 2000. The maturing of capitalist agriculture: farmer as proletarian. Pgs 93–106 in F. Magdoff, J. B. Foster, and F. H. Buttel, Eds. 2000. Hungry for Profit: The Agribusiness Threat to Farmers, Food, and the Environment. Monthly Review Press, NY.

Licht, S., B. Cui, B. Wang, F.-F. Li, J. Lau, and S. Liu. 2008. Ammonia synthesis by N_2 and steam electrolysis in molten hydroxide suspensions of nanoscale Fe_2O_3. Science 345: 637–640. doi: 10.1126/science.1254234 .

Li, J.-G. and Y.-H. Dong. 2013. Effect of a rock dust amendment on disease severity of tomato bacterial wilt. Antonie van Leeuwenhoek (2013) 103:11–22. doi 10.1007/s10482-012-9781-4

Liebman, M. and A. S. Davis. 2009. Managing weeds in organic farming systems: an ecological approach. Pgs 173–195 in C. Francis, Ed. 2009. Organic Farming: The Ecological Systems. Agronomy Monograph 54. American Society of Agronomy, Madison, WI.

Little, A. 2014. A journalist and a scientist break ground in the G.M.O. debate. New Yorker 25 April 2014 newyorker.com/tech/elements/a-journalist-and-a-scientist-break-ground-in-the-g-m-o-debate

Magdoff, F. 2015. A rational agriculture is incompatible with capitalism. Monthly Review 66 (10 (March)" monthlyreview.org/2015/03/01/a-rational-agriculture-is-incompatible-with-capitalism/

Magdoff, F. and B. Tokar. Eds. 2010. Agriculture and Food in Crisis: Conflict, Resistance, and Renewal. Monthly Review Press. New York.

Mahmood, H. 1987. Reservoir Sedimentation. Impact, Extent, and Mitigation. World Bank Technical Paper, no. 71 documents.worldbank.org/curated/en/888541468762328736/Reservoir-sedimentation-impact-extent-and-mitigation

Mallarino, A. P., R. R. Oltmans, J. r. Prater, C. X.Villavicencio, and L. B. Thompson. 2011. Nutrient uptake by corn and soybean, removal, and recycling with crop residue. 2011 Integrated Crop Management Conference - Iowa State University www.agronext.iastate.edu/soilfertility/info/mallarino-2.pdf

Manning, D. 2004. Exploitation and Use of Quarry Fines. MIRO - Final Report. Mineral Industry Research Organisation, Report No. 087/MIST2/DACM/01. MIST project reference: MA/2/4/003, 19th March 2004. http://scholar.google.com/scholar_url?url=http://www.katlapumice.com/mist/mist2.pdf&hl=en&sa=X&scisig=AAGBfm2zY06g06jaYMQ8po6TjtncOnPbBQ&nossl=1&oi=scholarr

NFFC. 2018. Food Sovereignty. National Family Farm Coalition.http://nffc.net/index.php/issues-2/food-sovereignty/

Nicholls, C. I., N. Perez, L. Vasquez, and M. A. Altieri. 2003. The development and status of biologically based integrated pest management in Cuba Integrated Pest Management Reviews 7: 1–16.

Norberg-Hodge, H., P. Goering, and J. Page. 2001. From the Ground Up: Rethinking Industrial Agriculture. Zed Books. UK.

Patel, R. 2012. Stuffed and Starved, 2nd Ed. Melville House, Brooklyn, NY.

Perfecto, I. J. Vandermeer and A. Wright. 2009. Nature's Matrix. Earthscan, London.

Pickett, J. A., C. M. Woodcock, C. AO Midega, and Z. R. Khan. 2014. Push-pull farming systems. Current Opinion in Biotechnology 2014, 26:125–132.

Pimentel, D. and M. Burgess. 2013. Soil erosion threatens food production. Agriculture 3: 443–463. https://www.bmbf.de/files/agriculture-03-00443.pdf

Pimentel, D. and T. W. Patzek. 2005. Ethanol production using corn, switchgrass, and wood; biodiesel production using soybean and sunflower. Natural Resources Research 14: 65–76.

Pollan, M. 2006 The Omnivore's Dilemma. Penguin Press, N.Y.

Pretty, J. 2010. Can ecological agriculture feed nine billion people? Pgs 283–298 in Magdoff, F. and B. Tokar. Eds. 2010. Agriculture and Food in Crisis: Conflict, Resistance, and Renewal. Monthly Review Press. New York.

Rabin, J., G. Zinati, and P. Nitzsche. 2012. Yield expectations for mixed stand, small-scale agriculture. Monthly Briefing from Rutgers New Jersey Agricultural Experiment Station 7 (1):1–4 (11 September, 2012).

Reganold, J.P. and J. M. Wachter. 2016. Organic agriculture in the twenty-first century Nature Plants 2: 1–8.

Ritter, S. K. 2008. The Haber-Bosch reaction: an early chemical impact on sustainability. Chemical and Engineering News 86 (33), August 18, 2008. https://pubs.acs.org/cen/coverstory/86/8633cover3box2.html

Roberts, T. L. 2014. Cadmium and phosphorous fertilizers: the issues and the science. Procedia Engineering 83: 52–59.

Rodale. 2017. 8 Backyard Weeds You Can Actually Eat. Organic Life, April 3, 2017 http://www.rodalesorganiclife.com/garden/8-weeds-you-can-eat Rodale. 2018. http://rodaleinstitute.org/our-work/organic-no-till

Royte, E. 2015. Urban farms now produce 1/5 of the world's food. GreenBiz, May 5, 2015. https://www.greenbiz.com/article/urban-farms-now-produce-15-worlds-food

Rosset, P. 2006. Food is Different. Why We Must Get the WTO Out of Agriculture. Zed Books, Plymouth, UK.

Rosset, P. 2010. Fixing our global food system: food sovereignty and redistributive land reform. Pgs 189–205 in F. Magdoff and B. Tokar. Eds. 2010. Agriculture and Food in Crisis: Conflict, Resistance, and Renewal. Monthly Review Press. New York.

Rosset, P. M. 2011. Preventing hunger: change economic policy. Nature 479: 472–3.

Rosset, P. M. and M. A. Altieri. 2017. Agroecology: Science and Politics. Fernwood Publ., Nova Scotia, Canada.

Sharpley, A. 2001. Managing Phosphorus for Agriculture and the Environment. Penn. State Extension. http://extension.psu.edu/plants/nutrient-management/educational/soil-fertility/managing-phosphorus-for-agriculture-and-the-environment

Seufert, V., N. Ramankutty, and J. A. Foley.2012. Comparing the yields of organic and conventional agriculture. Nature 485: 229–232.

Shiming, L. and S. R. Gliessman, Eds. 2016. Agroecology in China: Science, Practice, and Sustainable Management (Advances in Agroecology). CRC Press. Boca Raton FL

Sullivan, P. 2003. Intercropping Principles and Production Practices. Appropriate Technology Transfer for Rural Areas (ATTRA), Agronomy Systems Guide.

Surowiecki, J. 2017. The Trump-era corporate boycott. New Yorker. 9 January. http://www.newyorker.com/magazine/2017/01/09/the-trump-era-corporate-boycott

Tan, Z. X., R. Lal, and K. D. Wiebe. 2005. Global soil nutrient depletion and yield reduction. Journal of Sustainable Agriculture, 26: 123–146.

Thomas, J O. 1998. With change in habit, beetles shake up corn country. New York Times, 20 October, 1998.

Tokar, B. 2010. Biofuels and the global food crisis. Pgs 121–138 in Magdoff, F. and B. Tokar. Eds. 2010. Agriculture and Food in Crisis: Conflict, Resistance, and Renewal. Monthly Review Press. New York.

UPM. 2014. A new innovative way to fertilize through leaves. Universidad Politécnica de Madrid, October 14, 2014. https://phys.org/news/2014-10-fertilize.html

USDA. 2011. Planting and Managing Giant Miscanthus as a Biomass Energy Crop. USDA Natural Resources Conservation Service Plant Materials Program, July 2011 Technical Note 4. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044768.pdf

USDA. 2017. Food Prices and Spending. Economic Research Service. September 15, 2017 https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-prices-and-spending.aspx

Vandermeer, J. H. 1989. The Ecology of Intercropping Systems. Cambridge Univ. Press.

Vandermeer, J. H. 2011. The Ecology of Agroecosystems. Jones and Bartlett Publ., Sudbury, MA.

Vandermeer, J., D. Jackson, and I. Perfecto. 2014. Qualitative dynamics of the coffee rust epidemic: educating intuition with theoretical ecology. BioScience 64:210–218. doi.org/10.1093/biosci/bit034

Vandermeer, J., I. Perfecto, and S. Philpott. 2010. Ecological complexity and pest control in organic coffee production: uncovering an autonomous ecosystem service. BioScience 60: 527–537.

Vitosh, M. L., Z. R. Helsel, and V. Grubinger. 2012. Energy-Efficient Use of Fertilizer and Other Nutrients in Agriculture. eXtension. March 23, 2012. http://articles.extension.org/pages/62014/energy-efficient-use-of-fertilizer-and-other-nutrients-in-agriculture

Wilson, L. T., P. Charles, H. Pickett, D. L. Flaherty, and T.A. Bates. 1989. French prune trees: refuge for grape leafhopper parasite. California Agriculture. March–April 1989.

Zhang, S. 2016. We need a new, sustainable way to make fertilizer. Newsweek May 17. 2016. http://www.newsweek.com/haber-bosch-fertilizer-natural-gas-fossil-fuels-460895

Zhou, Y. and R. S. J. Tol. 2005. Evaluating the costs of desalination and water transport. Water Resources Research 41, 10 pp. http://onlinelibrary.wiley.com/doi/10.1029/2004WR003749/abstract.

HISTORY AS A COMPANION PLANT FOR AGROECOLOGY

By
Angus Wright

Agroecology, including the work of John Vandermeer, has relied heavily on putting the insights of history into practice in the field and in social movements. History has taught us how we have arrived at the environmentally disastrous and socially unjust forms of agriculture now dominant. It has also given us myriad examples of agricultural practice that reflect the principles of good agroecological practice and has allowed us to begin to understand how such desirable practices have arisen and evolved within social and cultural contexts. The use of history has arisen as a sheer necessity of building the discipline of agroecology rather than as a way of "enriching" the field with interdisciplinary work. A more conscious and deliberate effort to use history, as well as historical geography, plant geography, and anthropology offers opportunities to enrich both the science and practice of agroecology. As a historian, (in this talk) I offer various ideas about how to proceed in this fashion, including how to more effectively enlist greater assistance from those in other disciplines who may not thoroughly appreciate how valuable their work could be in building a more just and ecologically sound food system.

AGROECOLOGY: FOR JOHN VANDERMEER

By
Steve Gliessman

Can you imagine what it was like to be standing in front of a group of curious and critical young Mexican agronomists-to-be in Tabasco, Mexico in the late 1970s, trying to translate into Spanish one of John's early forays into the quantification of diversity and competition in intercropping systems in the tropics? This was before John learned to dominate Spanish, and before I understood what the heck he was talking about! Now John can present his own talks in Spanish, but I still don't think I understand most of the theoretical agroecology that he keeps coming up with!

John has had profound impact on my formation, first as an ecologist, and then, my formation as an agroecologist. We are both what might be called self-proclaimed agroecologists. This began with the basic question of why is there more diversity in the tropics, which we asked over and over again in "OTS Tropical Biology: An Ecological Approach" courses from 1969-1972. It moved from questions about nature to questions about agriculture during my sojourn as resident farmer ecologist at Finca Loma Linda in Coto Brus, Costa Rica in 1972–1974, and visits from his team of ecologists beginning to ask questions about how ecology and agriculture could mix. Next, it moved to Cárdenas, Tabasco, Mexico, at the Colegio Superior de Agricultura Tropical from 1976–1980, during which time we shared the beginnings of *agroecología*, standing together in a Mayan farmer's planting of corn, beans, and squash talking about species interactions, and where NWAEG came into existence over multiple Tecates.

After I moved to UC Santa Cruz in 1980, and *agroecología* became agroecology, this sharing in each of our developments as agroecologists continued. We linked forces when we tried to bring agroecology into OTS in 1985 and 1986 with the Tropical Agroecology summer course in Costa Rica. And after that, meetings, students, ideas, and even a beer or two, have helped move the field of agroecology to where it is today. I think that the symposium on agroecology that we all took part in at the ESA Centennial in Baltimore last year was a great summary of where we have come from, and perhaps most importantly, pointing out where agroecology must go in the future in order to integrate the science, practice, and movements for social justice needed in food systems around the world.

Thank you, ¡compadre!

Steve Gliessman
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SOCIAL MOVEMENTS, AGROECOLOGY, AND FOOD SOVEREIGNTY: RESEARCH FOR, WITH, AND BY SOCIAL MOVEMENTS, ACCOMPANYING THE COLLECTIVE READING AND TRANSFORMATION OF REALITY

By
Peter Rosset

Video of the lecture: https://www.youtube.com/watch?v=h4wQ0DsT6pM

As I prepared this essay and lecture, I was thinking about the ways in which John Vandermeer has most lastingly contributed to the work that I do today, which is trying to balance, on the one hand, being an academic at ECOSUR (http://www.ecosur.mx/academico/prosset/), and on the other hand being a full-time member of the technical support staff team of La Via Campesina[1] (Borras Jr., 2016). La Via Campesina is arguably the world's largest social movement. It's an alliance of peasant farmers, family farmers, indigenous people, farm workers, landless people, rural women, rural youth, and others in 80 countries. It speaks for some 200 million peasant and other kinds of rural families around the world. And, as a militant of that movement but also as an academic, I've been involved in research for social movements, research with social movements, and research by social movements, accompanying their collective reading and transformation of reality.

What do I mean by social movements? They are collective political actors. They are not political parties. They're not NGOs (there's a lot of confusion in the United States between what's a social movement, which is much more grassroots, and what's an NGO, which is five or six people with professional degrees and grants).

Here (Table 1) are some examples of social movements: I work directly for La Via Campesina. Members of Via Campesina include the Landless Workers Movement (MST) of Brazil and the Assembly of the Poor in Thailand (AOP). Rural social movements that are not members of La Via Campesina include the National Indigenous Congress (CNI) of Mexico and the Zapatistas. And today, the tendency is that social movements increasingly control territories and build at least relative autonomies on those territories.

Now, how in this work have I benefitted from the wisdom of Chairman John?[2] I think the single most important piece of advice that he gave me, or gave us, not once, not twice, but many, many, many, many, many times, was that the most important thing in your research is: *What is the question you are trying to answer?* And where your questions come from is from the people that you hang out with—the people you're with on a day-to-day basis; the people you drink beer with. (Or if you can't drink beer, do other things with.) And I think that's the most essential thing. If we want to do socially relevant research, research that has the actual capacity to transform reality, we have to do it together with, and if possible, within, the movements that have the correlation of forces, the mobilizing capacity, to actually make change. Because change doesn't come from scientific papers, but it often does come from the number of people that you can put in the street.

John taught me that the kinds of questions that you ask are very different depending on your "fellow travelers." I remember John used to tell us that if you are a tomato agronomist and you hang out with agribusiness executives in the Midwest, then you're going to focus your research on answering their question, which is: *How do we do away with farm workers and bust unions?* Therefore, you're most likely to work on mechanical harvesters (Vandermeer, 1986; Rosset and Vandermeer, 1986). On the other hand, if you hang out with the farm workers, you're most likely to ask: *How can we do away with the short-handled hoe and have a more healthy and comfortable way to do farm work, without farm workers losing their jobs?* (Murray, 1982). So the very questions that you start with, come from the relationships that you have with people.

Table 1.— Social Movements: Collective political actors—typically not electoral parties—of a mobilizing nature, who fight for structural social change, usually through nonconventional, contentious, "contestatory", and collective actions.

Transnational Movement
La Via Campesina
National Movements
Landless Worker's Movement (MST), Brazil
Assembly of the Poor (AOP), Thailand
National Indigenous Congress (CNI), México
Zapatistas (EZLN) México
etc.
They differ from NGOs, electoral parties, trade unions, communities, etc.
Increasingly, they control territories and build autonomy

[1] www.viacampesina.org

[2] When we were John Vandermeer's graduate students, fellow activists, and members of the same research collective and study group, our fond nickname for him was 'Chairman John' (as in 'Chairman Mao').

Wisdom from Chairman John:

"Who you hang out with determines the questions you ask."

So when I work with rural social movements, the kind of questions that I find challenging my research, or questions that need research to answer them, would be things like: *What pedagogical methods work best when we want to use agroecological training to forge a political subject out of the peasantry?* (McCune et al., 2014, 2016, 2017). La Via Campesina is focusing on agroecology as a major strategy, but not agroeceology practiced by one family on one farm; but rather agroeceology as mass collective action in resistance to agribusiness. Through agroecology (and land occupations), they are trying to transform rural territories, from agribusiness territories into family farming and peasant territories (Rosset and Martínez-Torres, 2010).

How can we best use diálogo de saberes, or dialogue amongst different knowledges, to turn "food sovereignty"-based agroecology into an effective banner of joint struggle based on cross-sector and cross-class alliances? (Martínez-Torres and Rosset, 2014). *How can we use it to have consumers and the urban poor fighting together with peasants and family farmers, for example?*

Recently, we had a global conference on agrarian reform of Via Campesina, which was held in Marabá, Brazil, and the main question that came out of that conference was: *How does the recent rise of financial capital and the nature of the alliances that it has built with extractive industry capital, the state, and the mass media, change the nature of struggle for land and the defense of territory?* And: *How should agrarian movements like La Via Campesina or the MST in Brazil change their tactics or our tactics of discourse in order to respond to the rise of that new alliance of financial capital?*[3] That is a specific question from Via Campesina thrown into a space where I'm a researcher, the Land Research Action Network, which is an ally of Via Campesina on research issues (Rosset 2013).

Another key nugget of wisdom from Chairman John is that we are not *Marxicologists*. Now, what does he mean by that? He used to say a Marxicologist is like an armchair quarterback: It's somebody who sits at home and uses Marxist analytical tools to analyze reality but does nothing to change it. Whereas a *Marxist*, according to Chairman John, is somebody who is actually out there on the barricades with working-class people in their struggle against the state and against transnational corporations. This attitude led me to get, for example, clubbed by the Brazilian police in a Via Campesina march of women peasants in Brazil and to get teargassed and have my arm broken in a march against free trade agreements in Quito in Ecuador. This reminds me of the documentary, *The War at Home*, about the antiwar movement in Madison, Wisconsin.[4] The film features the man who eventually bombed the Army Mathematics Research Center building. He initially came to the University of Wisconsin campus as a Young Republican. He was an innocent bystander watching an anti-war demonstration when he was beaten by the cops in a "police riot." He says: "In that moment between when the club hit my head and my head hit the pavement, I had been radicalized." Such experiences can have a strong effect on the questions you ask in your research.

I can make some assertions from a lifetime working with social movements. *Rural social movements are an increasingly important space for the collective production of new knowledge and new theory.* In terms of political theory, in terms of many rural issues, almost all of the new thinking is coming from social movements like the MST and the Zapatistas, rather than the academy. The dialogue among knowledges, *diálogo de saberes*, is part of that, and part of it is the incredible emphasis and investment by social movements today in political training schools and political processes, including producing our own organic leadership—organic intellectuals—through, in the case of Via Campesina, peasant training schools, many of which now are at the university or even post-graduate level (McCune et al., 2014, 2016, 2017). Our first peasant and indigenous people's university is in Venezuela, created by Via Campesina in agreement with Hugo Chavez. And our first graduating class chose the slogan: "estudio lucha y organización con la agroecología en la revolución." They were engineers in agroecology—fifty percent technical training in agroecology and fifty percent training in political theory and political organizing.

All research, and every researcher, has ideological baggage, is situated, is positioned, is located in relations of power. There is no such thing as neutral. What varies is only the degree to which this is made explicit and how aware each researcher is or is not of their own position. And it's very important that when we work with social movements, we be aware of our positioning—that we be transparent.

A key issue in doing research with social movements is access. Most people can't get access to social movements, which would allow them to do research with those movements. Most social movements distrust researchers, NGOs, political parties, and other external actors. It's not easy being granted access while it is very easy for access, to be cut off. The key factor is building trust and maintaining trust.

Key issues in doing research with social movements

There are all kinds of problems that have to do with the differences between researchers and the social movements that they work with. These include class origin, race, gender,

[3] https://viacampesina.org/en/index.php/actions-and-events-mainmenu-26/17-april--day-of-peasants-struggle-mainmenu-33/2041-international-conference-of-agrarian-reform-declaration-of-maraba1

[4] https://en.wikipedia.org/wiki/The_War_at_Home_(1979_film)

and vested interests like the need to get academic points (Cox, 1998, 2015). Researchers tend to be raised in the culture of individualism, social movements in the culture of collectivity. There are issues of money, as in how research grants and other funds are to be used. Social movements have had many bad previous experiences around the appropriation of knowledge, around betrayals, and around washing their dirty laundry in public without their permission. Furthermore, researchers and intellectuals in general have a lot of confusion over when criticism is appropriate and how criticism can be transmitted in ways that are constructive versus destructive.

When we engage in activist research with social movements, we need to be aware that the social conditions of the research are important (Edelman, 2009). You have to find a way to participate in the movement in order to deserve the access that you're given to it. Some people have said that in the best case, research with social movements is the collective construction of knowledge—collectively by both researchers and movement activists. However, all too often, differences arise about which knowledge to produce, how to produce it, what to do with it, and who owns it. And the researcher has to be continually aware of the conditions under which trust has been granted and can be taken away. And in practical terms, if you want to be able to work with social movements, you can't just do what you want to do with them. You have to put yourself at the service of the movement. If that means making photocopies, if that means painting banners for a march, you have to do what the movements ask of you. Whatever it is, you have to be always available to do whatever has to be done to the best of your ability, and in exchange, maybe at some point you get to do a little bit of research with the movement.

Activist research with social movements

- The "social conditions" of a research project are fundamental. To research a particular reality means, among other things, "finding a way to participate in it" and "contributing to it in any way asked of us."
- Elements of class and other relations of power have to be critically examined, in order to find the best ways for the participants to "situate" the researcher and to locate the research activity within their own perspectives and projects.

To effectively do research with social movements, you need to have certain attitudes: In general terms, to be in a*greement with the movement*, you have to

believe that *all kinds of knowledge are valid*,
practice horizontal relations,
avoid being the protagonist in the political process,
understand and accept what the movement wants, and *be very flexible.*
You have to be *humble*, *patient, honest, transparent, committed, and have entrega*[5]*—you have to have it and demonstrate it.*
You have to *live up to your commitments to the movement.*
Also, *don't do everything yourself*, *don't make decisions alone, think about the power relations*, *don't take sides in internal conflicts*;
Be careful of resources;
Don't make the movement dependent on you.
The intellectual/researcher must avoid falling into excess protagonism. Many times researchers wittingly contribute to the splitting and fragmenting of movements.

One example, and then I'll close, is of a wonderful experience I had in what Latin Americans call *co-labor* research (Leyva Solano and Speed, 2008)—meaning research together with a social movement—which was to document, for the purpose of teaching and sharing in a farmer-to-farmer way, the success in Cuba of the farmer-to-farmer agroecology process (Rosset et al., 2011). La Via Campesina wanted to do it in order to have a book to be used in the more than 70 peasant training schools in agroecology that Via Campesina now has in four continents (Machín Sosa et al., 2013). But it was also possible to produce an academic paper in *The Journal of Peasant Studies* (Rosset et al. 2011)—I mention this, since a lot of us academics and researchers do also have to worry about academic points.

And so research *with*, *for*, and *by* social movements can be very rewarding, and it can produce knowledge that is very useful to peasant organizations in other countries and to academics trying to understand, in this case, how agroecology works. With Helda Morales and Bruce Ferguson and other faculty and students at ECOSUR in Mexico, we have an academic group trying to understand how the scaling up and massification of agroecology works, and this kind of research with social movements is critical to developing a theory of scaling up agroecology (Rosset, 2015; McCune et al., 2016, 2017; Khadse et al., 2017). The co-labor research process in Cuba consisted partially of participatory workshops at farmer co-ops along the length and breadth of Cuba. The key method was essentially to induce—using popular education methodology—peasant men and women to collectively reconstruct their own history. Our role as researchers and movement cadre in a mixed team was to be scribes—to write that down, to systematize it, and then to give that back to the movement in Cuba as feedback for their own internal planning process. We visited and interacted with agroecological farms and families all over Cuba to come up with this collective production (Figure 1). Peasant men and women in the workshops came up with the typical division of labor amoung different members of a family in an ecological farm, for example, on an average basis (Machín Sosa et al., 2013:137–138).

In summary, thanks to a great degree to everything I learned from and with John Vandermeer, I have so far been privileged to lead a life of scholar-activism (Borras, 2016), using my

[5] Perhaps *dedication* is the closest word in English. http://www.wordreference.com/es/en/translation.asp?spen=entrega

Figure 1.— Agroecological peasant family in Holguin Province, Cuba.

research and organizing skills to help social movements in their efforts to create a better world. In this essay, I have sought to share some lessons that I have distilled from my accumulated experience, in the hope that they may be useful for new generations of scholar-activists.

So many thanks to Chairman John for all his wisdom, and really, I have to say, it has sustained me for all these years. So, thank you, John.

BIBLIOGRAPHY

Borras Jr, S.M. 2016. Land politics, agrarian movements and scholar-activism. http://www.cetri.be/Land-politics-agrarian-movements?lang=fr

Cox, L. 1998. Gramsci, movements and method: the politics of activist research. Paper to 4th "Alternative Futures and Popular Protest" conference, Manchester Metropolitan University, April 1998. http://eprints.nuim.ie/442/

Cox, L. 2015. Scholarship and activism: A social movements perspective. *Studies in Social Justice* 9(1):34–53.

Edelman, M. 2009. Synergies and tensions between rural social movements and professional researchers. *The Journal of Peasant Studies,* 36(1), 245–265.

Khadse, A., Rosset, P.M. Morales, H., and Ferguson, B.G. 2017. Taking agroecology to scale: The Zero Budget Natural Farming peasant movement in Karnataka, India. *The Journal of Peasant Studies.* DOI: 10.1080/03066150.2016.1276450.

Leyva Solano, X. and S. Speed. 2008. Hacia la la investigación descolonizada: nuestra experiencia de co-labor. pp. 65–110 in X. Leyva, A. Burguete y S. Speed (coords.), *Gobernar (en) la diversidad: experiencias indígenas desde América Latina. Hacia la investigación de co-labor.* Guatemala, Ecuador y México: FLACSO y CIESAS.

Machín Sosa, B., Roque Jaime, A.M., Ávila Lozano, D.R. and Rosset, P.M. 2013. *Agroecological Revolution: The farmer-to-farmer movement of the ANAP in Cuba.* Jakarta and Havana: la Via Campesina. https://viacampesina.org/en/index.php/publications-mainmenu-30/1448-agroecological-revolution-the-farmer-to-farmer-movement-of-the-anap-in-cuba

Martínez-Torres, M. E., and P. Rosset. 2010. La Vía Campesina: the birth and evolution of a transnational social movement. *The Journal of Peasant Studies* 37(1): 149–75.

Martínez-Torres, M. E., and P. Rosset. 2014. *Diálogo de Saberes* in La Vía Campesina: food sovereignty and agroecology. *The Journal of Peasant Studies* 41, no. 6: 979–97.

McCune, N., J. Reardon, and P. Rosset. 2014. Agroecological *formación* in rural social movements. *Radical Teacher* 98: 31–37.

McCune, N, P.M. Rosset, T. Cruz Salazar, A. Saldívar Moreno and H Morales. 2016. Mediated territoriality: rural workers and the efforts to scale out agroecology in Nicaragua, *The Journal of Peasant Studies*, DOI: 10.1080/03066150.2016.1233868

McCune, N., Rosset, P.M., Cruz Salazar, T., Morales, H. and Saldívar Moreno, A. 2017. The Long Road: Rural Youth, Farming and Agroecological *Formación* in Central America. *Mind, Culture, and Activity,* DOI: 10.1080/10749039.2017.1293690

Murray, D.L. 1982. The abolition of *el cortito*, the short-handled hoe: A case study in social conflict and state policy in California agriculture. *Social Problems* 30(1):26–39.

Rosset, P. 2013. Re-thinking agrarian reform, land and territory in La Via Campesina. The Journal of Peasant Studies. 40 (4), 721–775.

Rosset. P. M. 2015. Social organization and process in bringing agroecology to scale. In Food and agriculture organization (FAO) of the united nations, Agroecology for food security and nutrition. Rome: FAO. Available from: http://www.fao.org/3/a-i4729e.pdf

Rosset, P.M., et al. 2011. The campesino-to-campesino agroecology movement of ANAP in Cuba: social process methodology in the construction of sustainable peasant agriculture and food sovereignty. *The Journal of Peasant Studies,* 38(1), 161–91.

Rosset, P., and M. E. Martínez-Torres. 2012. Rural social movements and agroecology: Context, theory and process. *Ecology and Society* 17, no. 3: 17.

Rosset, P.M. and Vandermeer, J.H. 1986. The confrontation between processors and farm workers in the midwest tomato industry and the role of the agricultural research and extension establishment. *Agriculture and Human Values* 3(3):26–32.

Vandermeer, J.H. 1986. Mechanized agriculture and social welfare: The tomato harvester in Ohio. *Agriculture and Human Values* 3(3):21–25.

*From a lecture given by Peter Rosset on May 7, 2016, at the conference, "*Science with Passion and a Moral Compass: In Honor of John Vandermeer, His Ongoing Work and Legacy*" at the University of Michigan at Ann Arbor.*

1960's

TRANSFORMING THE FOOD SYSTEM

By
Catherine Badgley

"Contrary to common sense, big problems are often more soluble than small ones." – Richard Levins

INTRODUCTION

John Vandermeer and his collaborators have demonstrated the interdependence of ecology and social justice for achieving a genuinely sustainable agriculture within the larger food system. Their field studies, theoretical analyses, and political activism are at the leading edge of challenges to the norms and practices of the industrial food system. Their work demonstrates that a radically better food system is possible. The transformative potential of their work has energized John himself, his partner Ivette, and several generations of their students, as well as many who know them only through their books, articles, and talks.

Many of us are excited and hopeful about the grassroots changes emerging in the food system around the world—from Michigan to Cuba to Kenya. Where are these changes in the food system going? Will the current power structure maintain control and grudgingly allow incremental improvements? Is a fundamental redesign gaining ground? A clear idea of the future outcome can motivate and focus our energies on the specific changes that will be necessary to accomplish the transformations that we want: to provide nourishing, accessible food for all of humanity; to maintain native biodiversity across farmlands and arrest the massive losses of biodiversity attributable to the food system; to employ more people in satisfying livelihoods within the food system; and to persist through climate change.

Here I offer my vision of a food system in radical transition to serve the people and the planet, inspired by the Vandermeer collective. First, I present the vision as a set of 15 attributes of the future. Then, I explain the rationale and transitions embodied in these points, focusing on the food system of the United States.

A VISION OF THE U.S. FOOD SYSTEM IN 2030

Imagine the year 2030, far enough ahead for substantial changes to occur and close enough to plan for. Growing economic inequalities since the Reagan era have bolstered waves of antiestablishment sentiment. The energy and enthusiasm of the Bernie Sanders campaign in 2016 has focused nonpartisan policies on redressing economic inequality, providing opportunity across the economic spectrum, restoring the justice system to broader fairness, and enacting strong environmental protections.

1. **The Secretary of Agriculture will be an agroecologist.** Only a person with expertise grounded in ecology, food sovereignty, participatory learning, and social change in a wide range of agricultural systems can tackle the crises and opportunities in the food system (Miles et al., 2017).

2. **The U.S. Department of Agriculture will have implemented the 50-year Farm Bill** that Wes Jackson and Wendell Berry presented to President Obama. This five-decade plan involves a systematic replacement of annual grain crops with perennial polycultures across the United States, based on the research of the Land Institute and its partner organizations (www.landinstitute.org; Jackson et al., 2011). It embodies a realistic goal for a sustainable future.

3. **Across the United States, there will be thousands of new diversified farms.** The average farm size will be 100 acres, down from 441 acres in 2015 (USDA National Agricultural Statistics Service, 2016, pp. IX–1), and most farms will grow more than 10 kinds of crops. Along with the increase in the number of farms, the average age of farmers will decline from 58.3 in 2012 (USDA Economic Research Service, 2017) to 52.5.

4. **The number of livestock animals will be half the number that it was in 2016.** Fifty percent of livestock animals will be raised on pasture, a proportion that is increasing every year. Concurrently, feed-grain production will decline by 60%

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from 2016 levels. New regional slaughterhouses in every state will enable small-scale livestock operations to process their animals in USDA-approved facilities within less than 50 miles of their farms.

5. **There will be a tripling of fruit and vegetable production across U.S. farms**, compared to 2016. This increase surpasses the production needed to meet the recommended consumption of fruits and vegetables by all Americans in the U.S. Dietary Guidelines (Union of Concerned Scientists, 2013; USHHS and USDA, 2015).

6. **Farm Bill payments to farmers will continue but with different funding priorities.** Allocations will be high to farms where soil organic matter is increasing (organic, perennial, no-till); where soil microbial diversity is high; and for fruit and vegetable production. Support payments for the commodity crops of 2016 will be phased out. Payments for nutritional assistance will increase.

7. **A new biodiversity index will emphasize species that are indicators of ecosystem services**, for example:

$$D = \frac{(\textit{No. spp. ants})^2 + (\textit{No. spp. amphibians})}{\textit{Area}}$$

The index *D* recognizes the importance of ants as predators, nutrient cyclers, and keystone species (Offenberg, 2015; Vandermeer et al., 2010) and amphibians as significant indicators of water quality and quantity in agroecosystems. The susceptibility of tadpoles to glyphosate (Relyea, 2005) also makes amphibians useful as indicators of herbicide applications.

8. Organic agriculture will occupy 25% of U.S. farmland area. From 2015, when less than 1% (4.36 million acres) of U.S. farmland was in certified organic production (USDA National Agricultural Statistics Service, 2016), the area and proportion of pesticide-free and soil-building farmland will grow steadily every year. Concerns about the effects of pesticides on pollinators (Bonmatin et al., 2014; van der Sluijs et al., 2014) and on human health (U.S. Geological Survey, 1999; Lu et al., 2006) will increase demand for food grown without pesticides.

9. The number of farmers markets in both rural and urban settings will continue to double every ten years. This trend reflects the growing engagement of the American public with local food systems, which expand accordingly (USDA Agricultural Marketing Service, 2015). New marketing opportunities for local farm products, such as year-round farm markets, are expanding across the United States. (e.g., www.argusfarmstop.org).

10. Urban gardens will thrive in U.S. cities. The popularity of urban gardens and their potential to provide a substantial proportion of residents' vegetable and fruit production will increase (e.g., Colasanti et al., 2010). In major urban areas, African American leaders are revitalizing the urban core through innovations in urban food systems (Allen and Wilson, 2012; Yakini, 2017). Most U.S. public schools will have a vegetable garden that is tended by students.

11. All farm workers will receive a living wage. As part of the national trend to raise the minimum wage that began to achieve legislative successes in 2015, farm-worker wages will have a floor of the minimum wage. Higher wages and the increase in diversified farms that require year-round labor should provide a steady growth in full-time and part-time jobs in rural and urban farms.

12. The price of food will increase. The price will reflect increased consumption of labor-intensive vegetables and fruits, the rising wages of farm workers, and increased public valuation of food and farming. Animal products will be even more expensive, reflecting their resource intensity (Weis, 2013; Tilman and Clark, 2014) and the longer time that pasture-raised animals require to grow and produce milk or meat (Stone Barns Center, 2017). Food prices will be inversely proportional to the position of the food item on the public-health food pyramid (Harvard Health Publications, 2008). Public and private funds will ensure that low-income residents maintain access to healthy food as food prices rise.

13. The incidence of obesity, diabetes, stroke, and heart disease will fall by 25%. Health indicators for the U.S. population will improve, largely in response to changes in eating habits across all ages and ethnic groups (Union of Concerned Scientists, 2013). A combination of incentives (e.g., lower costs of plant foods, lower health insurance premiums for people enrolled in wellness programs), increased access to fresh produce year-round, as well as disincentives (the higher price of animal products, taxes on sugary beverages) will motivate most consumers to follow healthy eating habits. School lunch programs that utilize locally grown, organic food and school gardens will shape the food preferences of children and young adults to healthier choices (McAleese and Rankin, 2007; Benson et al., 2015).

14. Mexico will no longer import corn from the United States. This trend follows from reduction in the amount of corn (and other commodity crops of 2015) grown, an increase in the price of corn, and renegotiation of food products under the North American Free Trade Agreement.

15. Archer Daniels Midland (ADM) and Monsanto will lose prominence in our food and economy. Failures in the industrial food system will diminish the iconic powerhouses of the industrial food system.

PRINCIPLES

These predictions follow from a vision of the food system in transformation. They are based on three principles, influenced by the work of John Vandermeer and Ivette Perfecto. First, complex systems are governed by networks of causality in which each cause leads to multiple effects, and each change

is influenced by multiple causes. This principle is clear within natural systems and in some scientific circles (Levins and Lewontin, 1985). For example, the current configuration of industrial food production, large farms, low food prices and low wages, habitat destruction, and poor health outcomes are all inter-related consequences of institutions and agribusinesses who have managed to convince most policymakers and most of the media that industrial agriculture is necessary in order to feed the world (Latham, 2015; De Schutter, 2017). These inter-relations make it hard to achieve substantial change *within* the industrial food system. Its constraints make some aspects of the vision for 2030 seem impossible. But there are hidden vulnerabilities. (See below.) A food system based on different principles and priorities can achieve these changes.

Second, agroecology is the guiding paradigm for food production. This means using ecological knowledge, complemented by place-based traditional knowledge, and local inputs as the principles for farming practices (Berry, 1977, 1990; Jackson, 1980; IAASTD, 2009; De Schutter, 2014). Synthetic fertilizers and pesticides would not be eliminated entirely, but would be used as a last resort or in unusual circumstances, rather than as the *modus operandi*.

Third, social justice is central to the practices and goals of the transformed food system. The umbrella of social justice includes producers and consumers—particularly those who have been marginalized in the industrial system—and the welfare of farm animals in the United States and the rest of world.

In addition, several ideas—both empirical truths and basic principles that run counter to the narrative of industrial agriculture—provide a foundation for transforming the food system. First, small diversified farms can feed the world (and have been doing so throughout history). Most food for direct human consumption is produced on farms of less than 50 ha in size (ETC Group, 2014; Herrero et al., 2017), and the potential for yield improvements on small-holder farms is great (Zhang et al., 2016). Second, farming and ranching serve many roles beyond food production; they also provide livelihoods, enable social and economic connections, foster cultural traditions new and old, and include critical wildlife habitats (IAASTD, 2009; National Research Council, 2010; White, 2008). Third, locally based food systems, supplemented by fair trade with distant regions, are adaptable and economically sustainable (Hamm, 2008; Kleppel, 2014). Fourth, food prices should reflect the actual costs of production, including labor, and at least some of their positive and negative environmental impacts. The price premiums for organically grown food and grass-fed beef in the United States primarily reflect the increased costs of production (Crowder and Reganold, 2015; Stone Barns Center, 2017). Some fair-trade systems, such as the "Bird-Friendly" label and "Rainforest Alliance" seal, recognize the positive environmental impacts of shade-grown coffee production (Perfecto and Vandermeer, 2015).

CRISES AND OPPORTUNITIES

Although the alternative food system is growing rapidly in many dimensions, it still comprises a small proportion of the U.S. agricultural land area and food economy. It is doubtful that the current momentum alone can scale up agroecological practices, fair pricing, and increased access for low-income communities to become the dominant food system. However, crises that lie ahead for the industrial food system provide opportunities for the sustainable food system to achieve greater prominence and public recognition.

Grassroots activities.— Many elements of a fairer, more sustainable food system occur in microcosm in the local-food movements across the U.S. today. The number of small farms producing fruits, vegetables, and humanely raised livestock animals has expanded rapidly in the last two decades (Kleppel, 2014). This growth is a response to the increasing public demand for fresh produce, higher standards of animal welfare, and healthier diets in homes, restaurant, and institutions. These shifts in consumer eating habits have made a large enough impact on purchasing habits in grocery stores to alarm the packaged-goods industry, which noted a $4-billion loss in market share in 2014 (Kowitt, 2015). More consumers want to know their farmers by subscribing to Community Supported Agriculture (a regular subscription of farm-fresh food), purchasing food at farmers markets, or eating at farm-to-table restaurants. These trends are driven largely by idealistic consumers and beginning farmers, often abetted by local non-profit organizations and governments. Across the country, municipal and county governments have funded programs to provide young farmers with land to rent or purchase in local greenbelts (Iles and Marsh, 2012; www.beginningfarmers.org).

Farms and urban gardens that grow primarily food (not feed) are centers of community building and empowerment. The labor-intensive practices of growing and harvesting provide jobs and internships for young people. Urban gardens provide opportunities for leadership and employment for residents of cities that have been food deserts for many years and foster interactions among people of different generations, ethnic groups, and economic groups (Allen and Wilson, 2012; Ahmadi, 2017; Yakini, 2017). Growers in areas with multiple farms or urban gardens often collaborate to coordinate crop plantings (to avoid all growing the same crops), share experiences, and form marketing cooperatives (Carlisle, 2015).

Although federal and state policies continue to support the industrial food system, there are increasing provisions for beginning farmers, organic production, and local food in school-lunch programs (Iles and Marsh, 2012). Incremental changes have resulted from strong pressure from citizen action groups, such as the Pesticide Action Network, the Union of Concerned Scientists, Food First, the Fair Food Network, the Wild Farm Alliance, and the Center for Food Safety. The 2014 Farm Bill, for example, contains $100 million in matching

funds for states and cities to offer the Double Up Food Bucks program, in which low-income residents can double the value of their Bridge Card purchases for locally grown, fresh produce (Fair Food Network, 2016; www.doubleupfoodbucks.org).

As pervasive and inspiring as grassroots changes are, their growth alone will not transform the food system. The industrial food system is vast in terms of land area, inputs and machinery, and food products, and it wields enormous political and economic power (De Schutter, 2017). This system must be dismantled or transformed from master to servant. What events could undermine the hegemony of the industrial food system? Three likely factors are global climate change—to which industrial agriculture has been a major contributor (Stehfest et al., 2009; Tilman and Clark, 2014)—and declining abundance of water and fossil fuels.

Climate change.— A likely feature of twenty-first century climate change is an increasing frequency of droughts lasting more than 10 years. A series of climate models tuned to hindcast drought severity over the last millennium and to forecast drought severity between 2050 to 2099 generated future droughts that will be longer and more severe than historically documented droughts in North America (Cook et al., 2015). Harbingers of such megadroughts are already underway, such as the severe, five-year drought in California from 2012 to 2016 (http://ca.water.usgs.gov/data/drought/index.html). Droughts can cause yield losses and outright crop failures. Maize varieties bred for high yields experience reduced yields under growing temperatures greater than 30ºC; these yield reductions nearly double under drought conditions (Lobell et al., 2011, 2014).

Major crop failures of commodity crops and livestock herds under drought and water scarcity will highlight the vulnerabilities of industrial farming methods and narrow genetic crop diversity (Heinemann et al., 2013). Reliance on extensive areas of high-yielding monocultures and synthetic fertilizers reduces the productivity and resilience of soils under drought (Lobell et al., 2014). In contrast, agroecological farming systems are more robust to drought stress. The water-retention capacity of topsoil increases with soil organic matter (Magdoff and Van Es, 2009; Lotter et al., 2003), which increases over time under agroecological management. For example, in the 30-year Rodale Farming Systems Trial that compares row crops grown under organic and conventional management in Pennsylvania, yields of corn were 31% greater in the organic plots compared to conventional plots during dry years (Lotter et al., 2003; Rodale Institute, 2011). (No-till farming also increases soil organic matter and soil moisture; Triplett and Dick, 2008). In addition, perennial crops are superior to annuals at coping with drought because of deeper root systems and less disturbance to the soil surface (Soule and Piper, 1992; Glover et al., 2010). The transition to perennial grains as a key element of natural-systems agriculture will become a critical means for adapting to climate change (Land Institute, 2009). The increase in organic and perennial systems will reduce soil erosion and increase carbon sequestration across agricultural landscapes (Pimentel et al., 2005; Delate et al., 2015).

Widespread yield losses of industrial monocultures during drought periods would capture the attention of not only farmers and ranchers but also the public and policymakers about the dangers of relying on industrial production for the majority of food grown in the United States. Along with the steady increase in organic and other agroecological practices at the grassroots level, industrial crop failures would mark a turning point to broader recognition of agroecology as the appropriate guiding principles for food production (De Schutter and Vanloqueren, 2011; Altieri et al., 2015; Nicholls et al., 2016). This realization would underscore the value of a Secretary of Agriculture with experience in agroecological practices across a wide range of farming systems. Under a broadly trained Secretary, the USDA extension system would transmit the fundamental principles of agroecology and provide guidance and incentives for conversion from large-scale monocultures to small-scale, diversified farming systems.

Crop failures in the U.S. grain belt would also force a realignment of priorities for the uses of grain. Instead of livestock and ethanol as major destinations for grain, human consumption would become the top priority. From the 2016 U.S. corn harvest, 38% became livestock feed, 29% became biofuel, and less than 10% went to domestic food, seed, and other industrial uses, including high-fructose corn syrup (http://www.worldofcorn.com/#corn-usage-by-segment, accessed July 10, 2017). These data indicate that corn for human consumption and industrial uses could be grown on a small fraction of the ~90 million acres in production over the last decade.

Crop failures would necessitate more rational uses of water in U.S. agriculture. In 2016, 67% of freshwater withdrawal (excluding thermoelectric power) went to agriculture (Maupin et al., 2014), with most of that use dedicated to irrigation for livestock feed and forage. In western states, where fresh water is in short supply, agricultural water has been heavily subsidized by public funds (High Country News, 1987). Under prolonged droughts, priorities would need to change. In particular, raising food for direct human consumption would take precedence over food for livestock or industrial uses. Livestock production would decline, and livestock animals would be raised on pasture rather than in confinement. The increase in pasture would replace some of the millions of acres where growing grain is no longer profitable or ecologically appropriate. Perennial grasslands would be restored over much of their former area. In some regions, native ungulates would be raised on restored grasslands or woodlands under management by Native Americans (e.g., Anderson, 2005). Pasture-raised mammals require less water than animals raised in confinement operations (Chapagain and Hoekstra, 2003). With many fewer confinement livestock operations, the runoff from manure lagoons and manure-sprayed fields

would decrease, in contrast to the current practice of excessive manure applications to farm fields that then contribute to harmful algal blooms in downstream waterways (Less=More Coalition, 2015, 2017). Consequently, dead zones and harmful algal blooms in lakes, rivers, and the Gulf of Mexico should shrink or vanish altogether. The high price of meat and dairy products would reflect their true cost in the absence of subsidies of water, grain, and hay that currently support these products, and the expenses associated with more stringent regulations on the handling of manure from the remaining confinement operations. Meat and dairy consumption would decline in the American diet, and grains, vegetables, and fruits would increase.

With much more farmland in pasture and a huge decline in synthetic pesticide use, populations of songbirds, monarch butterflies, fishes, and amphibians would increase across the country. The widespread use of and research in biological control of agricultural pests would lead to the development of new biodiversity indices that estimate the abundance of biological control agents and monitor the maintenance of native biodiversity. Conservation would become the consequence, not the victim, of agriculture (Jackson and Jackson, 2002).

New areas would be designated as wilderness farmlands, where livestock animals live at low densities on open range, where perennial vegetation sequesters carbon, native ungulates have healthy populations, and mammalian carnivores are protected—a condition similar to the Buffalo Commons proposed by Popper and Popper (2006). This change would reduce predator-control programs over these states as well, so that mammalian predator populations could gradually expand over more of their former range. Livestock animals on pasture would be protected by guard animals rather than poisons or traps (Imhoff, 2003). Hiking, camping, limited hunting, and ecotourism would occur across these areas, as in the American Prairie Reserve (https://www.americanprairie.org/). The number of grazing allotments on public lands would need to decline under drought conditions and the price of such allotments should increase to their market value on private lands (Ferguson and Ferguson, 1983).

More small farms.— After commodity crop failures, the USDA will need to develop programs and incentives to convert large (>500 acres), monoculture farms to smaller (~100 acres), diversified farms. This conversion would require a major recruitment of new farmers, stimulated by several innovations at the federal level, under agroecological leadership (Miles et al., 2017). First, so that newly available farmland would be affordable, different ownership models should be available, including outright purchase at controlled but reasonable prices, rent-to-own, and usufruct, in which the farmer would pay minimal usage fees to work the land but would not own it. Second, immigrants with farming experience in their home country should be granted work permits to become farmers in the United States Third, a series of credits should be developed for sustainable management of farmland—including for increased carbon storage in soils; for renewable energy generation from small-scale solar, wind, and biogas operations; and for natural habitat (e.g., Bowman and Zilberman, 2013). A new requirement for U.S. farmland could be that 20% of contiguous 1,000-acre parcels and 20% of any non-contiguous farms ≥100 acres in area be managed as natural habitat, with permitted use of light grazing, harvesting of firewood, fruit trees, and other activities that support the persistence of native species. An additional requirement of any farms receiving federal assistance would be that 60% of the food grown is for direct human consumption. Finally, a doubling of retail prices for grains, vegetables, and fruits, and an increase in the price of animal products would change the economics of farming so as to make it a financially viable occupation for both farmer-operators and farm workers.

The emphasis on agroecological production methods and increase in the area of organic farming would require more labor on farms than under industrial practices and would contribute to a rise in food prices (Reganold and Wachter, 2015). This increase would need careful explanation to the general public, so that changing the expectation of cheap food, cultivated in the United States since the 1950s (Carolan, 2011; Ikerd, 2016), would be balanced by the broad social benefits of higher food prices for the American public. The discrepancy in the price increase for animal foods compared to plant foods would be partly a consequence of incentives for vegetable and fruit production under a new Farm Bill, rather than the reverse, as is largely the case today. This price differential would reflect the actual costs of resources needed to raise animals, including water, grain, hay, and land.

One of the main goals of a fair food system is that all farm workers receive a living wage. A rise in food prices and supports would make this possible. With a living wage, farm work would be a more attractive profession, whether for migrant laborers, students during the summer months, or young people starting a career. Thereby, agriculture could contribute substantially to employment across the country. An increase in jobs and wages for farm work would stimulate more families to live in rural communities and reverse the "unsettling of America" that ramped up in the 1970s (Berry, 1977). Communities that became ghost towns in rural America during the Green Revolution would once again have enough residents to support schools, clinics, hardware stores, restaurants, and libraries. Ecotourism and farm-to-table restaurants featuring regional specialties in rural areas, which are flourishing in California (e.g., Occidental Arts and Ecology Center, www.oaec.org), Minnesota (Joannides et al., 2001), New York (e.g., Stone Barns Center, www.stonebarnscenter.org), and many other parts of the United States would increase.

The increase in the number of farms, farm workers, and the price of food would support more farmers markets in rural and urban settings, leading to the continued doubling in their numbers per decade, a trend that has been under way since

1990 (USDA Agricultural Marketing Service, 2015). These changes would expand the throughput of local food systems, including new opportunities for direct marketing between producers and consumers (e.g., www.argusfarmstop.org). This expansion is providing fresh food to more individuals, restaurants, and institutions and reducing the transportation and processing factors contributing to food waste in the United States. The increase in food prices and growth of local food systems would also reduce food waste from the current figure of 40% of food from U.S. farms (Gunders, 2012).

The increase in farms and farmers across the country, in combination with their reliance on agroecological production methods, necessitates new expertise for farming practices and knowledge. One consequence is the recognition that knowledge-intensive farming involves an evolving set of skills, information, and experience (Carlisle, 2015; Timmermann and Félix, 2015). Another is the development of infrastructure for transmitting local and regional knowledge about agroecological practices, which are often specific to the climate, terrain, crop varieties, pests, and history of specific regions. A socioecological practice honed by La Via Campesina is farmer field schools, a form of farmer-to-farmer exchange that has enabled the expansion of agroecological practices in many peasant-agriculture communities around the world (e.g., Rosset et al., 2011). These farmer-based methods of transmitting knowledge illustrate the importance of social processes in agrarian reform, in scaling up agroecological practices, and in transforming the food system more broadly (Holt-Giménez and Altieri, 2012; Nicholls et al., 2016). After visits by a few experienced practitioners from farmer field schools in Latin America, farmer field schools would become popular, effective, and dynamic in the United States during the expansion of agroecological farms. Academic agroecologists would partner with farmers in transmitting insights from ecology, microbiology, and complexity theory for food production in rural and urban contexts (e.g., Montgomery and Biklé, 2015; Ong and Vandermeer, 2015; Vandermeer and Perfecto, 2017).

Federal funding.— The new Farm Bill would focus on food rather than commodities. It would continue to provide financial support to farmers under the principles that food is a human right, that farming practices are determined by agroecology, and that a strong nation needs a robust farming sector (De Schutter, 2014). The new Farm Bill should provide substantial incentives for beginning farmers, for agroecological research on farms, and for growing food for direct human consumption. In addition, the Farm Bill should offer incentives for farms that are shifting from industrial to agroecological practices (Ikerd, 2007). At the state level, the allocation of funds from the Farm Bill would be determined by committees of individuals representing farmers, nonprofit organizations, and nutritionists. These individuals would be elected every six years by members of the groups that they represent. This practice would prevent entrenched bureaucrats from retaining decision-making power for decades and would ensure that representatives are responsive to majority views rather than to a powerful minority, as in the current system (Ikerd, 2010; Imhoff, 2012).

The new Farm Bill should also address the affordability of food and healthy eating. The higher price of food by 2030 will have lifted many farmers and farm workers out of poverty. In the larger economy, progressive tax policies, funding for education, and incentives for small business could reduce poverty in the United States generally and make the distribution of income more equitable than it is today. In order to ensure that healthy foods are affordable to low-income citizens, fresh fruits and vegetables, whole grains, and some oils and animal products should be available for purchase at discounted prices through Bridge Cards, similar to the Double Up Food Bucks program today (www.doubleupfoodbucks.org). Sugary drinks, candy, and many other processed foods should be taxed, with the proceeds going to support healthy-eating programs (Rudd Center for Food Policy & Obesity, 2009). The U.S. dietary guidelines will follow the recommendations of nutritionists and public health practitioners and will be protected from special interests (Willett and Skerett, 2001; Harvard Health Publications, 2008).

In just 15 years, American eating habits could shift, partly as a consequence of the changes in pricing structure, partly from greater availability of fresh produce, and partly from the influences of celebrities in sports, entertainment, and restaurants advocating for healthy diets. As a consequence, the rates of adult and child obesity will decline substantially. This trend will generate positive feedbacks as healthier, more active people—especially children and teens—motivate their peers to follow suit. These improvements in health and health indices would notably reduce the costs of healthcare for individuals, hospitals, and health-insurance programs. The current disparities in health among ethnic and socioeconomic groups (Satia, 2009) will disappear.

This transformation would have significant repercussions for other countries as well. As one example, the United States would no longer export corn to Mexico, as it has been doing for decades (Wise, 2010). The decline in land and federal subsidies devoted to commodity grains, water, and livestock production would eliminate the huge surpluses of corn, soy, wheat, and milk beyond the needs of domestic consumption that have characterized the last five decades (Ikerd, 2016; Stiglitz, 2016). Consequently, exports of corn, which ranged from less than 1 million mt in 1993 before the North American Free Trade Agreement (NAFTA) grew to over 10 million mt in 2006, would decline. This decline would stimulate farming in Mexico, reversing the loss of small farms that began with NAFTA in 1994. Mexican farmers would once again have robust domestic markets for their many landraces of corn. The improving farm economy in Mexico would provide more jobs in rural areas and reverse the migration of workers from rural areas to large cities and from both sources to illegal

immigration into the United States (Collier, 2005; Bacon, 2014). Thus, the reduction in U.S. corn production would facilitate the redress of a series of negative consequences from NAFTA and other trade policies.

CHANGES IN POLITICAL ECONOMY

Beyond the innovations at the margins of the current food system, the transformation of the U.S. food system requires fundamental changes in the political economy of the food system (Buttel, 2006; Iles and Marsh, 2012; De Schutter, 2017). Indeed, this aspect of transformation is the biggest challenge to the scaling up of sustainable agriculture and marketing. At issue are both the dismantling of obstacles to greater adoption of sustainable practices and expansion of policies to strengthen a sustainable food system. The latter should precede the former, so that the sustainable system (from access to land, funding of research, sharing of knowledge, incentives for conservation, and expansion of markets) are fully functional and widespread as the industrial system weakens and shrinks. The following examples of public and private initiatives illustrate reforms that could be scaled up without leading to concentration of economic power.

1. Access to land and resources. One of the main impediments to new farmers is the price of land and startup costs. Both federal and private programs are providing loans, equipment, and technical support to new farmers and ranchers (Iles and Marsh, 2012). The 2008 and 2012 Farm Bills contain programs to support loans for purchasing farmland and grants to nonprofits that provide technical assistance to new producers. While small in comparison to demand, these programs are increasing access to land and resources by new farmers, often from previously underserved populations. There also need to be programs that enable farmers to shift from industrial to agroecological production.

2. Rewards for conservation practices. Incentives to increase conservation practices include payments from the Farm Bill for specific accomplishments (such as carbon sequestration) or price premiums from specialty labels and certification (e.g., salmon-safe farms and other businesses in the Pacific Northwest; www.salmonsafe.org). The Environmental Quality Incentives Program (EQIP) could support perennial polycultures and grass-fed livestock operations instead of manure lagoons for confinement animal feeding operations. Corresponding disincentives could also facilitate change. Fines could be increased for violations of the Clean Water Act, whereby excess nutrients or biocides are released into local waterways (Less=More Coalition, 2017). Taxes on biocides and synthetic fertilizers could provide revenues for the monetary rewards (Miles et al., 2017).

3. New marketing opportunities. One of the main reasons for the recent growth of small diversified farms over the last two decades is direct marketing between farmers and consumers (Conner and Hamm, 2007; Kleppel, 2014). New kinds of stores, such as farm-market stores and food hubs—essentially everyday, year-round farmers markets—provide opportunities for local farmers to realize high profit margins and for consumers to have regular access to fresh, local farm products. A major obstacle to expansion of market share is lack of access to larger supply chains. However, consumer preferences are driving many mainstream venues to increase their offerings of local food (Tropp and Moraghan, 2017). Institutional purchasing by universities, hospitals, and public schools is on the rise. For example, the purchase of local food by public school systems (farm-to-school programs) has increased from 2,000 programs in 2009 to 47,000 programs in 2016, involving >42 percent of school districts in all 50 states (National Farm to School Network, www.farmtoschool.org).

4. Food policy councils. Civil society needs new ways to deliberate and to exert influence over the workings of the U.S. food system, without undue influence from agribusiness and other vested interests. Food policy councils at the local, regional, and national level offer one such mechanism (De Schutter, 2017). A food policy council is a group of representatives from different sectors of the food system, typically involving producers, local businesses, members of government agencies, food activists, and members of nonprofit organizations. In principle, the council has the capacity to evaluate the food system as a whole, explore the ramifications for changes at the local or regional level, make recommendations to elected officials, and implement new programs (Harper et al., 2009).

These transformations will require coordinated efforts involving a grassroots network of participants and organizations committed to a fair, sustainable food system. The environmental crises of the twenty first century will provide shocks to the industrial food system and openings for expansion of the emerging sustainable practices. Practitioners in the sustainable food system need to anticipate these shocks and be prepared with leadership and strategic visions during food system crises. The winners in this transformed food system will be the American public, the farming economy, rural communities, livestock animals, and native biodiversity. The losers will be the agribusinesses that supply inputs for production of commodity crops destined for livestock, biofuels, and export (e.g., ~90% of the 2016 U.S. corn crop) (National Corn Growers Association, 2017, http://www.worldofcorn.com/). Archer Daniels Midland and Monsanto (and other agribusinesses) should fail because the food system in which they thrived and dominated federal policy will no longer exist. The demand for seed grain, herbicides, pesticides, and synthetic fertilizers will decline as small-scale diversified farms increase in number and economic success. These trends will accompany the decline in consumption of meat and sugary drinks. In addition, the major food-processing corporations should have a diminishing share of the retail market, reducing their influence on supply chains and the products available to consumers (Patel, 2012).

CONCLUSION

The year 2030 lies less than 15 years in the future. The vision outlined here and the proposed transitions from the food system of today to a just and sustainable food system that we theorize about, are only halfway to the goal by then. But the proposed changes represent such a departure from the industrial food system of the late twentieth century that we can be confident that further transformation to achieve a just and sustainable food system is happening. As Richard Levins perceived, "…big problems are often more soluble than small ones." We have a decent chance to solve this "big problem" because the ways forward are clear, the beneficiaries are vast, the momentum is growing, and the alternative leads to further disasters. The fair food system that we envision builds soil organic matter and sequesters carbon, protects and maintains native biodiversity, supports livelihoods on rural and urban farms, rebuilds and maintains rural economies, promotes healthy eating and healthy body weights, and distributes the profits from farming, processing, and selling food far and wide. This system is worthy of our commitment, research, practice, activism, and pride.

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REFERENCES

Ahmadi, B. 2017. Land, ownership, and West Oakland's struggle for food justice (Interview). In J. M. Williams and E. Holt-Giménez, eds. Land Justice: Re-imagining Land, Food, and the Commons in the United States. Pp. 192–201. Food First Books, Oakland, California.

Allen, W. and C. Wilson. 2012. The Good Food Revolution: Growing Healthy Food, People and Communities. New York, Penguin.

Altieri, M. A., C. I. Nicholls, A. Henao, and M. A. Lana. 2015. Agroecology and the design of climate change-resilient farming systems. Agronomy for Sustainable Development 35: 869–890.

Anderson, M. K. 2005. Tending the Wild: Native American Knowledge and the Management of California's Natural Resources. Berkeley, California, University of California Press.

Bacon, D. 2014. Globalization and NAFTA caused migration from Mexico. Political Research Associates. http://www.politicalresearch.org/2014/10/11/globalization-and-nafta-caused-migration-from-mexico/#sthash.CR5X6lnO.dpbs (accessed 19 July 2017).

Benson, M., M. Russell, and D. Kane. 2015. USDA Farm to School Grant Program FY 2013–FY 2015 Summary of Awards. U.S. Department of Agriculture, Food and Nutrition Service, Washington, D.C.

Berry, W. 1977. The Unsettling of America. San Francisco, Sierra Club Books.

____. 1990. What Are People For? New York, North Point Press.

Bonmatin, J.-M. and et al. 2014. Environmental fate and exposure; neonicotinoids and fipronil. Environmental Science and Pollution Research 22: 35–67.

Bowman, M. and D. Zilberman. 2013. Economic factors affecting diversified farming systems. Ecology and Society 18(1): 33. http://dx.doi.org/10.5751/ES-05574-180133.

Buttel, F. H. 2006. Sustaining the unsustainable: agro-food systems and environment in the modern world. Pp. 213–229 In: P. J. Cloke, T. Marsden, and P. H. Mooney, eds., Handbook of Rural Studies. Thousand Oaks, California, Sage Publications.

Carlisle, L. 2015. The Lentil Underground: Renegade Farmers and the Future of Food in America. New York, Gotham Books.

Carlisle, L. and A. Miles. 2013. Closing the knowledge gap: How the USDA could tap the potential of biologically diversified farming systems. Journal of Agriculture, Food Systems, and Community Development 3(4): 219–225.

Carolan, M. 2011. The Real Cost of Cheap Food. London, Earthscan.

Chapagain, A. K. and A. Y. Hoekstra. 2003. Virtual water flows between nations in relation to trade in livestock and livestock products. Value of Water Research Report Series No. 13. UNESCO-IHE.

Colasanti, K. C. Litjens, and M. Hamm. 2010. Growing food in the city: the production potential of Detroit's vacant land. Report of the C. S. Mott Group for Sustainable Food Systems at Michigan State University, East Lansing, Michigan.

Collier, G. A. 2005. Basta! Land and the Zapatista Rebellion in Chiapas. Oakland, California, Food First Books.

Conner, D. S. and M. W. Hamm. 2007. The economics of pasture raised animal products: food, markets and community. White paper, C. S. Mott Group for Sustainable Food Systems, Michigan State University, East Lansing, Michigan.

Cook, B. I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Science Advances 1:e1400082. DOI: 10.1126/sciadv.1400082.

Crowder, D. W. and J. P. Reganold. 2015. Financial competitiveness of organic agriculture on a global scale. Proceedings of the U.S. National Academy of Sciences 112 (24): 761–7616.

De Schutter, O. 2014. Final report: The transformative potential of the right to food. Report of the Special Rapporteur on the right to food to the Human Rights Council, United Nations, 25th session, GE. 14–10537.

____. 2017. The political economy of food systems reform. European Review of Agricultural Economics, doi: 10.1093/erae/jbx009, pp. 1–27.

De Schutter, O. and G. Vanloqueren. 2011. The new green revolution: how twenty-first century science can feed the world. Solutions 2: 33–44.

Delate, K., C. Cambardella, C. Chase, and R. Turnbull. 2015. A review of long-term organic comparison trials in the U.S. Sustainable Agriculture Research 4: 5–14.

ETC Group. 2014. With climate chaos, who will feed us? The industrial food chain or the peasant food web? White paper, http://www.etcgroup.org/.

Fair Food Network. 2016. Double Up Food Bucks: A Five-Year Success Story. Report from the Fair Food Network. https://fairfoodnetwork.org/wp-content/uploads/2016/09/FFN_DoubleUpFoodBucks_5YearReport.pdf. Accessed May 1, 2017.

Ferguson, D. and N. Ferguson. 1983. Sacred Cows at the Public Trough. Bend, Oregon, Maverick Publications.

Glover, J. D., and et al. 2010. Increased food and ecosystem security via perennial grains. Science 328: 1638–1639.

Gunders, D. 2012. Wasted: How America is losing 40 percent of its food from farm to fork to landfill. Natural Resources Defense Council Issue Paper, IP-12-06-B.

Hamm, M. W. 2008. Linking sustainable agriculture and public health: opportunities for realizing multiple goals. Journal of Hunger and Environmental Nutrition 3: 169–185.

Harper, A., A. Shattuck, E. Holt-Giménez, and F. Lambrick. 2009. Food policy councils: Lessons Learned. White paper, Institute for Food and Development Policy, Oakland, California.

Harvard Health Publications. 2008. Healthy eating: A guide to the new nutrition. (Report) Boston, Massachussetts, Harvard Medical School.

Heinemann, J. A., M. Massaro, D. S. Coray. S. Z. Agapito-Tenfen, and J. D. Wen. 2013. Sustainability and innovation in staple crop production in the US Midwest. International Journal of Agricultural Sustainability, dx.doi.org/10.1080/14735903.2013.806408.

Herrero, M. and et al. 2017. Farming and the geography of nutrient production for human use: a transdisciplinary analysis. Lancet Planet Health 1: e33–42.

Holt-Giménez, E. and M. A. Altieri. 2012. Agroecology, food sovereignty, and the new green revolution. Agroecology and Sustainable Food Systems 37: 90–102.

High Country News. 1987. Western Water Made Simple. Washington, D.C., Island Press.

IAASTD (International Assessment of Agricultural Knowledge, Science, and Technology for Development). 2009. Agriculture at a Crossroads: Synthesis Report. Washington, D.C., Island Press.

Ikerd, J. 2007. Conflicts of U.S. farm policy with food safety, nutrition, and health. Essay prepared for presentation at Rudd Center for Food Policy and Obesity, Yale University, February, 2017. http://faculty.missouri.edu/ikerdj/papers/YaleFarmPolicyFoodsafetyhealth.pdf

____. 2010. Corporatization of agricultural policy. Small Farm Today. http://faculty.missouri.edu/ikerdj/papers/SFTCorporatizationofFmPol910.pdf

____. 2016. Farm policy perspectives: Past, present, and future. Essay prepared for presentation at annual meeting of the National Farmers Organization, Peoria, Illinois, January 2016. http://faculty.missouri.edu/ikerdj/papers/IllinoisNFOFarmPolicy.pdf

Iles, A. and R. Marsh. 2012. Nurturing diversified farming systems in industrialized countries: How public policy can contribute. Ecology and Society 17(4): 42. dx.doi.org/10.5751/ES-05041-170442.

Imhoff, D. 2003. Farming with the Wild: Enhancing Biodiversity on Farms and Ranches. San Francisco, Sierra Club Books.

____. 2012. Food Fight: The Citizen's Guide to the Next Food and Farm Bill, 2nd ed. Healdsburg, California, Watershed Media.

Jackson, D. L. and L. L. Jackson, eds. 2002. The Farm as Natural Habitat: Reconnecting Food Systems with Ecosystems. Washington, D. C., Island Press.

Jackson, W. 1980. New Roots for Agriculture. Lincoln, Nebraska, University of Nebraska Press.

____. 2011. Nature as Measure: The Selected Essays of Wes Jackson. Berkeley, California, Counterpoint Press.

Jackson, W., S. Cox, and T. Crews. 2011. The next synthesis, pp. 199–226 In W. Jackson, Nature as Measure, Berkeley, California, Counterpoint Press.

Joannides, J., S. Bergan, M. Ritchie, B. Waterhouse and O. Ukaga, eds. 2001. Renewing the Countryside–Minnesota. Institute for Agriculture and Trade Policy; Great Plains Institute for Sustainable Development.

Kleppel, G. 2014. The Emergent Agriculture: Farming, Sustainability and the Return of the Local Economy. Gabriola Island, British Columbia, New Society Publishers.

Kowitt, B. 2015. Special report: The war on big food. Fortune magazine, http://fortune.com/2015/05/21/the-war-on-big-food/. Accessed on June 4, 2015.

Land Institute. 2009. The 50-Year Farm Bill. White paper, The Land Institute, Salina, Kansas. https://landinstitute.org/wp-content/uploads/2016/09/FB-edited-7-6-10.pdf. Accessed Nov. 15, 2010.

Latham, J. 2015. How the great food war will be won. Blog post, January 12, 2015, Independent Science News|Food, Health and Agriculture Bioscience News. https://www.independentsciencenews.org/environment/how-the-great-food-war-will-be-won/. Accessed May 20, 2017.

Less=More Coalition. 2015. Follow the manure: Factory farms and the Lake Erie algal crisis. White paper documenting the distribution of confinement animal feeding operations and their animal waste in the western Lake Erie Basin. http://www.sierraclub.org/michigan/follow-manure-factory-farms-and-lake-erie-algal-crisis. Accessed Nov. 20, 2015.

Less=More Coalition. 2017. A watershed moment. White paper documenting the distribution of confinement animal feeding operations and their animal waste in Michigan. http://www.sierraclub.org/michigan/michigan-cafo-mapping-report. Accessed May 25, 2017.

Levins, R. and R. Lewontin. 1985. The Dialectical Biologist. Cambridge, Massachusetts, Harvard University Press.

Lobell, D. B., M. Bänzigar, C. Magorokosho, and B. Vivek. 2011. Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change 1: 42–45.

Lobell, D. B. and et al. 2014. Greater sensitivity to drought accompanies maize yield increase in the U.S. Midwest. Science 344: 516–519.

Lotter, D. W., R. Seidel, and W. Liebhardt. 2003. The performance of organic and conventional cropping systems in an extreme climate year. American Journal of Alternative Agriculture 18: 1–9.

Lu, C., K. Toepel, R. Irish, R. A. Fenske, D. B. Barr, and R. Bravo. 2006. Organic diets significantly lower children's dietary exposure to organophosphorus pesticides. Environmental Health Perspectives 114: 260–263.

Magdoff, F. and H. Van Es. 2009. Building Soils for Better Crops: Sustainable Soil Management. Washington, D.C., Sustainable Agriculture Research and Education (SARE) Program.

Maupin, M. A., J. F. Kenny, S. S. Hutson, J. K. Lovelace, N. L. Barber, and K. S. Linsey. 2014. Estimated use of water in the United States in 2010. U.S. Geological Survey Circular 1405, Washington, D.C. http://dx.doi.org/10.3133/cir1405.

McAleese, J. and L. Rankin. 2007. Garden-based nutrition education affects fruit and vegetable consumption in sixth-grade adolescents. Journal of the American Dietetic Association 107: 662–665.

Miles, A., M. S. DeLonge, and L. Carlisle. 2017. Triggering a positive research and policy feedback cycle to support a transition to agroecology and sustainable food systems. Agroecology and Sustainable Food Systems 41: 855–879.

Montgomery, D. R. and A. Biklé. 2015. The Hidden Half of Nature: The Microbial Roots of Life and Health. New York, W. W. Norton.

National Research Council, Committee on Twenty-First Century Systems Agriculture. 2010. Toward Sustainable Agricultural Systems in the 21st Century. Washington, D.C., National Academies Press.

Nicholls, C. I., M. A. Altieri, and L. Vazquez. 2016. Agroecology: Principles for the conversion and redesign of farming systems. Journal of Ecosystem & Ecography S5: 010. doi:10.4172/2157-7625.S5-010.

Offenberg, J. 2015. Ants as tools in sustainable agriculture. Journal of Applied Ecology 52: 1197–1205.

Ong, T. W. I. and J. Vandermeer. 2015. Coupling unstable agents in biological control. Nature Communications 6, doi:10.1038/ncomms6991.

Patel, R. 2012. Stuffed and Starved: The Hidden Battle for the World Food System, 2nd ed. Brooklyn, New York, Melville House.

Perfecto, I. and J. Vandermeer. 2015. Coffee agroecology: A New Approach to Understanding Agricultural Biodiversity, Ecosystem Services, and Sustainable Development. Oxon, UK, Routledge.

Pimentel, D., P. Hepperly, J. Hanson, D. Douds, and R. Siedel. 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. BioScience 55: 573–582.

Popper, D. E. and F. J. Popper. 2006. Onset of the Buffalo Commons. Journal of the West 45(2): 29–34.

Reganold, J. P. and J. M. Wachter. 2015. Organic agriculture in the twenty-first century. Nature Plants 2, doi:10.1038/nplants.2015.221.

Relyea, R. A. 2005. The lethal impact of Roundup on aquatic and terrestrial amphibians. Ecological Applications 15: 1118–1124.

Rodale Institute. 2011. The Farming Systems Trial: Celebrating thirty years. Report from the Rodale Insitute; https://rodaleinstitute.org/our-work/farming-systems-trial/farming-systems-trial-30-year-report/. Accessed Oct. 22, 2011.

Rosset, P. M., B. M. Sosa, A. M. R. Jaime, and D. R. A. Lozano. 2011. The Campesino-to-Campesino agroecology movement of ANAP in Cuba: social process methodology in the construction of sustainable peasant agriculture and food sovereignty. The Journal of Peasant Studies 38: 161–191.

Rudd Center for Food Policy & Obesity. 2009. Soft drink taxes: a policy brief. Yale Rudd Center, 7 pp.

Satia, J. A. 2009. Diet-related disparities: understanding the problem and accelerating solutions. Journal of the American Dietetics Association 109 (4): 610–615.

Soule, J. D. and J. K. Piper. 1992. Farming in Nature's Image. Washington, D.C., Island Press.

Stehfest, E., L. Bouwman, D. P. van Vuuren, M. G. J. den Elzen, B. Eickhout, and P. Kabat. 2009. Climate benefits of changing diet. Climatic Change 95: 83–102.

Stiglitz, J. E. 2013. The insanity of our food policy. New York Times, Opinionator, November 16, 2013.

Stone Barns Center. 2017. Back to grass: the market potential for U.S. grassfed beef. White paper, Stone Barns Center for Food and Agriculture, Pocantico Hills, New York. http://www.stonebarnscenter.org/images/content/3/9/39629/Grassfed-MarketStudy-F.pdf.

Tilman, D. and M. Clark. 2014. Global diets link environmental sustainability and human health. Nature 515: 518–522.

Timmermann, C. and G. F. Félix. 2015. Agroecology as a vehicle for contributive justice. Agriculture and Human Values 32: 532–538.

Triplett, G. B. and W. A. Dick. 2008. No-tillage crop production: a revolution in agriculture! Agronomy Journal 100: 153–165.

Tropp, D. and M. R. Moraghan. 2017. Local food demand in the U.S.: Evolution of the marketplace and future potential. Pp. 15–41 In: A. Dumont, D. Davis, J. Wascalus, T. C. Wilson, J. Barham, and D. Tropp, eds., Harvesting Opportunity: The Power of Regional Food System Investments to Transform Communities. St. Louis, Missouri, Federal Reserve Bank of St. Louis.

Union of Concerned Scientists. 2013. The Healthy Farmland Diet. White paper of Union of Concerned Scientists. www.ucsusa.org/healthyfarmlanddiet.

USDA Agricultural Marketing Service. 2015. National farmers market manager survey shows farmers markets continue to grow. Release No. 108–15.

USDA Economic Research Service. 2017. Beginning farmers and age distribution of farmers. (Accessed online 10 April 2018). https://www.ers.usda.gov/topics/farm-economy/beginning-disadvantaged-farmers/beginning-farmers-and-age-distribution-of-farmers/.

USDA National Agricultural Statistics Service. 2016. Agricultural Statistics 2016. Government Printing Office, Washington, D.C.

U.S. Geological Survey. 1999. The quality of our nation's waters. USGS Circular 1225. https://pubs.usgs.gov/circ/circ1225/html/pesticides.html.

USHHS and USDA. 2015. 2015–2020 Dietary Guidelines for Americans, 8th ed. http://health.gov/dietaryguidelines/2015/guidelines/.

Van der Sluijs and et al. 2014. Conclusions of the World Integrated Assessment on the risks of neonicotinoids and fipronil to biodiversity and ecosystem functioning. Environmental Science and Pollution Research 22: 148–154.

Vandermeer, J. and I. Perfecto. 2017. Ecological complexity and agroecosystems: seven themes from theory. Agroecology and Sustainable Food Systems 41: 697–722.

Vandermeer, J., I. Perfecto, and S. Philpott. 2010. Pest control in organic coffee production: uncovering an autonomous ecosystem service. BioScience 60: 527–537.

Weis, T. 2013. The Global Hoofprint: The Global Burden of Industrial Livestock. London, Zed Books.

White, C. 2008. Revolution on the Range: The Rise of a New Ranch in the American West. Washington, D.C., Island Press.

Willett, W. C. and P. J. Skerett. 2001. Eat, Drink, and Be Healthy: The Harvard Medical School Guide to Healthy Eating. New York, Simon and Schuster.

Wise, T. A. 2010. Agricultural dumping under NAFTA: Estimating the costs of U.S. agricultural policies to Mexican producers. Mexican Rural Development Research Reports, Reporte 7. Washington, D.C., Woodrow Wilson International Center for Scholars.

Yakini, M. 2017. Urban land-grabbing and a movement for community-based control in Detroit (Interview). In J. M. Williams and E. Holt-Giménez, eds. Land Justice: Re-imagining Land, Food, and the Commons in the United States. Pp. 202–211. Food First Books, Oakland, California.

Zhang, W., and et al. 2016. Closing yield gaps in China by empowering smallholder farms. Nature 537: 671–674.

THE MICHIGAN MATRIX: CREATING HABITATS TO SUPPORT CREATIVE MIGRATIONS

By

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INTRODUCTION

Since the late twentieth century, interdisciplinary research has been upheld as the holy grail of scholarly activities in research universities in the United States. However, many organizational, epistemological, and social barriers persist that impede researchers from migrating across boundaries that are at once disciplinary and social. Inspired by John Vandermeer's commitment to making NWAEG a vibrant space for creative inquiry, I appropriate the title—*Nature's Matrix*—of the book that John coauthored with Ivette Perfecto and Angus Wright, in order to argue for the value of facilitating migratory flows of researchers across the physical and mental borders found at most, if not all, research universities. John and Ivette have played leading roles in creating a "Michigan Matrix" that includes habitats for creative exchanges of researchers in informal gatherings.

Before advancing an argument, I want to say simply "thank you" to John and Ivette Perfecto who have worked long and hard to create intellectual environments that promote cross-pollinations and hybridity. Only now, after more than 15 years as a faculty member at a research university, can I truly appreciate the challenges associated with creating and *sustaining* such rich places. However, I know that neither John nor Ivette have much patience for hagiography, so after describing my own "migratory" experience as a student at Michigan, I present the results of exploratory research done in tracking the influence of agroecology across scholarly disciplines since the 1970s. Preliminary results suggest that agroecology has migrated, at variable rates, across disciplinary boundaries. However, agroecology does not appear to have migrated far beyond the confines of academic circles.

I was both an undergraduate (1985–'89) and a graduate student (in residence from '91–'94) at the University of Michigan, Ann Arbor. Political events of the 1980s fueled my interest in both Latin America and environmental issues. These events included both the civil wars in Central America and the U.S. involvement in those conflicts, along with a transnational movement to protect rain forests. My inchoate interest in these affairs did not begin to coalesce around agroecology until my senior year, when I wrote a senior thesis on the environmental history of the Central American banana industry, encouraged by environmental historian Richard Tucker, who was teaching in the then School of Natural Resources and Environment (today, School of Environment and Sustainability). I believe it was Richard who encouraged me to meet John, who by that point had already supported Ed Russell's work on the historical connections between warfare and pesticide development in the United States. John graciously allowed me to audit his course on agroecology, even though I was clearly unprepared for its mathematical dimensions.

I returned as a graduate student, pursuing a master's degree. from SNRE and a doctorate in Latin American history. I was something of a migrant—a privileged one, to be sure—who moved back and forth across the Diag—a short distance in mathematical terms, but often an enormous one in the intellectual ecology of the university: Few of my friends in SNRE had a clue about life in the history department and vice versa[1]. The weekly NWAEG meetings provided me with a critical habitat in which I could interact with biologists and other kinds of researchers. John, rather than using the presence of non-biologists to reinforce a disciplinary identity, "used" the non-biologists in attendance to challenge his own students to think differently about their research. Agroecology/ NWAEG, then, provided me not merely with new kinds of research "data," but also a framework for integrating analysis of social and ecological phenomena, and a network of researchers that included many other "migrants" interested in border crossings. Weekly NWAEG meetings were by no means "purely" academic exchanges: The commingling of scholarship, politics, and sociality (i.e., beers and banter) was also vital for creating bonds of friendship that are seldom indicated—who am I kidding?—that are entirely hidden in scholarly publications, yet motivate and sustain many of us, particularly inexperienced researchers.

[1] I should acknowledge that the Graduate Employees Organization (GEO) provided another critical context in which graduate students from different disciplines to come together. However, discussions generally focused on the "bread and butter" issues relevant to a union of graduate assistants, not research per se.

My doctoral dissertation in history bore the title "Landscape and Livelihood: An Agroecological History of the Export Banana Industry in Honduras." Although a handful of pioneering U.S. environmental historians such as Donald Worster had used the term "agroecology," I was inspired as much by my exchanges with John, Ivette (a formal member of my dissertation committee) and many NWAEG participants about both biological evolution *and* political revolution as I was by scholarship within "my field." In other words, my research bore fruit in part because NWAEG was a critical meeting point—*los encuentros*—in an ecosystem marked by many barriers (i.e., academic departments) that, sometimes inadvertently, impeded flows of ideas in the name of mastery of a "discipline." However, strict policing of disciplinary boundaries is no more likely to nurture creative inquiry than border patrols along national parks are likely to preserve biological diversity over the long haul. In this sense, NWAEG's embrace of migrants created a dynamic, creative matrix that challenged academic departments' tendency toward the "museumification" of knowledge.

PUTTING THE PERSONAL INTO CONTEXT: THE MIGRATION OF AGROECOLOGY

Methods:

Curious to situate my own experience into broader trends in university research, I searched the ProQuest database using the term "agroeco*" to identify how often terms like "agroecology," "agroecological," "agroecosystem," etc. appeared in titles or as a keyword of dissertations and theses. I then used the same search term ("agroeco*") without any filter ("anywhere") in order to detect "weaker" or a more superficial presence of agroecology in scholarship. I also used the term "agroeco*" to search titles that listed "history" as a subject in order to detect migrations of agroecology into a humanistic academic field. Finally, I searched a second database, ProQuest Historical Newspapers: *New York Times*, using the same search term to detect the degree to which agroecology has migrated beyond the confines of research universities.

Table 1.— Top Disciplinary Classifications for Dissertations with "agroeco*" in title/keyword (N = 772), 1973–2015.

Ecology	249
Agronomy	237
Entomology	141
Environmental Science	125
Soil Science	113
Agriculture	92
Agricultural Econ	71
Geography	51
Biogeochemistry	47
Cultural Anthropology	25

Table 2.— Frequency of "agroeco*" in title/keyword of dissertations: meta population and "ecology" Subpopulation (N = 249), 1973–2015.

Years	All Fields	Ecology
1973–1979	7	0
1980–1989	91	29
1990–1999	208	87
2000–2009	242	74
2010–2015	224	59

Table 3.— Frequency of "agroeco*" in title/keyword of dissertations: "social science" Subpopulation (N=133), 1980–2016.

Years	Social Sciences
1980–1989	11
1990–1999	52
2000–2009	35
2010–2016	35

Table 4.— Top disciplinary classifications for dissertations with "agroeco*" anywhere (N = 8,993)

Ecology	1,987
Agronomy	1,729
Environmental Science	1,452
Soil Science	1,314
Entomology	1,070
Agricultural Economics	793
Geography	686
Agriculture	570
Forestry	565
Biogeochemistry	529
Cultural Anthropology	421

Table 5.— Frequency of "agroeco*" in dissertations with "history" as a subject (N= 351), 1980–2016.

1980–1989	6
1990–1999	89
2000–2009	150
2010–2016	106

Table 6.— Number of times that "agroeco*" appeared in the *New York Times*, 1984–2008.

1984–2008	4

Interpretation of Results:

Based on the data held in the ProQuest databases, agroecology's influence appears to be strongest in closely related disciplines, including ecology and agronomy. It exerted significant, but decidedly less, influence in fields like geography and anthropology (see Table 1). When trying to detect "weaker" influence (Table 4), the results indicate that agroecology remains a stronger presence in the fields of ecology, agronomy, entomology, and soil science than it does in agricultural economics, geography, or cultural anthropology. But the relative differences among fields diminish when comparing the frequency that "agroeco*" appears anywhere in a text. For example, dissertations in the field of ecology were almost 10 times more likely to use agroecology or a variant as a title or keyword than dissertations completed in cultural anthropology, but ecology dissertations were only five times more likely to use agroeco* anywhere than those completed in cultural anthropology.

"Agroecology" and its derivatives have unquestionably migrated into some social sciences, particularly agricultural economics and geography, as well as some multidisciplinary fields like environmental science. The data also indicate that agroecology has migrated into humanistic fields like history, arguably one of the longer conceptual journeys. The number of hits for "agroeco*" in dissertations and theses listing "history" as a subject increases sharply from a handful in the 1980s to more than one hundred in the early 2000s (Table 5). My own dissertation (completed in 1998) fits into the "take-off" period for agroecology in the discipline of history, suggesting that my experiences at Michigan were relatively novel but not unique.

In terms of change over time, the term agroecology and its variants have appeared in all fields with increasing frequency since the 1970s (Table 2). The number of theses and dissertations jumped by two orders of magnitude (from single digits to hundreds) between the 1970s and 1990s; over the past 20 years, the rate of increase appears to have slowed. Unsurprisingly, migrations took place first (1980s) in closely related fields like ecology; more time was required for agroecology to enter social sciences like geography or anthropology. The burst of interest in agroecology in the social sciences in the 1990s appears to have leveled off in the early twenty-first century (see Table 3), but in the absence of more robust data, long-term trends are far from clear.

Finally, the exceedingly small number of hits in the *New York Times* database during a period when agroecology was flourishing and migrating across fields at many research universities is not entirely surprising and possibly a misleading result produced by my rather crude methodology that does not consider words or phrases that are conceptually related to agroecology. For example, my decision to drop "agroecology" from the title of the published book based on my dissertation was motivated in part by a sense that agroecology would be perceived as scholarly jargon, so I resorted to words like "agriculture" and "environment." In fact, the titles of Vandermeer and Perfecto's own popular writings tend to drop "agroecology" from their titles. Although this practice may raise pertinent questions about the linguistic and cultural dimensions of "scaling up" agroecology, there can be little doubt that the *New York Times* ran far more than four stories about topics such as "organic" and/or "local" farming; peasant movements for land; and controversies over the use of pesticides, fertilizers, or GMOs that are implicitly informed by the research of agroecologists without identifying them as such.

This preliminary attempt to measure the migratory flows of agroecology has major limitations. The absolute number of keyword hits does not indicate frequency; that is, the data set does not reveal changes in agroecology in relationship to changes in other disciplines. So, for example, we do not know yet if agroecology has had a larger influence on anthropology than say, biomedicine or genetic markers. Another limitation appears to be that using keywords like "agroecology," "agroecosystem," or "agroecological" in ProQuest only captures a subset of researchers who have been connected to NWAEG at Michigan. For example, my searches only turned up 15 theses or dissertations completed at the University of Michigan between 1998 and 2013; the research of many of the Michigan-trained scholars who presented at "VandyFest" did not appear in my search. Clearly, a more thorough and nuanced search strategy is needed to identify dissertations and theses that utilize keywords that are closely related conceptually to agroecology.

CONCLUSIONS

As an academic discipline, there can be little doubt based on empirical evidence that agroecology has expanded significantly over the past 40 years, migrating not only into fields like entomology and soil science, but also geography, forestry, economics, and history. But the quantitative data only tells part of the story. As a historian who trained during a boomlet in agroecological research during the 1990s, my own sense of the importance of agroecology in general and NWAEG and John, Ivette, and many others in particular, is not limited to set of conceptual tools, methodologies, or political ideologies. Instead, a key contribution was creating a social place and network in which it was okay to cut across boundaries of disciplines and, I should add, scholarship and "activism" or political engagement.

Looking to the future and when considering how to "scale up" agroecology, I would suggest that the goal of agroecologists (or historians) should not be to buttress their respective (monocultural) fields but rather to work create a diverse university ecology sustained by migrations. As fields like agroecology become more established and recognized in academic worlds (and beyond), practitioners and theorists alike should value creative movements as fundamental both to knowledge production and political change.

My invoking of scholarly migrants and migrations runs the risk of committing a familiar act of appropriation of the lived experiences of poor people of color by a white, affluent member of the so-called "creative class." Therefore, I must stress that I am not suggesting that the challenges facing scholars interested in interdisciplinary research models and methods are in any way comparable to the daily struggles of migrants, refugees and other displaced people who frequently are forced to risk their lives in the pursuit of livelihoods, respect, dignity, or safety. Instead, I want to draw a parallel to the (self-)policing of disciplinary borders in the name of purity, and the policing of geohistorical borders in the name of a racialized "national" identity.

Finally, my act of appropriation is intended to cast light on the deep historical connections between literal monocultures and migratory, exploited labor forces that are not just poor but systematically denied full rights of citizenship. The potency of agroecology does not lie so much in its ability to produce new technoscientific farming methods but rather in its potential contributions to forging a new socio-ecological relationship rooted in equality and bio-cultural diversity.

[1]Ivette Perfecto, John Vandermeer and Angus Wright. *Nature's Matrix: Linking Agriculture, Environment and Food Sovereignty.* New York: Routledge, 2009.

[2]Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring.* Cambridge: Cambridge University Press, 2001.

[3]In addition to Nature's Matrix, I am thinking of Vandermeer and Perfecto's *Breakfast of Biodiversity: The Truth about Rainforest Destruction*. Oakland, CA: Food First Books, 1995. Also see, John Soluri, *Banana Cultures: Agriculture, Consumption and Environmental Change in Honduras and the United States.* Austin, Texas: University of Texas, 2006.

A MORAL COMPASS FOR THE TEACHING AND PRACTICE OF SCIENCE

THE NEW WORLD AGRICULTURE GROUP IN NICARAGUA: NWAG MEMBERS REFLECT ON THEIR EXPERIENCE

By
Katherine Yih, 2016

INTRODUCTION

Inspired by the triumph of the Sandinista revolution in July 1979, the New World Agriculture Group (NWAG)[1] contacted Sandinista officials in 1980, and nine members traveled to Nicaragua in February 1981.[2] This first, exploratory visit, organized largely by John Vandermeer, was followed by an official delegation of five in August 1981.[3] Collaboration agreements were signed with the Ministry of Agriculture, the National Agricultural University, and the Center for Research and Documentation of the Atlantic Coast. Under the auspices of these institutions, NWAG members provided bibliographic and material support, conducted socio-/agro-/ecological research, much of it under John's mentorship, and trained a number of young Nicaraguan scientists. By 1988, close to 30 NWAG cooperants from the United States and Canada had spent one or more years in Nicaragua, making contributions in the following areas:[4]

Creating Infrastructure	Solving Problems	Developing Human Resources
Soils laboratory	Alternative insecticides	Teaching research methods
Plant protection lab	Laboratory techniques	Research planning
Computation center	Cultural pest control	Undergraduate teaching
Living insect cultures	Biological control	Research apprenticeships
	New production methods	Scientific journal

NWAG members also worked to educate U.S. audiences about the Nicaraguan revolution and U.S. intervention through speaking tours and writing, seeking to build public opposition to the United States–funded counterrevolution.

NWAG's work in Nicaragua continued after the Sandinistas were voted out of power in 1990 and included a multi-year study of rainforest regrowth, with Nicaraguan student participation, after Hurricane Joan in 1988.

METHODS

Seeking to capture and describe the experience of NWAG in Nicaragua for the May 2016 symposium in John's honor, I developed a qualitative survey and sent it by e-mail to the NWAG distribution list in February 2016, calling on those who had spent time as a NWAG member in Nicaragua to respond to any or all questions. I sent one reminder three weeks later, one week before the deadline I had set. The survey included open-ended questions about lessons learned, contributions made, the difficult issues, and the greatest achievements and greatest mistakes of NWAG in Nicaragua. In addition, the following request was made: "If John had a role in your decision to go to Nicaragua and/or served as a mentor to you during your time there, please comment on what you learned from John in this period or share some memories of working with him or hanging out with him in this period." Respondents were asked whether their responses could be shared, and all agreed. I grouped the answers received into categories and themes within categories and chose a few quotes to illustrate or exemplify each theme.

FINDINGS

Fifteen people sent substantive replies. The estimated response rate was 50%, although the denominator, i.e., the number of NWAG participants in Nicaragua on the NWAG distribution list, is not known with precision.

The responses, grouped into categories and themes, were as follows:

1. The Issues

A. Whether, when, and how to criticize

- How far does party/group support go? When and where is it OK to not fall in line? Where are the lines in the sand? Where does loyal criticism lead? (AH, participant)

Nicaragua, Atlantic Coast (RAAS: Bluefields Project), 1989. Left to right: Doug Boucher, John, Nelson Zamora.

- The petty opportunism of some of our Nicaraguan comrades was exceedingly difficult for me to navigate. And for me, a dominant A-type white male, the tendency to try and always tell them what to do was a constant struggle within me. This created really difficult psychological and personal political problems for me. It was Nicaragua's revolution, not mine. Is it OK if they want to promote *oportunistas* and fire true revolutionaries, and what business of mine is it to point this out to them? As said to me one time …, "It is our Revolution, not yours. Maybe we're doing it wrong, but it is *we* who are doing it." I guess he was right? (JV)

B. The rights of social sectors that were not being addressed by the Revolution

- Indigenous/Atlantic Coast issues – solidarity with the revolution and the peasant majority vs. solidarity with indigenous peoples (DB)
- The policies that punished *campesinos* for "smuggling" beans to Managua to sell (PR)
- Public policies insensitive or oblivious to rural women as farmers, farm workers, and local entrepreneurs (FG)

Nicaragua, Atlantic Coast (RAAS: Bluefields Project), 1989.

C. Production in the short run vs. sustainability in the long run, the big-ag proclivities of the government

- The immediate need to increase productivity in agriculture vs developing sustainable agriculture in the long run (e.g., the Sandinistas once asked us for pesticides) (IP)
- Mistaken policy of capital accumulation in state sector and large growers, and ineffective policy to foment peasant agriculture (FG)
- Strong ties with private sector tied up with green revolution technologies then and GMOs now (FG)

D. What were we doing? Was it doing any good?

- Were we really making a difference in restraining the United States.? Were we really helping Nicaragua, or should we have given all that plane ticket money to them directly? There were so many small solidarity groups competing for resources...(BS)
- What is revolutionary action embedded in a traditional scientific model? What is a "true" action of solidarity? How can we participate in incremental development practice when we know we need a revolutionary structural change? Who cares about our academics when urgent political mobilization is necessary? Who should we be in solidarity with? What science should we be doing? (KN)

E. Issues post-1990

- … [A]sadness…had settled on Nicaragua by the mid-1990s. Gone were the days of heady excitement from the romantic 1980s. Gone were the groups of graduate students working together on agroecological problems that could increase crop production in a more sustainable manner. Instead, the 1990s had a sad nostalgia about what used to be. I worked with *campesino* families in which the parents could read, but the kids could not because the rural schools had disappeared. The parents had been trained as health aides, while the kids wallowed in filth and suffered from injuries and diseases they should not have known. The hope for the future had been replaced by a sense of powerlessness, reinforced by rampant corruption. As a result, the attention of the Michigan labs started moving towards Chiapas in the mid-1990s and eventually settled there. In some ways I envied the teams that worked together in Nicaragua of the l980s or the groups in Chiapas since the late 1990s. (CP)
- Much of what was accomplished, especially in the later years (those before and during Daniel's second round) went by the wayside. So many *informes*, studies, reports that took so much effort to develop, ended up in some director's drawer, unread and forgotten. So often, the professionals we trained ended up fighting each other, far from being a team. (IGC)
- Really, the most difficult issue for me has been watching the return of the U.S. and Chinese influence in the country since the end of the war. It would be great to re-establish

NWAG's collective voice over the proposed canal, deforestation, the influx of "improved" crop varieties and corporate agriculture, large-scale cattle production, displacement of small farmers, etc. (RO)

2. Some of NWAG's Contributions

A. Teaching, mentoring, training scientists

- All of the five students we mentored most closely went on to get PhDs, and four of them are working in Nicaraguan educational institutions. (JV)
- One of the students I worked with there went on to study biometrics in England. (BS)
- That collective multi-year [post-hurricane rainforest] research effort trained some Nicaraguans in ecological fieldwork. (KY)
- I seem to have instilled a lifelong commitment to agroecology in a number of my colleagues. (PR)

B. Building scientific community and friendship across national, class, and race lines

- Along with John and others, we created a vibrant intellectual community. (IP)
- [We facilitated] lines of communication between Nicaraguans and North American institutions/scientists AND between Central Americans. (IGC)
- [We contributed] a flow of human capital that worked with Nicaraguans in solidarity, through teaching, construction, research, cooking, protests, poetry, friendship. (KN)

C. Working toward more sustainable agriculture, public-health applications of ecology, and participatory research

- We helped to create a cadre of agroecologically inclined Nicaraguan comrades. (PR)
- I nudged a regional IPM (Integrated Pest Management) program to examine the way science is done and who the knowledge creators can be; of course, this was done in collaboration with others. (KN)
- The time as a NWAG member was an important phase for me to retool and renovate myself as a practical agroecologist, and I have stayed here since then, working with many toward these goals in the next decades in Nicaragua:
  - biological control of malaria vectors
  - biological control of rodent populations to control leptospirosis
  - biological control of the spittlebug in sugarcane
  - working with social movements to push for laws and policies to foment food sovereignty and agroecological food production. (FG)

D. Standing in solidarity with the Nicaraguan revolution and influencing political discourse in United States.

- [Our actions showed] Nicaraguans the difference between the U.S. government and the American people. (DB)

Second research trip to study hurricane damage to rainforest of Nicaragua's southern Atlantic Coast, 1990; The Women. Left to right: Judith Appel, Katherine Yih, Lin Roth, Nicaraguan student, Ivette Perfecto, and Nicaraguan student.

- My sense is that our contribution to getting the information out about U.S. policy, together, did have an effect on supporting the Nicaraguan democratic process through the end of the war. (RO)

E. Providing an education, political and otherwise, to NWAG members

- Mentorship of U.S. students [by NWAG members was done] in a way that encouraged them to conduct research in an ethical way through engaging with local communities. (KM)
- [NWAG contributed] a cohort of organizers, scholars, academics, managers, etc. who have the Nicaraguan solidarity experience at the core of their early formation and have been able to use it to transform institutions they encountered over the years. (KN)
- Many NWAG members who'd worked in Nicaragua have continued doing research, teaching, policy, and/or organizing work related to agroecology or other fields of importance to society, and this work has likely been informed by their experiences in Nicaragua. (KY)

3. Some Mistakes/Failings

- Failing to fully integrate into Nicaraguan life and culture (PR, FG, KY)
- Leaving Nicaragua after the fall of the Sandinistas (1990) (FG, BS)
- Underestimating shortcomings of (and declining popular support for) the Sandinista government (DB, BS)
- Not using political analysis to inform our work—might we have done better at bringing theory and collective experience to bear on problems of collaboration? (KY)
- Lack of focus on gender and youth (FG)
- Not doing enough with the resources/opportunities in our network (KN)

Annual NWAG-in-Nicaragua meeting, probably Matagalpa, Nicaragua, 1987. Left to right: Falguni Guharay, Allan Hruska, Bob Rice (behind), Sally Gladstone, Todd Anderson, John Vandermeer, Peter Rosset. Front row: Kathryn Savoie, Brian Schultz, Ivette Perfecto, and Jaime ("Kiko") Morales.

4. What We Learned

A. The contradictory nature of a revolutionary process (DB)

- That revolutionary processes are messy (IP & JV)
- I learned how opportunists at the level of mid-level and cadre can undermine the populations' revolutionary fervor (PR)
- That there are opportunists everywhere (IP & JV)
- That socialist revolution is possible, or at least it was then, but is very, very difficult to maintain, not only because of external forces such as U.S. imperialism but also because revolutionary movements and parties can slide into undemocratic and corrupt practices (KY)

B. Solidarity with the peasantry

- I went from being a "statist," believing in the socialist development state, to being a "campesinista." (PR)
- Research with nontraditional partners like peasants and base organizations is equally relevant as formal research with scientists but needs different skills, methods, and theories. (FG)
- Peasant men aren't hugely better off than peasant women. (I became less of an us-vs.-them feminist by seeing peasant life.) (KY)

C. The impact of U.S. imperialism

- I learned how significant an impact U.S. foreign policy could have on so many innocent people. (KM)
- I became intimately aware of the awful effects of U.S. aggression e.g., funeral. (I also remember being in a crowded museum in Managua in 1981 and coming upon photos of U.S. marines holding severed Nicaraguan heads by their hair. Sure made you proud to be an American -- not!). (BS)
- I still use the research with neem and Bt in my classes about IPM and also about how Nicaragua was trying to find alternatives to pesticides and break dependency on imports. I still have a *Nuevo Diario* newspaper clipping headline slide about "El 'Nim' ... Un insecticida para matar multinacionales." (BS)

D. Science in the interests of justice and equality

- Science, big or small, local or global, HAS to serve society toward justice, equality, progressiveness (and socialism). There is no such thing as non-political science– as a scientist, you have to take a stand and stick to it. (IGC)
- Our time in Nicaragua and with NWAG was one of only two times in my life when I really understood the complicated relationships between ecology, politics, economics, and sociology. In most other experiences, we focus on only one or two of those areas, but NWAG/John/Ivette take them all on at once like few other mentors or colleagues in my life … Most biologists are afraid to really talk about links between their science and economics, sociology, or politics. (CP)

E. Personal growth and self-awareness

- I of course learned a lot from living in a different culture, with different history, assumptions, and customs, and how they viewed the United States. (BS)
- Specifically from John: how to be a mentor and teacher in a completely different environment than the U of M campus. (PF)
- Personal resilience and strength; the value of being a role model (RO)
- Despite all the work I've done in other countries, I'm still very much a gringo. (DB)

F. There is hope for humanity (IP)

- The joy of making a small contribution to a large social transformation (DB)
- Humans are far more generous and optimistic globally than we are aware of/experience in the United States. (RO)
- That people can work together and achieve great things (IP & JV)

JOHN'S INFLUENCE ON NWAG MEMBERS

The following sampling of quotations from the survey responses reflects John's engagement with and lasting influence on those he mentored:

> My memory of John on the trips to Nicaragua is that he was tireless and always filled with excitement over ecology of the rain forest. Even an insect in a pile of cow dung excited him. His passion and enthusiasm for the science and also for the Nicaraguan students was contagious and has always been a source of inspiration for me in my own work.
>
> --Krista McGuire

> John's enthusiasm in the field was infectious and has served as an example for the way I teach. John is at heart a little kid still excited to watch bugs and hold frogs.
>
> --Chris Picone

> …with John, you were challenged, interrogated, reminded the next day that you had not really come up with a complete thought—politically or scientifically. Yet, he shared his energy, intellect, and excitement about ideas with all, creating a community that together supported each other in working for justice, expanding political ecology, adding to scientific insights, and living in solidarity through many means.
>
> --Kristen Nelson

> I learned what revolutionary commitment means. I learned Marxism. I learned critical thinking. I learned how to work in a collective.
>
> --Peter Rosset

> I learned from John the importance of community—groups of people who could share and work and make things happen together. I learned from John that you can have a good time–enjoy life–while working on nontrivial things. John is the quintessential leader by example – always working and thinking–way out front. He's thought intensive, but with a big heart.
>
> --Allan Hruska

> John was my inspiration. Without him, I would never have gone in the first place, nor stayed involved for so many years. He was also enormously important as a sympathetic friend who could understand what it was like to work there and the personal tensions and pressure that it created.
>
> --Doug Boucher

> John was a tough mentor who surprised you with his caring. I once got an insultingly harsh review (from someone outside of U of M), and John picked me up off the floor and put things in perspective. While [I was] in Nicaragua, he kept up correspondence with me better than my own family, even while he was off in Holland on sabbatical with Ivette. As he freely admitted, he really was a "sensitive new-age guy trapped in the body of an arrogant asshole."
>
> --Chris Picone

CONCLUSION

NWAG established formal cooperation agreements with agriculture-related Sandinista institutions within the first two to three years of the Sandinista Revolution. John Vandermeer provided much of the original vision and ongoing impetus for the collaboration and was a key influence on many NWAG participants. NWAG members supplied bibliographic and infrastructural support, undertook applied research in partnership with Nicaraguan students and scientists, trained Nicaraguans through classroom and in-field teaching and mentorship, and sought to educate the U.S. public about the devastating effects of the U.S.-funded counterrevolution. It was very much a two-way street. Through the revolutionary period and beyond, NWAG participants learned from their Nicaraguan colleagues; NWAG members also witnessed the effects of poverty, the accomplishments and promise of a socialist revolution powered by a mobilized and politically conscious population, the destructive force of the counterrevolution, and some of the weaknesses of the revolution. Questions NWAG had grappled with earlier—such as ecology vs. production, the meaning of collaboration, and the appropriate role of gringos in Latin America[5]—persisted. These experiences and quests shaped the consciousness and subsequent scientific and political work of NWAG members and significantly affected the perspectives and trajectory of NWAG as an organization.

APPENDIX

Partial list of NWAG participants in Nicaragua: Robert Ambrose, Pamela Anderson, Todd Anderson, Judy Appel, Inge Armbrecht, Miguel AuClair-Valdez, Bill Barclay, Doug Boucher, Iñigo G. de la Cerda, Peter Feldstein, Paul Foster, Sally Gladstone, Falguni Guharay, Charlie Hale, Lillian Hall, Allan Hruska, Dick Levins (visited), Krista McGuire, Kristen Nelson, Rachel O'Malley, Ivette Perfecto, Chris Picone, Sunny Power, Bob Rice, Peter Rosset, Linda Roth, Kathryn Savoie, Brian Schultz, John Vandermeer, Tom Will, Katherine Yih.

END NOTES

1. The New World Agriculture Group subsequently changed its name to the New World Agriculture and Ecology Group, NWAEG, to be more inclusive. For simplicity, the original name is used throughout this paper.
2. The group consisted of David Andow, Sarah Cohen, Cruz Phillips, Bob Rice, Phil Rosen, Peter Rosset, Brian Schultz, John Vandermeer, and Katherine Yih.
3. The delegation comprised Pamela Anderson, Doug Boucher, Charles Hale, Ivette Perfecto, and John Vandermeer.
4. The New World Agriculture Group Agricultural programs in Nicaragua. Booklet for fundraising purposes, 1988.
5. Boucher, Douglas H. and Isadore Nabi. 1985. The "New World Agriculture Group: A History". *Radical Science* 17: *Issues in Radical Science*, pp. 88–104. Free Association Books, London.

THE PASSION AND THE MORAL COMPASS: STRANGE ATTRACTORS AND A PHASE SPACE OF POLITICAL ECOLOGY

By
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We are arguably at a unique juncture in human history, meaning that multiple possible trajectories—in terms of social welfare, governance, and relationship with and conservation of non-human nature—stretch out before us. Achieving a more equitable, sustainable, and just future will require continued advancements in scientific thought from both social and natural scientists. It will also need new institutions to reflect and strengthen the possibilities of cooperation, caring, redistribution, and living within our ecologies. The career, research, and mentorship of John Vandermeer shows how both he and his many students over the years have oscillated between focusing on shared passions for contact with the natural world and developing better ecological theory, and the moral compass guiding many of us towards socio-political analysis and political activism. John, his partner in life and in research, Ivette Perfecto, and their many students and colleagues have oscillated through this "strange" space where science, activism, and passion interact. As a group, we have chosen our places and spread throughout the "moral compass/ passion phase space,"... because of John's advice or, equally as often, against it. Perhaps such a diversity of oscillating trajectories may be just what is needed to help push us towards positive changes for a more sustainable and just future, within the realm of the academy and beyond.

INTRODUCTION

It is a pleasure to contribute to this compilation in honor of John Vandermeer, his work, and the tremendous effect he has had on the lives of so many people as a mentor, collaborator, and friend.

In developing this piece, I originally set myself to the challenge of pulling off what we might call a "full Vandermeer." A full Vandermeer, of course, is discovering a new and elegant mathematical insight, describing it vividly and clearly, and then using it to demonstrate some larger, non-mathematical point of importance, often having to do with the futility, inhumanity, and destructiveness of capitalism. The current piece, with some charity, could be thought of as a half Vandermeer. In it, I will try to explain some of the mathematical concepts that John has used (and in some cases, developed), but which I will use mainly as metaphor. This is followed by a discussion of my own thoughts on the significance and potential of embracing both the naturalist's passion and the social activist's moral compass, as John has done over his storied career and pushed so many of us to do as well.

A little light math

This piece itself is an interesting recapitulation of my experiences as one of John's students. When I began working with him, I was a recovering engineer. John had been hoping that, as a trained engineer, I would have been really excited to work with him on the theoretical biology elements of his work, an obvious passion of his that he once joked to me, "I kind of do all of the other work I do to justify playing around with math." Unfortunately for him, I am not actually that passionate about math, although I frequently threaten to re-integrate it into my work. I have instead found my own balance of passion and moral compass along different lines. So, as far as the current piece is concerned, the closest I will come to the type of mathematical insight underlying a "full Vandermeer" will be coining the phrase "moral n-dimensional hypercompass."

To begin, let us pivot to the concepts of strange attractors and phase spaces, before we go on to use them in metaphor.

With regards to phase space, or more specifically, a phase plane we can see in Figure 1 from *Population Ecology: First Principles*, a textbook John co-wrote with his long-time colleague Deborah Goldberg. A phase plane shows how variables x and y correspond to each other over time. As can be seen both in the phase plane and in a graph of each variable as a time series, the systems in question show oscillatory behavior. As Figure 1's caption says, we can think of this as x representing prey and y representing predator, as with the famous example of lynx and hare population dynamics.

Examining the next two figures (2 and 3 from *Population Ecology*), we can see another way to think about attractors. They do, in fact, just what it says on the tin: they attract trajectories towards them. And so in these figures, we have a way to physically intuit the behaviors of attractors: they are a class of behaviors similar to a bowl (in this case, somewhat

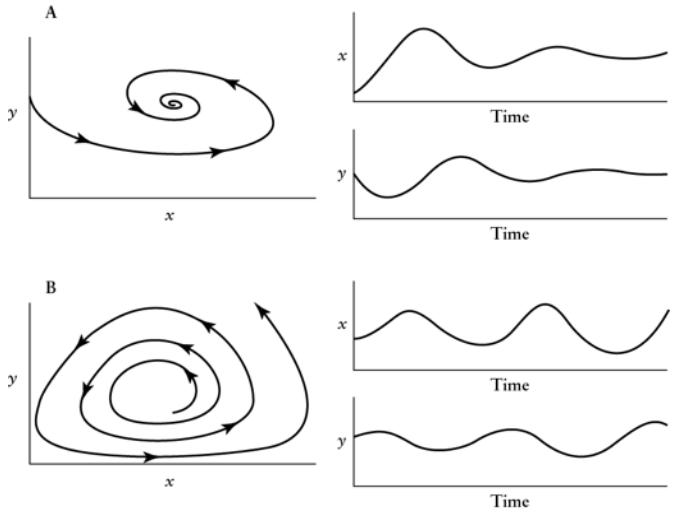


Figure 1.— Traditional representations of an oscillatory attractor (A) and an oscillatory repeller (B). x represents prey, and represents prey, and y represents predator. The graph of y versus x is the traditional "phase plane" diagram. The same data are plotted to the right as a time series in both variables. Vandermeer and Goldberg (2013)

oddly shaped bowl) with a marble circling around it. If a marble on the lip of the bowl were to wobble from the center of the lip, it would either fall off the edge or circle down into the bowl towards the inside trough. Similarly, if a marble placed on the inside peak deviated at all from the center of that peak, it would roll into the trough: the trough is an attractor. In this case, a periodic attractor, which is just to say if we observe the (frictionless) marble that has fallen down into it, it will continue circling around the trough, coming back to each point *periodically*.

As the saying goes, I told you that story to tell you this one:

A *strange* attractor has the same basic idea; imagine that we keep everything the same *except* that now the "floor" of the trough is flat. Our frictionless marble, rolling into the trough, will again circle around and around, but on the flat surface, it has the "freedom" to go any number of different places on the trough floor. You might not be able to predict where, between the slopes of the trough, it is at any given moment, but once it has rolled in the trough, you know it will always be rolling somewhere on that trough floor. Or as Vandermeer and Goldberg (2013) say, "Being a region that attracts all trajectories yet has no tendency within it to move to the center… it is thought to be rather strange. This is why it is referred to as a strange attractor, and the behavior of a system within it is referred to as chaotic."

From strange attractors to spatio-symbolism and civil rights

For some reason, reflecting on John's career and my many academic siblings who have also trained with him, I thought about the Lorenz attractor. This is even before I revisited a presentation where he explicitly mapped all of us into a phase space of "passion" and "moral compasses" (Vandermeer, 2011; see also Figure 4, 5). Even in John's original slide from his 2011 lecture (that is, without the Lorenz attractor superimposed), one can plausibly see a pattern in the way my siblings and I occupy different parts of the space. Over John's career, we have spun off in different directions, maybe even somewhat chaotically, as we followed our own passions and compasses into places that bear significant family resemblances, but also a number of differences. John's students have gone on professionally to work at liberal arts colleges, major research

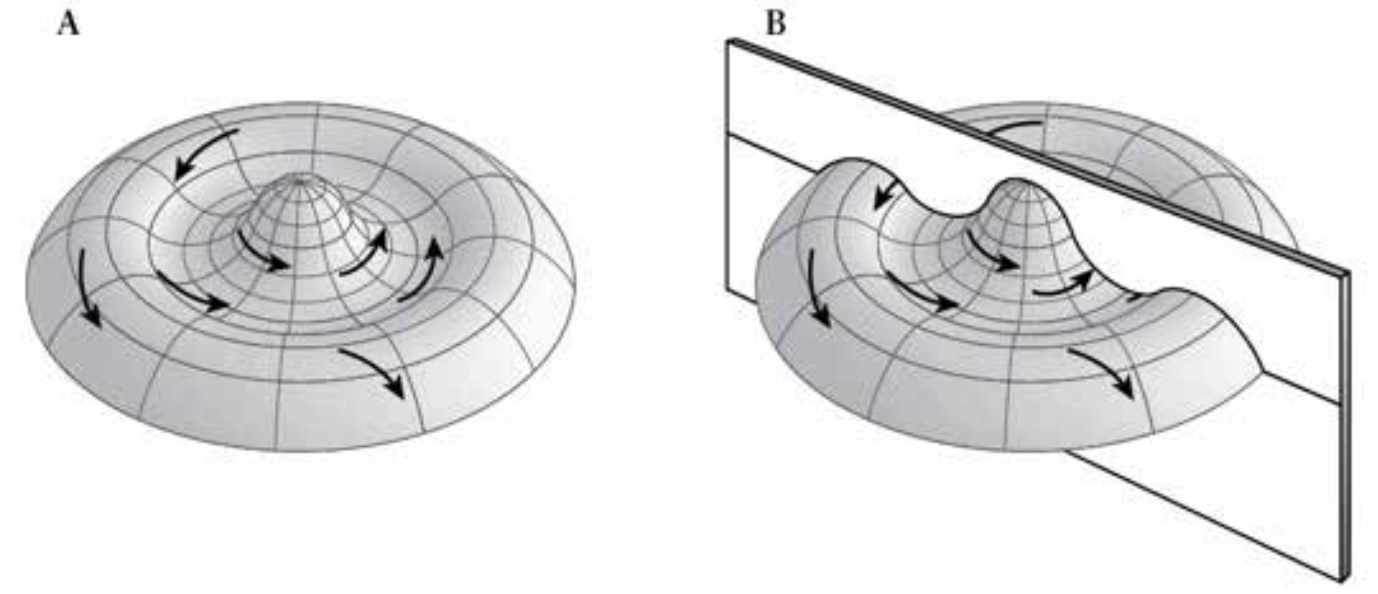


Figure 2.— Physical model illustrating a periodic attractor (limit cycle).

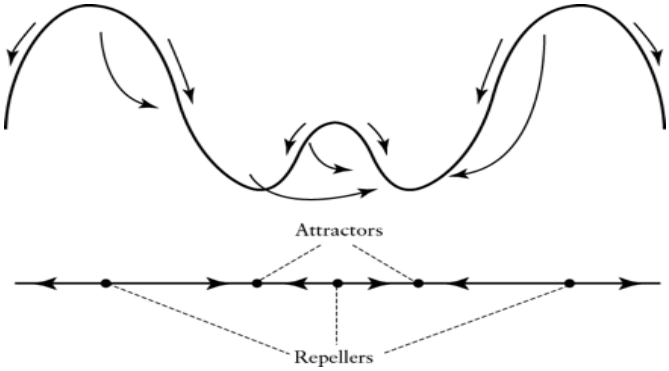


Figure 3.— Cross section (Poincaré section) through the surface of [Figure 2B], showing how the dynamics of the system can be illustrated. Vandermeer and Goldberg, 2013.

universities, community colleges, local universities and universities abroad, and into a plethora of NGOs. Some have ventured even beyond, going into government agencies and other areas off the typical Vandermeer-family concentration in NGOs and academia, in a sort of "here there be dragons" kind of way. Our family of chaotic trajectories is hardly surprising, as we each chose different routes guided by our own individual moral n-dimensional hypercompasses. Which is to say, there is of course no single "moral compass," and many different values always compete in any person's life, so our paths have diverged as often as they have converged, adding whole other axes to our moral compasses. Maybe it is no surprise that along the way, our paths may have come to resemble something like the classically strange Lorenz attractor.

One might consider the way that our different trajectories have evolved over time, in terms of the many different students John has influenced over the past decades. Additionally, given that strange attractors arise from behavior along at least two axes through time, one might also look and see that many of our careers have moved in similarly chaotic or strange ways within the space of one single person's career trajectory. Speaking from my own example, I went into graduate school being absolutely sure that I wanted to work in the nonprofit sector; I briefly considered running over to environmental law (which John concernedly talked me out of); and despite thinking I definitely wanted to avoid academia, I went on to a postdoc at Cornell University. This was followed by a tenure-track position at Washington State University … before I oscillated into a 2 ½ year trajectory at the nonprofit thinktank IATP (the Institute for Agriculture and Trade Policy), before oscillating back into academia at Coventry University's Centre for Agroecology, Water and Resilience. Various other "Perfectameer" alumni have undergone similar fluctuations. Finally, one could even think of fluctuation within the context of a career at a single institution; many Perfectameerkats have focused, sequentially or simultaneously, on writing, speaking, and agitating for issues most closely aligned with social justice. (Such issues included working conditions for students, support for unions, for protecting environment and fighting global climate change, against discrimination, for gender equality and feminism, against industrial agriculture, against war, and more). At other times, many of us have followed our passions into experiencing and writing about the elegance of theoretical ecology or the wonders of direct contact with the natural world.

In short, it is obvious that I have taken the idea of the cyclical but chaotic nature of strange attractors and definitively *ran* with it, stretching the power of metaphor to the breaking point. But to venture yet further in thinking about the mathematical parallels of John's career and influence, I would like to expand on the idea of symbolically combining space and time, to look at history itself as a metaphorical "space." This is not my own insight. In particular, I have been influenced by Zoe Trodd's "A Negative Utopia: Protest Memory and the Spatio-Symbolism of Civil Rights Literature and Photography" (2008). Although the detailed circumstances of today differ from those during the height of the U.S. Civil Rights' struggle, we of course face a large number of contemporary struggles, some new and some old. It does, in essence, feel like we are at an historical juncture (Wallerstein, 1999): a unique moment of possibility.

Of the historical juncture represented by the Civil Rights era, Trodd writes, "Fusing literal notions of space with figurative notions, Civil Rights activists, writers, and artists saw their battle in spatio-symbolic terms." Rather than "'our common understanding of space is that it is simply there, intangible but given,' we should instead consider space as an indicator of 'embedded ideologies,'", as Trodd quotes from historian Liam Kennedy. Although John has never explicitly claimed, to my knowledge, that space as (an indicator of) embedded ideology is a logical corollary to his analyses of Turing-type processes, metapopulation dynamics in agroecological landscapes and the like, neither does such an implication seem to be a huge leap. The links between John's mathematical conceptualizations of ecosystem dynamics and the spatio-symbolic roots of struggles for justice may be further seen in Trodd's references to bell hooks's "spaces of agency" (hooks, 1991) and, from Niethammer, the "cultivation of alternative forms of life in the margins and cavities of the system" (Niethammer, 1992, in Trodd, 2008). What has John's work in landscape ecology and with social movements such as Vía Campesina been but agitation for spaces of agency, change, and alternatives, both ecological and social? When he traces lines connecting the conservation implications of metapopulation theory to the decades of work by Dick Levins, and the insights of thinkers from Marx and Darwin to Anne Fausto-Sterling, Bunyan Bryant, Grace Lee Boggs, Peter Rosset, Hannah Wittman, or Annette Desmarais, the linked considerations of landscapes, history, and possibility strongly parallels the "reimagining" Trodd speaks of in terms of Civil Rights artists and activists. These figures used their approaches of spatio-symbolism to, in Trodd's terms, link "what is and what might have been."

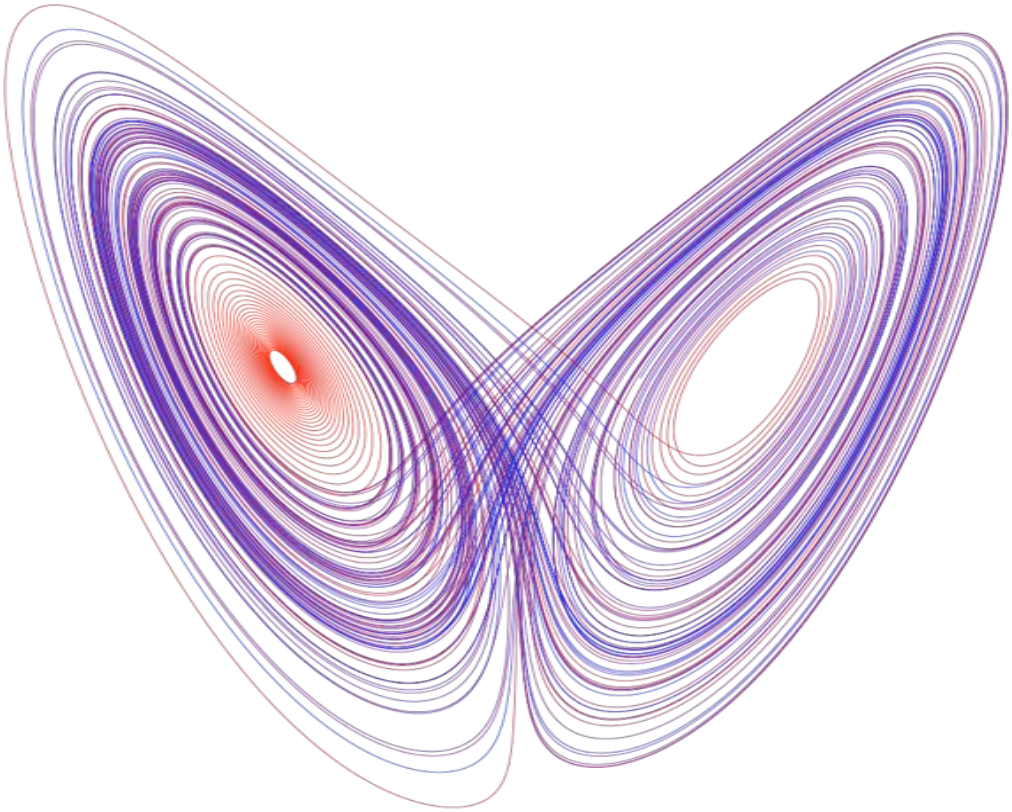


Figure 4.— A Lorenz attractor. Used under Creative Commons Licence from Dschwen.

Figure 5.— Lorenz attractor overlaid with slide depicting a "phase space" of Vandermeer students. Vandermeer (2011).

It is easy to imagine John reciting Ralph Ellison's incisive observations about the founding of the United States, as Trodd does, to the perhaps-impressionable students of Biology 101:

> At Philadelphia the Founding Fathers were presented the fleeting opportunity of mounting to the very peak of social possibility afforded by democracy. But after ascending to within a few yards of the summit they paused, finding the view to be one combining splendor with terror…So having climbed so heroically, they descended and laid the foundation for democracy at a less breathtaking altitude. (Ellison, 2003, 781)

Making new space and possibility in The Academy: The Extension of Everything

> In contrast to that wing of the New Left that saw universities as mere accomplices of imperialism and demanded that student activists 'shut it down,' the Red University idea was to open them up—to put resources in the hands of those who sought to end international war, abolish the ghettos, and make political democracy viable through participatory control of the economy. Younger Michigan faculty of the 1970s and 1980s (John Vandermeer, Ivette Perfecto, Tom Weisskopf, Cecilia Green, Buzz Alexander, Bunyan Bryant) stormed the barricades of a repressive elite Eurocentric culture believing that scholarship and social justice were compatible. In some cases, we (and our student and community allies) didn't just raise the Jolly Roger of defiance but assaulted the curriculum, priorities in hiring and admissions, and concerns about campus climate with the forward energy of a barreling freight train. Sit-ins, picket lines, teach-ins, building takeovers, demands for divestment, marches on the regents' meetings, petitions, fact-finding missions… debates, arrests for civil disobedience… and endless meetings were the alternative university we kept alive and is the one I will remember. (Wald, 2015)

Clearly, the "Founding Fathers" of the United States are not the only ones to have ever slunk away from the full liberatory implications of their philosophy to settle at seeking some degree of social justice at a "less breathtaking altitude." The university system has seen a similar lowering of ambition and betrayal of elements of its ideals, shrinking, and sinking, over recent decades, until the clinging, smoggy haze of the neoliberal valley has replaced the views from the highest peaks of academic ideals. (Though, as with the founding of the United States, those ideals took place against a set of classist presumptions.) Many of us who have worked with John have more than once imagined a university—one with vivid and varied shades of Red—that might have been, and might yet be.

As I've mentioned, there has been some element of oscillation, within and between the careers of John's many former students, from academia to NGOs and back again. Individual Perfectameerkats have sometimes focused on directly applying our moral compass around social change, and other times focused more on a passion for the beauties of abstract science, theory, and direct contact with nature. We have maintained joint loyalties to both aspects—bringing theory to bear and working with nature as we apply our moral compasses, or honoring a dedication to social justice through how we mentor our own students, who we mentor, and what we push for within our universities or NGOs. And as we can see with the revival of Science for the People, alongside the many years of the New World Agriculture and Ecology Group (NWAEG), the pushing for an alternate university continues. Though, as John commented in his keynote speech at the 2014 conference of the revived Science for the People, it is perhaps time for science *with* the people.

Thinking about what "science with the people" might look like is what led my colleague Garrett Graddy-Lovelace and I to conceptualize what we are calling "the Extension of Everything." Rather than shooting from trajectory to trajectory, I think quite a lot of scholars today (and in years past) wish to challenge academia to be a place where one does not have to cycle out of academia in order to cycle *into* work aligning with both our moral compass and our academic passions. This includes work that closely engages with communities, and that does so beyond the flawed "deficit model," where it is assumed we can advance society simply by "informing" them of science (or worse yet, a singular set of "the facts") (Besley and Nisbet, 2013; Groffman et al., 2010; Oreskes, 2004). While many studies "suggest that scientists tend to favor one-way communication with the public via the media, viewing engagement as chiefly about dissemination rather than dialogue" (Besley and Nisbet, 2013), the Extension of Everything seeks to create new deliberative spaces within the university, and between the university and other communities. It further proposes that the creation and flourishing of respectful, community-engaged spaces should be recognized and rewarded within the academic system as another form of the creation of scientific knowledge co-equal to traditional peer-reviewed literature, and the recognition of the knowledge of praxis as a valid academic pursuit.

We propose that such spaces have multiple benefits for academia, researchers, and communities beyond the university, besides a moral component of embodying a science and university for the people, rather than simply for reproducing privilege. For those of us concerned with change towards social justice and sustainability, we should remember not only the power of narratives to shape social change (e.g., Jones and McBeth, 2010), also the importance of relationships, and the knowledge engendered by simply *listening* (Prugh et al., 2000). For example, at the Institute for Agriculture and Trade Policy (my former organization), the "Rural Climate Dialogues" have literally seen participants beginning with the attitude of "What is this liberal kumbayaa," and ending with

gratitude and excitement for the process: "I came out of it a total winner as far as believing in global warming" (Ostrander, 2017) and "It's not been perfect, and it will not be perfect, but we can always make it better, and things like this are a start. Thank you for the opportunity" (Carlson and Chappell, 2015). As the second participant noted, deliberative processes are imperfect and rarely lead to universal agreement. But when done well and with respect, listening, and equality, they can lead to consent for action, even in the face of disagreement (Prugh et al., 2000).

The Extension of Everything proposes that real listening and deliberation—allowing and encouraging academics and members of the non-academic community to talk to each other *as people*—will not only help science better work *for* people, but can also generate real consent *from* people for the university. That is, as "new normals" for funding university science (Howard and Laird, 2013) take hold alongside the current context of declining government support for universities on a per-student basis (Daniels, 2016; Mitchell et al., 2017), deep democratic deliberation with citizens offers academia and academics a chance to argue for public support as a comrade-in-arms of the people, rather than as elites yelling down from the Ivory Tower. Extension of Everything argues that we can no longer afford (if we ever could) the kinds of attitudes that greet community-engaged scholars: "That's nice, but where's the peer-reviewed paper?" For example, at one institution I had the experience where many members of the local community—including the local NAACP chapter, union leaders, and indigenous groups—pointed to a specific report as having been the most valuable work the university had produced for the community. (Our branch of the institution was meant to specifically serve members of the regional community.) At the same time, the university administration was questioning the value of the university center that had sponsored the report, and expressed ambivalence about promoting the report's author to full professor, since one of their major works (the report) was not formally peer-reviewed. Similarly, in my work with the local community, people literally gasped when I told them that the work we were doing together would only "count" should it result in a peer-reviewed paper. Actually improving the lives of the local community and generating co-produced knowledge was nice and all, but it was clearly and expressly of the lowest priority when it came to professional evaluation. With such an attitude, how can we be surprised at declining public support for higher education? And while chained to such an ethos, how can we ask new, young, and precarious researchers to take a gamble on participatory research? Today's academia pushes chiefly to reproduce its own flawed model, valuing producing papers analyzing the methods and value of social change, while undermining one of the few spaces where thoughtful change and the science of practicing change might be thoroughly and freely explored. Who has time to *listen* to people when we need to be publishing about them?

At this point, in conversations about the Extension of Everything, the question often arises: But how would you evaluate academics if peer-review is not the ultimate standard? This gets to the reason for the name, the *Extension* of Everything. There is, in fact, a model for evaluating scientists beyond peer review: agricultural extension. Land-grant universities in the United States have been conducting extension for decades and have, unsurprisingly, indeed found ways to evaluate extension work. Washington State University's *Tenure and Promotion Criteria For Extension Program Unit Faculty* lays out Criteria for Extension Faculty, including, "Demonstrates the capacity to identify significant problems or issues faced by target audiences, and utilizes the research capacity of WSU and other institutions to address these problems"; "Employs an appropriate program design and methods to effectively reach intended and diverse audiences"; and "Actively engages with stakeholders (e.g., industry groups, commodity groups, consumers, private firms, agencies) and others (e.g., county-based faculty, researchers) in this planning process." Correspondingly, criteria for delivering extension programs include making "major contributions in addressing relevant issues and problems facing target audiences, and should demonstrate value for the public good." In judging outcomes, "Extension programs should include a rigorous assessment of outcomes, including behavioral change of participants and industry, economic impacts, environmental impacts, etc." and "Program outcomes … should qualitatively and/or quantitatively report the impact of a faculty member's work." Ultimately, "Promotion of non-tenure-track faculty is largely dependent on documented evidence of Extension publications and creative work; achieving programmatic outcomes; and demonstrating professional conduct similar to tenure-track faculty; but without the expectation of peer reviewed professional journal scholarship associated with tenure-track positions." Cornell University, for its part, includes in its review process for tenure that, "Evidence of service to the community, the department, the college, and the university is compiled. Letters are solicited from colleagues in the university and from outside experts to provide an evaluation of the quality of the candidate's creative work and its impact on the scholarship of the field." Although Cornell University's Faculty Handbook also makes clear that employees working as extension and senior extension associates are *not* members of the University Faculty, there is, of course, no particular reason—outside of tradition—that they couldn't be. There is no particular reason that joint research/extension appointments could not be made more commonly, or that extension could not be regularly considered to be one possible line of tenure-track progress in *every* field.

We propose that the science, scholarship, and creativity of community-oriented praxis can be embraced and supported in any field. Why not make it a matter of course that a math professor who focuses on developing mathematical approaches that are useful to the local community, or on math education, could equally belong to a math department as to an

education department? Or as part of a broadened Extension organization within any university? A number of universities have instituted "Professors of Practice," but this is often still a non-tenure-track position, and of course is already separated from an uninflected *Professor*. But is there any *compelling* reason that it must be this way? Interestingly, tenure-track faculty members in certain fields (or with very understanding colleagues) might get professional credit for publishing an exegesis of their participation in "Sit-ins, picket lines, teach-ins, building takeovers, demands for divestment, marches on the regents' meetings, petitions, fact-finding missions" (Wald, 2015) in a peer-reviewed journal. Yet other forms of peer review are possible. At Washington State University, "Peer-reviewed Extension Publications" include accessible "factsheets, manuals, technical bulletins, and curricula that are published by WSU Extension or another institutional publisher." Such work is still "validated through a formal, blind peer-review process." More radically yet, at a session on public intellectuals at a recent meeting of the American Association of Geographers, two senior faculty members seated next to me explained how they got tenure for a colleague who had focused on participatory, community-based work: "The faculty manual says that you must produce high quality, peer-reviewed work in order to be granted tenure. It does not," they pointed out, "define who a 'peer' is." They (apparently successfully) made the argument that the members of the community the faculty member worked with were, in fact, one form of peers. Having solicited formal feedback from the community, who were very positive about the work of the faculty member, they were able to prove that the faculty member had in fact produced high quality, peer-reviewed work. It is further worth appreciating, for one moment, a certain irony: when research is deeply involved with practice, it becomes possible in some cases to actually observe whether the relevant dynamics behave as predicted. Said another way: when you work with *praxis*, at least some of the time, you are able to see your theory disproved by reality unfolding in front of you, and the reactions and feedback of other people involved in practice. Meanwhile, theory about applied systems in a peer-reviewed journal may never actually be exposed to the cold light of reality; it is enough that theoretically, a given theory will work in practice. Or as the economist asks in the old joke, "That works in practice, but does it work in theory?" Why not create a university where both answers have value?

To be clear, the extension model as practiced has been far from perfect and has many elements that have extended a paternalistic, top-down, diffusion/deficit-model approach to working with farmers (see Danbom, 1986; Norman, 2015). But in terms of alternative models, in some ways, another world is already here: Gilbert (2016) and Harwood (2013), among many others, have established that other models have occasionally flourished in the past; Ostrom et al., (2010), Samberg (2016) and Zhang et al., (2016) give just a taste of some of the many alternative models in the present. To say nothing of the work by any number of NWAEGies in the spirit of Science For and With The People, including Marcia Ishii-Eiteman, Ginger Nickerson, Bruce Ferguson, Helda Morales, and Peter Rosset, who all have worked in various ways to combine the practices and philosophy of agroecology with the liberatory demands of food sovereignty. And the idea of treating communities as one group of peers who may evaluate academic work directly has a number of interesting implications—some may be uncomfortable, some even may be unfortunate, but the same certainly can be said of current peer-review practices! We propose that adding a formal place for input encompassing "Was the research partnership respectful? Did the research/extension accomplish something relevant to your life? Did the possibilities and practices in your community change? Was something built that was more sustainable?" poses many challenges, but at least as many potential rewards.

The Extension of Everything does not propose that it should become the entire model of academia. But it does propose moving to a regime where it is *a* model that exists, and is valued, in academia: a model this is equally valued as one path on the tenure-track, that not everyone has to do, or wants to do. But for those of us who have been around several loops of the passion and moral compass dynamic system, and for the students of today who already want to be part of a different kind of university, such a model could provide a place for our attraction to strange mixtures of passion and morality.

Listen here

The potential power of a more open university, where the Extension of Everything allows for listening, science in practice, relationship- and trust-building, can be seen in some of the recent literature of opinion change: "Existing research depicts intergroup prejudices as deeply ingrained, requiring intense intervention to lastingly reduce. Here, we show that a single approximately 10-minute conversation encouraging actively taking the perspective of others can markedly reduce prejudice for at least 3 months [the length of the study]" (Broockman and Kalla, 2016). "The intervention," they note, "also increased support for a nondiscrimination law, even after exposing voters to counterarguments." On the website *Fivethirtyeight.com*, science reporters Christie Aschwanden and Maggie Koerth-Baker (2016) commented that Broockman and Kalla's technique was:

> structured more like a Socratic dialogue and can take as long as 20 minutes to get through and on average lasts 10 minutes. Canvassers are aiming for a conversation, in which they ask questions and the subject gets to talk. They don't tell people ahead of time what conclusion they want to reach. There's no sermon built in. The goal is that, by the end, subjects will have built up empathy with a group of people different from themselves.

The prejudice in question was transphobia; the intervention

appeared to increase positive feelings about transgender people by an average of 10 points on a 100-point "feeling thermometer," which they note is larger than the average decrease in homophobia among Americans between 1998 and 2012.

University of Michigan's James E. Crowfoot Collegiate Professor Dorceta Taylor came at similar issues of listening from the point of view of participatory research at the 2015 University of Michigan-hosted Food Sovereignty Conference, *Local Struggles, Global Movement*. Speaking of working with community members in Detroit, she stated, "I work with them for one, two, three years before I begin to think about papers to write." This is because, she said, those first couple years when they were talking to her, they weren't trying to give her data, and their information wasn't for a paper. Those conversations were about getting to know each other and about talking to a person and building trust. For this reason, Taylor said, "I dare you, I dare you not to publish for three years when you're working with a community." Coming from a tenured professor, Dr. Taylor's comments may somewhat underplay the challenges of this stance for more junior academics. Taking such a position may not often be viable in our current academic systems. But to me that simply speaks of a need to change the academic system: the time is right for a regime shift.

Regime changes

The chaotic trajectories of John's many students, not to mention the many stresses and manifestations of chaos seen throughout the current Western academic regime, brings to mind yet another mathematical parallel: Schmallhausen's Law. I saw the late Dick Levins present on this at a meeting of the American Public Health Association (Levins, 2006). This presentation, incidentally, was to set the pattern for my own encounters with Dick, whose moral compass and passion had a profound effect on John Vandermeer, amongst many others. I had the privilege of running in to Dick every couple years or so. At each encounter he would casually make an observation that majorly reshaped some aspect of my understanding of the world. (And I'm fairly sure I'm not the only one who has had this experience.) His 2006 presentation on Schmallhausen's Law was no different (though he and Dick Lewontin had previously published on it in 2000). From his abstract:

> [Within a population] increased vulnerability is seen in greater variability of outcomes in response to even trivial differences of circumstance, making the variability an object of interest in its own right and not just a tool for estimating mean values. Resilience and resistance to stressors erode during a lifetime of coping, more rapidly in populations that are closer to their boundaries. Geographic variability of outcomes depend on the variability of exposure and the resources for resistance and response. The relative risk matrix and spectra are introduced as tools for examining patterns of vulnerability and focus on the strengthening of resistance and resilience as strategy for health improvement.

Dick tied this observation to the stress and coping placed on the disadvantaged, the discriminated-against and the poor in capitalist systems. As the abstract says, we may think of the Law and its concepts as tools for improving the resilience and resistance of those on the precarious "business end" of capitalism. But one might also think of *capitalism* as the system under stress and seeing, right now, significant variability around means values—be that GDP growth, inequality, environmental devastation, employment, or voting behavior amongst capitalist powers. So in the variations seen in capitalism, and the increasingly neoliberal variances in universities, we might also be seeing a system under stress and thus *at a low point in resilience, and ripe for change*. If this is accurate, it will certainly not be the first time, and possibly not the last time that larger capitalist structures are approaching a shift in regime. Here we can see again the parallels with concepts from the Civil Rights era, as elaborated by Trodd and her evocation of Ralph Ellison: "In 1964, Ellison imagined history executing a spiral 'returning at a later point in time to an earlier point in historical space' (*Essays*, 567)." Or as the saying goes, "history doesn't repeat itself, but it rhymes."

One key point to take from this, I believe, is that unfulfilled opportunities for regime shift should not necessarily be taken for failure. In some chaotic systems, you can get arbitrarily close to shifting regimes before swinging away from a border again. But this oscillation away does not mean the opportunity will not return, nor that shifting regimes is impossible—much to the contrary. So in the rhymes of history—be it echoes from Harpers' Ferry to the Civil War and abolition, to Civil Rights and desegregation, to today's tense times, or the feeling of radical opportunities for reshaping the university, in the 1970s or today—we should not necessarily see failure where our aspirations were not realized. We should always be reflexive, of course, and strive to do better, but the implication of the mathematical metaphor is that sometimes failure is just the dynamics of a system; sometimes random things happen. In ecology, we understand this (or at least accept that it happens). Socially, we may sometimes heap too much blame on ourselves when the change that we see as so desperately needed does not happen *right then*. Which again, is not to say that we don't need to learn from our previous experiences. Rather, when it comes back 'round again and we feel like we're at another historical juncture, we should seek fewer recriminations along the lines of "Ah, god, we tried to change it last time and it didn't work", and look at it more as a new opportunity, a parallel point in the trajectory where it might feel like we're going to go around in circles forever, but where at any point, our actions might be the push that jumps us to a whole different lobe—a different regime of behavior—in the overall space of the system.

Final remarks

These ideas are, obviously, still under development. And despite the fact that John might not agree with all of it (or maybe would agree with it if I expressed it differently), I owe much of this thinking to his mentorship and personal and professional guidance. I am tremendously in debt to him and incredibly fortunate to have had him as my advisor.

John has often said that he views his former students as his children—"I'm sorry, but I really do"—and I'm fond of saying that one's advisor is both your parent and your child. That is to say, one has a lot to learn from their wisdom and experience, and so it is always well-advised to listen carefully to what they have to say. But at the same time, you also need to know how to handle them when they're having a tantrum, or are trying to bluff their way through not having done some of their homework. As someone who has been an advisor, I very much include myself in this characterization. But perhaps the core of this idea is that the student-advisor relationship is unique, a sort of abbreviated childhood, where you rapidly go from babe in the woods to a peer: teaching each other and appreciating each other's insights. In this way, I'm incredibly proud to have been one of John's mentees and to be part of this family—a family, I think, in which we all teach AND learn from each other, following in a pattern of leadership alongside the humility necessary to appreciate and admire the wisdom of others.

Working with John was my entry into the strange state space of one's passions for theory and nature and moral compass for social analysis and change. I very much believe that people acting in this space will be a part of positive changes to come. So although I do not believe in the "Great Person" theory of history, where one person is the fulcrum for change (see Watts, 2011), I do believe that People and communities can be Great together and accomplish deep regime change. In these terms, John truly is *one* great person who has helped to build a great community. It is a community that I am honored to be part of.

REFERENCES

Aschwanden, C., and Koerth-Baker, M. (2016). How Two Grad Students Uncovered An Apparent Fraud—And A Way To Change Opinions On Transgender Rights. *Fivethirtyeight.com*. Retrieved from https://fivethirtyeight.com/features/how-two-grad-students-uncovered-michael-lacour-fraud-and-a-way-to-change-opinions-on-transgender-rights/

Besley, J. C., and Nisbet, M. (2013). How scientists view the public, the media and the political process. *Public Understanding of Science, 22*(6), 644–659. doi:10.1177/0963662511418743

Broockman, D., and Kalla, J. (2016). Durably reducing transphobia: A field experiment on door-to-door canvassing. *Science, 352*(6282), 220.

Carlson, J., and Chappell, M. J. (2015). *Deepening Food Democracy*. Retrieved from Minneapolis: http://www.iatp.org/files/2015_01_06_Agrodemocracy_JC_JC_f_0.pdf

Danbom, D. B. (1986). Publicly Sponsored Agricultural Research in the United States from an Historical Perspective. In K. A. Dahlberg (Ed.), *New Directions for Agriculture and Agricultural Research* (pp. 107–131). Totowa, NJ: Rowman and Allanheld.

Daniels, R. J. (2016). Free the Public Universities. *The Chronicle of Higher Education*. Retrieved from https://www.chronicle.com/article/Free-the-Public-Universities/236372

Ellison, R. (2003). *The Collected Essays of Ralph Ellison*. New York: Modern Library.

Gilbert, J. (2016). *Planning Democracy: Agrarian Intellectuals and the Intended New Deal*. New Haven: Yale University Press.

Groffman, P. M., Stylinski, C., Nisbet, M. C., and et al. (2010). Restarting the conversation: Challenges at the interface between ecology and society. *Frontiers in Ecology and the Environment, 8*(6), 284–291. doi:10.1890/090160

Harwood, J. (2013). Has the Green Revolution been a Cumulative Learning Process? *Third World Quarterly, 34*(3), 397–404. doi:10.1080/01436597.2013.784599

hooks, b. (1991). Choosing the margin as a space of radical openness. In b. hooks (Ed.), *Yearning: Race, Gender and Cultural Politics* (pp. 145–153). New York: Turnaround Press.

Howard, D. J., and Laird, F. N. (2013). The New Normal in Funding University Science. *Issues in Science and Technology, 30*(1), 71–76.

Jones, M. D., and McBeth, M. K. (2010). A Narrative Policy Framework: Clear Enough to Be Wrong? *Policy Studies Journal, 38*(2), 329–353. doi:10.1111/j.1541-0072.2010.00364.x

Kennedy, L. (2000). *Race and Urban Space in Contemporary American Culture*. Chicago: Fitzroy Dearborn.

Levins, R. (2006). *Schmallhausen's Law and the relative risk matrix.* Paper presented at the The 134th Annual Meeting & Exposition of the American Public Health Association, Boston. https://apha.confex.com/apha/134am/techprogram/paper_138609.htm

Lewontin, R., and Levins, R. (2000). Schmallhausen's law. *Capitalism Nature Socialism, 11*(4), 103–108. doi:10.1080/10455750009358943

Mitchell, M., Leachman, M., and Masterson, K. (2017). *A Lost Decade in Higher Education Funding*. Retrieved from https://www.cbpp.org/research/state-budget-and-tax/a-lost-decade-in-higher-education-funding

Niethammer, L. (1992). *Posthistoire: Has History Come to an End?* New York: Verso.

Norman, D. (2015). Transitioning from paternalism to empowerment of farmers in low-income countries: Farming components to systems. *Journal of Integrative Agriculture, 14*(8), 1490–1499. doi:https://doi.org/10.1016/S2095-3119(15)61041-3

Oreskes, N. (2004). Science and public policy: What's proof got to do with it? *Environmental Science & Policy, 7*(5), 369–383. doi:10.1016/j.envsci.2004.06.002

Ostrander, M. (2017). Talking About Climate Change in Trump Country. *Sierra*. Retrieved from https://www.sierraclub.org/sierra/2018-1-january-february/feature/talking-about-climate-change-trump-country

Ostrom, M., Cha, B., and Flores, M. (2010). Creating Access to Land Grant Resources for Multicultural and Disadvantaged Farmers. *Journal of Agriculture, Food Systems, and Community Development, 1*(1), 17. doi:10.5304/jafscd.2010.011.011

Prugh, T., Costanza, R., and Daly, H. E. (2000). *The Local Politics of Global Sustainability*. Washington, D.C.: Island Press.

Samberg, L. H. (2016). A collaboration worth its weight in grain. *Nature, 537*, 624. doi:10.1038/nature19431

Trodd, Z. (2008). A negative utopia: Protest memory and the spatio-symbolism of Civil Rights literature and photography. *African American Review, 42*(1), 25–40.

Vandermeer, J. H. (2011). Ecological complexity and the struggle for a new agriculture. (available at http://leccap.engin.umich.edu/leccap/viewer/r/hWDZtv). Ann Arbor, MI: Regents of the University of Michigan.

Vandermeer, J. H. (2014). *Mentoring Comrades: The Dialectics of Political Mentoring in the Natural Sciences*. Paper presented at the Science for the People: The 1970s and Today, Amhert, MA. http://science-for-the-people.org/keynote-lecture-john-vandermeer-with-video/

Vandermeer, J. H., and Goldberg, D. E. (2013). *Population Ecology: First Principles*. Princeton, NJ: Princeton University Press.

Wald, A. (2015). The Present of Future Things. In H. Brick, R. Lieberman, and P. Rabinowitz (Eds.), *Lineages of the Literary Left: Essays in Honor of Alan M. Wald*. Ann Arbor, MI: Michigan Publishing, University of Michigan Library.

Wallerstein, I. (1999). *Utopistics: Or, Historical Choices of the Twenty-First Century*. New York: The New Press.

Watts, D. (2011). What Are Leaders Really For? *Harvard Business Review, November 11*.

Zhang, W., Cao, G., Li, X., Zhang, H., Wang, C., Liu, Q., Dou, Z. (2016). Closing yield gaps in China by empowering smallholder farmers. *Nature, 537*, 671. doi:10.1038/nature19368

SCIENCE AND THE FARM LABOR MOVEMENT

By
Margaret Reeves, Ph.D. 1991

At the Pesticide Action Network (PAN) we work to expose the undue influence of pesticide, biotech, and agribusiness corporations in dictating how we grow food, with places the health and economic burdens of pesticide use on farmers, farmworkers, rural communities, and consumers. We work with those on the frontlines to tackle the pesticide problem and reclaim the future of food and farming.

My work with farmworkers began as a recent UM graduate in the early 1980s, when I joined the support group of the Toledo-based Farm Labor Organizing Committee (FLOC). At that time the FLOC support group was one of the largest and most progressive student organizations. At its core were leaders of the Ann Arbor Science for the People collective (SftP) and NWAG. When not driving around rural Ohio mapping locations of tomato fields as targets for FLOC strikes, NWAGies were conducting field experiments, in consultation with FLOC, designed to demonstrate the viability of integrated pest management (IPM) strategies as a means to reduce pesticide use and exposure among farmworkers.

Seeing how John's graduate students' research (and activism) was directly linked to the farmworker movement, I saw reason and direction for my own continued studies at the UM. With a focus on soil ecology rather than insect ecology, I took a similar path to research and subsequent work in Central America, as did many fellow NWAEGies. It was several years later, from a teaching position in Costa Rica, that I was recruited to the staff scientist position at PAN—in no small part due to the fact that at least two NWAEGies were members of the PAN Board of Directors.

Our work at PAN has served farmworker interests in many ways. We have worked with farmworker communities to document exposure to airborne pesticides by conducting both air monitoring and biomonitoring studies that include training community members to use PAN's "Driftcatcher" air monitoring device. Community members, thus empowered have used their data to successfully argue for greater protections from pesticide exposure through improved regulations of pesticide use in various California at county and state level. Those community-derived data also played a crucial role in United States. EPA's decisions to formally recognize and regulate both spray drift as well as volatilization drift. Most recently, the EPA announced the proposed cancellation of all food crop uses of the neurotoxic insecticide chlorpyrifos—the target pesticide of our 2006 biomonitoring study. Those same data, together with research at UC Berkeley, Columbia, and Mt Sinai, played a key role as well in last year's successful end to a 15-year campaign to improve the federal Worker Protection Standard—the only regulations designed to protect farmworkers and their families from exposure to agricultural pesticides.

Since PAN's beginning in 1982 we've worked in close collaboration with farmworker organizations from the major unions; the United Farm Workers (UFW), FLOC, Pineros y Campesinos Unidos del Noroeste (PCUN), and other organizations including the Farmworker Association of Florida. I'm happy to report that those relationships remain as strong as ever. For the past five years I have been deeply engaged as partner in a farmworker-initiated marketplace endeavor, explicitly requiring application of IPM in industrial-scale produce production throughout the U.S. and beyond. The Equitable Food Initiative (EFI) promises not only greater protections from pesticide exposure among hundreds of thousands of farmworkers. It also provides for all the elements of a collective bargaining labor agreement to be verified by third-party auditors and ensured through a process of on-farm workforce development, providing voice and agency to farmworkers at a scale not yet seen in agriculture anywhere.

To end; I really, truly owe a lot to John for his mentorship and camaraderie, without which I would not have ended up where I am. And I owe a lot to the many comrades in SftP and NWAEG that collectively influenced John and were influenced by his brilliance, commitment, and tireless ability to remain incredibly productive on such little sleep! Yes, it's true John – we'll all soon be sleeping for a really long time, so why waste time doing it now!

Thanks John!

A John anecdote:

In August 2014, NWAEG West hosted the annual NWAEG meeting in the Bay Area. The preceding February, ostensibly to plan the annual meeting agenda, we organized a NWAEG west meeting—one of only two or three in the past 20 years. Over a period of an hour, about 15 comrades trickled in to the PAN office in Oakland, each taking several minutes to update old friends on their personal histories of the past two to three decades. Invariably, as each person spoke, including latecomers who had not heard others' reports, one common theme emerged—John. John as mentor, comrade, hub of NWAEG Ann Arbor, and Science for the People; John at the vanguard of campus activism, from supporting farmworkers at FLOC and their Campbell's Soup boycott, to Central America solidarity work. When the planning meeting ended, my PAN colleague Emily Marquez quipped, "Who is this John person?"

BIO 101: BIOLOGY AND HUMAN AFFAIRS

By
Phillis Engelbert

I was a teaching assistant for Bio 101 in 1986. It's hard to imagine where the 30 years has gone–it feels like yesterday. But back in 1986, the campus was alive with activism around Central America, South Africa, homelessness, racism, sexual assault prevention, gay rights, and more. Bio 101 was an incubator for those ideas and John's lab was a command center. Over the years, campus activism has ebbed and flowed, but Bio 101 has remained, raising important ideas and giving questioning students the confidence to fight for what's right.

Bio 101, or Commie Bio as we affectionately called it, may well be the most impactful survey class ever taught at the university. The course has spanned decades and has shaped thousands of young minds. The brilliance of Bio 101 is that it attracts biology and non-biology majors alike. It satisfies a science credit for students who fear the hard sciences. They sign up for the course and thus unknowingly enter the zone of critical thinking. And many emerge changed. After taking Bio 101 they view the world a little differently. Some may even re-think their values and reconsider their career choices.

I'll never forget one student in my section. A hard-right Republican, he questioned and argued his way through every class. But somewhere toward the end of the semester, possibly after watching a film about the murder of the American nuns in El Salvador, he wrote a paper titled, "Maybe I'm wrong." I have to admit, I was a little disappointed. I missed his playing the foil in class, always giving the other students something to react to.

But as much impact as the class had on the students taking it, the effect was greater on those teaching it. Personally, I can think of no greater influence on my life and on my work than my semesters as a Bio 101 teaching assistant. What I learned from teaching my section, and especially from T.A. discussions around the big wooden table in John's lab, was how to be fearless. When you combine knowledge of injustice with fearlessness, and share that experience with a group of brilliant thinkers, you become equipped with the tools to make serious change. And you recognize your responsibility to get out and do it.

Would all the former and current Bio 101 TAs and GSIs please stand? The opportunity you provided us with, John, was nothing short of incredible. I believe I speak for all of us when I say thank you.

THOUGHTS ON JOHN VANDERMEER

By
Chela Vázquez

I met John Vandermeer in 1985 at a Tropical Agroecology course in Costa Rica offered by the Organization of Tropical Studies. The course, coordinated by Steve Gliessman from the University of Santa Cruz, California, was a mobile educational experience where we observed small-scale organic agriculture as well as large-scale agribusiness. The course exposed students to small-scale farming and farmers in the Global South and to philosophical thinking in science.

John Vandermeer taught one module and had a lasting impression on me. I was drawn to his rationale of doing science with a philosophical and political stance that was avant-garde. His clarity on explaining his research and his political-philosophical thinking attracted me from the start. At that time, John and his students were doing research in Nicaragua on agroecology and were working with small farmers. They had gone to Nicaragua after they had taken a decision to support the country following the revolution that overthrew Somoza.

For me, it was the first time I studied agroecology and the first time I heard scientists talk about science and research from a perspective of social, economic, and environmental justice. Since my years as a College student in Ecuador, student researcher in the Galápagos Islands, and later in the U.S., I was used to scientists who were focused largely on their research field and who tended to be conservative in their social thinking.

Talking with John Vandermeer made me aware that I could combine my passion for social and environmental justice with my interest in science. After I went back to OSU, where I attended graduate school, I became a regular attendant of the annual meetings of the New World Agriculture and Ecology Group (NWAEG), a group of scholars, students, and activists born out of John Vandermeer's lab discussions with his students at the University of Michigan. The annual NWAEG discussions brought together progressive scientists and students from all over the U.S.

NWAEG offered opportunities to meet and talk with great revolutionary thinkers, such as Richard Levins, from whom I have remarkable memories from his talks, conversations, and writings. The list of progressive scientists and activists in NWAEG that have made an impact and continue to raise waves in the world is long and would require more space to name them...

Thanks to John Vandermeer and NWAEG for offering this space where avant-garde thoughts and ideas are abundantly shared.

Chela Vázquez

LESSONS LEARNED: A TRIBUTE TO JOHN VANDERMEER

By
Bill Durham, PhD '77

I'd like to offer a simple tribute called, "Lessons I learned from John." There's an academic/professorial slant to these lessons, I grant you. But even if you are not an academic, I hope you will recognize John here, and find some value in this list.

Lesson #1: Master the basics in your chosen intellectual field, so that no one can say that your science is "weak" or that you are "not a scientist." Degrees and letters after your name mean very little, honestly: you really must know the basics inside and out. The basics include definitions, key theoretical principles, classic studies by others in the area, and certainly John would advise you to know the pertinent equations!

#2: Think through the social implications of what you do. As you focus in on what you care about and what excites you, consider its social, political, and economic implications. Ask yourself, how can this topic or research build a better world? How can it help to change the status quo on race, gender, class, and inequality? How can it help the poor and marginalized? How does it promote social justice?

#3: Be really good at what you do, but don't do it alone. If you are really good at what you do, people will give you more latitude, more slack. At the same time, always remember that you need friends and allies. No matter how well you start out, you can't get very far alone. You will always need friends and allies to make things happen.

#4: Put effort into your community. Find one to join or build your own. Saving the world alone never works. In your community, take time to listen: remember that listening is an act of love. Give and take criticism as a way of showing that you care. Work against being an "uptight professional" (one of John's favorite expressions back when): cultivate ways of having fun, letting loose, being wacky. Drinking a beer never hurts.

#5: Make sure you do some fieldwork every year. No hiding in the ivory tower: get your boots dirty at least once a year! The real test of theory is not in seminars and classrooms; it's out in the world. Fieldwork doesn't have to be long and complicated, but do include students and friends in what you are doing. *Fieldwork is life's best classroom.*

#6: Live and work in the field with local and indigenous people. You've already heard enough from elites and powerful people. Walk and talk with humble folks when you do your fieldwork. Practice "participant observation" and show that you are humble, too. Eat grungy chicken and drink local ponche. Hang out in the pulperia. Make it reciprocal: invite people to ask *you* questions, too. And above all, respect their local wisdom and "funds of knowledge;" you'll be amazed at how much they know!

#7: Coevolve your science and your politics in a mindful way. This is a favorite thing I learned from John. Join organizations or start organizations that share your vision. When you publicly engage in criticism or disagreement with others, make sure you are not alone. Meanwhile, be your own toughest critic: make it hard for your enemies to strike back. Anticipate their counter-critique and know in advance how you will respond.

#8: Teaching is fun: get past any fear you may have. Know the material well enough so you can relax and enjoy it. Work it without notes! Never ever read your lectures–it kills them. Set a high standard: ask a decent, fair amount from your class. And then listen to what students say; their feedback will help you improve. Don't be afraid to socialize with your students: have a coffee, drink a beer, sit on the floor with them.

#9: Encourage your students, when ready, to do their own thing. Do your best to get students going: teach them the ropes, give them the background and tools they'll need, and then let 'em do their thing. Support their creativity honestly and candidly: tell them if and when you disagree, even though it may be difficult. John has always been really good about saying, "Well, Bill, that's a great idea, but here's something else to think about …" Above all, *encourage independent thinking.*

#10: Don't worry about perfection. It's an imperfect world anyway. Do the best you can with reasonable effort, and then don't fret. Move on, let it be. If you do need help, ask for it. Allow others to help you just as you help them. It's all part of being in your community.

These are 10 lessons I learned from John that have been so very helpful to me. Please add what you, too, learned from John to this list. I hope you'll join me in saying …

THANKS JOHN, FOR ALL YOUR AWESOME LESSONS!

Bill

UNDERSTANDING, CONSERVING, AND MANAGING BIODIVERSITY

BIODIVERSITY, SUSTAINABILITY, AND ECOSYSTEM SERVICES IN URBAN AGRICULTURAL LANDSCAPES:A TRIBUTE TO JOHN VANDERMEER

By

Stacy M. Philpott (University of California Santa Cruz)
Shalene Jha (University of Texas)
Heidi Liere (Reed College)
Brenda B. Lin (CSIRO)

INTRODUCTION

Most of the United States population lives in urban areas, yet many residents lack sufficient access to fresh produce and nutrition. In response, urban agriculture has expanded dramatically, especially in under-served communities, and currently provides >15% of the global food supply. Yet, gardeners lack appropriate agricultural knowledge regarding pest control, pollination, water storage, and garden sustainability. In our USDA-funded research, we are aiming to determine the natural resources and production practices most essential for the sustained long-term production of crops and ecosystem services (e.g., pollination, pest control, water conservation, and food access) within urban agricultural systems. But the real story here is how we got to this point, and how John Vandermeer provided us with the skills and energy to make this happen. We trace our development as scientists, as researchers, and colleagues, starting with our participation in formative activities in Michigan and Nicaragua, development of our dissertation research in Mexico, and our ongoing commitment to asking innovative ecological questions that we hope also contribute to public benefit.

The Background

As students in Ann Arbor, Michigan, we developed our skills in reflection, learned how to direct our research with a moral compass, learned about the ethics of research, and the biases that we all have in designing and thinking about experiments, regardless of sound experimental design. We learned about doing science for the people. We learned about how to question scientific findings we read. We learned how to give excellent presentations, and how to withstand the grilling associated with a bad presentation, or a Friday morning chat about having missed NWAEG the evening before. We attended NWAEG, Tropibio, the Bluefields Group and MichMex. We took and taught Field Ecology and learned how to come up with questions and how to answer them in rapid-fire succession.

In Bluefields, Nicaragua, we were each immersed in long-term data collection to understand post-hurricane and post-agricultural succession. We learned from John about tropical -forest dynamics, tree and seedling biology, biodiversity, agroforestry systems, and of course, ants. But we also learned about the interplay of people with the environment with how they influence each other. We learned about how conservation (and agricultural policy) is deeply affected by social relationships based on race, class, and geographic origin. I think most importantly, we learned to interact with students from dramatically different backgrounds, cultures, and languages. We learned how to work together, and to understand the strengths that each of us brings to the table.

Eventually, we all made it to Finca Irlanda, in Chiapas, Mexico (otherwise known as the holy grail of coffee ecology research). For some of us, this continues to be such a strong part of our research lives. Others of us have moved on. But the skills that John taught us in this environment remain a very strong tool. We each chose a topic near and dear to our hearts —ants, ladybeetles, bees, and water, and all of the interactions surrounding these organisms and interactions. We were able to document highly complex ecological interactions and networks. We learned to avoid the "one pest-one predator" approach to pest management and instead think about the complex system approach. We learned that bee pollinators respond to local vegetation management and flowering patterns more than landscape composition. We learned that coffee management has important and strong implications for water management and use in coffee agroforestry systems. We learned how to live and work in stimulating and crowded conditions - constantly exchanging ideas about science and about life. We learned how to interact with those from dramatically different economic, social, and educational backgrounds while always

showing respect and discussing mutual interests. We learned how to make our research results relevant to farm managers and owners. We learned how to persevere, even when projects got rough. We learned how to manage and massage data, and how to do the most complicated t-tests.

The postdoc years—Also known as "withdrawl." Each of us went through somewhat of an existential crisis as a postdoc or early career researcher. Honestly, how many times have we had a conversation that goes something like this: "I just don't know how John did it? How could he just let us walk in his office at any time to ask a question? How did he always make us feel like we were the most important part of his job? How can we ever possibly emulate this style as we try to look for jobs? How did he get away with guilt tripping us for not attending NWAEG?" Then we try to move, and become mentors in our own ways, realizing that it will be impossible to live up to the high standard that we place on ourselves to follow John's example.

Today

Now, in 2017, we continue to pursue a line of research that John so strongly influenced. We are asking questions about complex ecosystems, relevant to the social movements and ecological questions of today. Specifically, we are (a) exploring relationships between local vegetation management, landscape composition, and ecosystem services within an urban garden context, and (b) examining relationships between local, landscape, and socio-cultural biodiversity and resulting impacts on garden contributions to food access. We will study vegetation, insect communities, water storage capacity, pest control, pollination, gardener demographics, and food access in coastal California urban gardens. We hope that our work will elucidate how changes in local garden management and surrounding landscape composition influence biological interactions, agroecosystem sustainability, provisioning of ecosystem services, productivity, and food access. Unfortunately we don't get enough time to spend together, as we struggle to make the videoconferences work in three different time zones, before or after our childrens' bedtimes. But we keep on with it because of the shared commitment to agroecology, to forwarding ecological theory, and to trying to make a difference. John instilled in us this tremendous dedication to the family (i.e., NWAEG family, the Finca Irlanda family, the Michigan family, and John and Ivette's very extended family).

So in sum . . .

John is an outstanding mentor, and he has made dramatic and positive contributions to each of our careers and life outlooks. He has made exceptional contributions as: (1) a doctoral advisor and mentor, (2) a science educator bringing basic and advanced education and encouragement towards graduate degrees to an international audience, and (3) as a driving force for improving the academic climate for women and others from underrepresented groups. John provides an *extraordinary level of individual mentorship* to each of his students. John continues to be a mentor for his students long after we finish our doctoral education, as we navigate postdocs, job interviews, grant applications, and life changes. His style of mentoring is something that we all try to emulate, as we simply admire his style, the ease with which he interacts with students, and the effectiveness of his mentoring. First, he treats his students as his colleagues, making us feel instantly respected. He has the gift of making us feel as if we are learning on our own, even as he provides very strong guidance. Second, John has an open-door policy. We really collectively cannot remember a single instance as a graduate student or in the decade since graduating that John has even hinted that he didn't have time to talk with us—immediately! He is simply available all the time for his graduate students, past, present, and future, to talk about research projects, data analysis, papers, grant proposals, job interviews, and personal struggles. Third, he is encouraging, open, helpful, and critical, and his constant level of supervision and dedication to students ensures that we are successful with whatever projects and careers we pursue. Fourth, John inspires us to publish, and provides us will the skills to do this. He frequently co-authors papers with students, to involve them for the first time in the publication process, and engages in friendly "competitions" with his students to encourage submission and resubmission. Fifth, John cares about his students far beyond their academic pursuits to ensure that not only are they successful scientists, but also mentally and physically healthy human beings who interact with and care about the world at large. He takes a healthy interest in where his students come from, their relationships and family life, in order to best adapt his advising style to meet the backgrounds and needs of his individual students. Furthermore, John encourages all of his students to think about the relationships of our science work to the "rest of the world" and how our basic investigations can improve humanity, something that has been central to his career and work over the past 45 years. John has had a tremendous positive impact on us and on his research circle in promoting success of women and people of color as researchers and as leaders. On top of all this, John is a friend. He cares deeply about our research and professional success, but he also is deeply committed to making sure that we are as happy as we can be as people.

John has made wonderful contributions to science, to the climate for women scientists and students from underrepresented backgrounds. He has improved our lives, and the lives of so many other people.

Thanks for everything, John!

SOCIAL AND POLITICAL PERSPECTIVES

TRIBUTE TO JOHN VANDERMEER

By

Richard Levins

It's rather strange that John and I almost never worked together. I think we have one chapter in a book on agroecology, but outside of that, we've not collaborated; and the basic reason for this is John's overwhelming energy. I would give a lecture, and by the next morning he had a paper based on it. So, working with John was having some influence on his thinking but not collaborating. And that characterized our coexistence and work.

I think of John as the outstanding terrestrial ecologist of our generation, and the reason for this is the scope of his work and the intensity of his theoretical endeavors. John has worked in tropical agriculture, invertebrate ecology, populations, mathematical ecology, history of agriculture, response of a forest to hurricanes (in this case, Hurricane Joan), [and] the political economy of agriculture in Central America. So, he has spanned a very large range of topics, and he did this from the perspective both of theory and of practical work. His practical work included the analysis of railroads and banana companies in Central America, [and] it included his monitoring of the resuscitation [of forests after] hurricanes in Central America. In his earlier work, he was looking at the co-existence of four species of invertebrates. So, I guess the basic role of John is integration of applied, theoretical, abstract, and practical ecology, primarily in relation to Central America and the Caribbean.

Back in Michigan, you could see political slogans rocking the boat from the window ledges of his office. John was never intimidated by the disapproval of administrators, chairmen, deans, and such sorts of creatures, and therefore, he was able to build up a community, a left community that was concerned with both the theoretical and ideological issues of ecology and quite a few of the practical ones. John has always been interested in the theoretical underpinnings—the philosophical underpinnings—of contemporary science. He recognizes that contemporary biology is limited—that it's still fragmented, it's still reductionist, it still looks at the world in pieces. And John has fought vigorously to prevent this from happening—to strengthen the complex view of nature that characterizes the Marxist tradition, and that has allowed him to look at all of these systems from different points of view.

There's one other thing that I think would be important to mention, and that is his long collaboration with Ivette Perfecto. Ivette introduced John to Puerto Rico, to the struggles of the Puerto Rican people, to the habitats of Central America, which he immersed himself in, such as bird populations in agricultural communities. And I think we could say that the collaboration of John and Ivette represents one of the outstanding collaborations in contemporary ecology.

Recorded by Alejandro Levins and Katherine Yih on January 13, 2016, 6 days before Prof. Levins's death. Transcribed for this volume by GRS and KY.

KNOWLEDGE GENERATED VERSUS KNOWLEDGE SUPPRESSED: JOHN VANDERMEER AND AGROECOLOGY VERSUS AGBIOTECH

By

Susan Wright
Department of Politics, University of California, Santa Cruz

I first met John in the fall of 1975 when it was becoming clear that the members of the University of Michigan research administration were set on positioning the University to develop the techniques with nothing more than a cursory look at the implications of the techniques, their possible risks inside and outside the laboratory, and their future applications.

Well before the first successful controlled genetic engineering demonstrations in the early 1970s conducted by Peter Lobban, a graduate student in the Department of Biochemistry at Stanford University, and Paul Berg, a biochemist and chairman of the same department (Wright, 1994, 72), the expectation was that the techniques would be applied to living things in agriculture, medicine, human gene therapy, and the military. Writing in 1968, the microbiologist and Nobel prizewinner Joshua Lederberg foresaw "dramatic applications" in agriculture and human therapies; around the same time, Lederberg joined the scientific advisory board of Cetus, a company that aimed to tap the practical potential of genetic engineering. Elsewhere, at the United Nations Conference on Disarmament, he warned of threatening military applications, of the creation of novel infective agents against which there might be no defense (Wright, 1994, 69).

Controversy over possible impacts of genetic engineering soon erupted—initially within the scientific community. Questions were raised both about possible hazards and about applications of genetic engineering in agriculture, human gene therapy, and the military. But the well-known conference held in Asilomar, California, in February 1975, attended mainly by prominent scientists drawn from fields closely related to the problematic techniques created in their community, addressed only the question of laboratory safety. Other issues were kept firmly off the agenda. In the end, the main result of the conference was to reinforce a policy that had already been decided: that the National Institutes of Health would draft voluntary controls which would be applied only to recipients of NIH research grants. Elsewhere, notably in the private sector and in the military, genetic engineering could develop without controls (Wright, 1994, 144–159).

In 1975, the outcome of the Asilomar conference quickly became controversial. Aside from the fact that the organization of the agenda had been tightly controlled, the social climate in the United States was characterized by major controversies about the use and abuse of scientific knowledge. The antiwar movement focused on the abuse of science for the development of weapons such as the chemical defoliant, Agent Orange, and the incendiary weapon, Napalm. The emerging environmental movement encouraged people to question the damage caused by uncontrolled, unregulated use of new technology, and the first Earth Day was held in 1970. Science and Engineers for Social and Political Action (SESPA), later renamed Science for the People, was formed in 1970 to challenge the development and use of science for military purposes and other purposes with potentially adverse effects on human beings and the environment.

So it is not surprising that a group of faculty and students at the University of Michigan, home of the first teach-in on the Vietnam War, met to address the issues raised by genetic engineering in the fall of 1975. By that time, news of the issues concerning the possible implications of genetic engineering was making waves around the country. The University of Michigan group raised the issues concerning the safety and social uses of genetic engineering across the campus. John and his students published an article in the *Michigan Daily*—an early expression of the way the Vandylab has worked to influence public awareness of the social issues related to techno-scientific development (Lin et al., 2011). I testified at a hearing before the Board of Regents (Rensberger, 1976, 1, 34). Ann Arbor, together with Cambridge, Massachusetts, became the first two communities to raise the issues; and the controversy spread to other cities, to the National Institutes of Health, and by 1977, to the United States Congress, where regulation of the new field became a hot issue.

Over the years, these questions about negative consequences of genetic engineering and related technologies have met with multiple forms of resistance from sectors that were strongly committed to investing in and developing the techniques for corporate profits (Table 1). For example, legislation drafted by members of Congress in 1997, especially legislation proposed by Senator Edward Kennedy which gave substantial policy-making authority to an independent commission, was met with

Table 1.— Techniques for corporate profits.

AGROECOLOGY	AGBIOTECH
Varied: Communities, private landowners, Via Campesina	Global: multinational corporations
Communities of small farmers define goals	Hierarchy: Board, CEO and Shareholders define goals
Sustainable systems for people and land	Goals: monoculture yields for corporate profit
Farmers (ideally): free to choose crops, animals	Farmers: Indentured to corporations via patented knowledge
Environmental impacts: Conservative and sustainable	Environmental impacts: BIG
Knowledge: Ideally shared; free inquiry into impacts	Knowledge: Patented knowhow; suppression of adverse impacts
OIL: low-0 dependence: lower effects on global warming in general (Lin et al., 2011)	OIL: Dependent. Major factor in global warming (Lin et al., 2011)
Public awareness: generally LOW. Important challenge!	Public awareness: HUGE

fierce opposition from many biotech, chemical, and industrial-ag organizations which lobbied to ensure that it would not be adopted (Wright, 1994, 256–278). A more recent example is the heavy corporate lobbying against labeling initiatives in Oregon, Colorado, California, Washington, Connecticut, and Vermont (Wikipedia, December 2016).

An important form of this resistance to social critiques of genetic engineering and application is the suppression of knowledge of adverse effects, through avoidance of investigations needed to clarify possible hazards and of regulations designed to catch possible hazards. A year and a half after the 1975 Asilomar Conference, this took the form of a decision, taken at a small private meeting at the National Institutes of Health in Bethesda, Maryland, not to undertake testing of the worst that could happen using the techniques, should there be an accident in which genetically engineered organisms escaped into the laboratory or the environment outside the laboratory (United States National Institutes of Health, 1976). One person at the meeting urged that this should happen—for example, that test animals should be exposed to a pathogen into which genes from a tumor virus were introduced into *Salmonella typhi*, a pathogen of mice. The pathogen would colonize the mouse, giving time for the mouse to be exposed to tumor virus DNA. Instead, it was decided that the experiment would use a weak laboratory strain of *Escherichia coli, E. coli K12,* which would not colonize the host animal and would be quickly killed and excreted. One participant called this a "slick *New York Times* kind of experiment"—one which would persuade the general public that the genetic engineering was safe. And indeed this happened: in the "risk assessment" experiment pursued by two NIH virologists, genes from a tumor virus were introduced, not into a pathogen of the test animal, but into the weakly *E. coli* K12, which is not a pathogen (Wright, 1994, 231–235 and 364–374).

Even using *E. coli* K12, the results of this and other experiments were ambiguous enough to provoke heated debate within the scientific communities involved in designing and pursuing them. In any case, truly "worst case" scenarios were never tested. Persuading the public and Congress that genetic engineering posed no real problems was what the NIH risk assessment program for genetic engineering was about. *E.coli* K12 was used for the great majority of the experiments. For the general public, the complexity of the risk assessment results was reduced to the message that genetic engineering posed no risk at all. A headline in the *New York Times* nicely expressed both this public relations achievement and its interpretation by major media in 1977: "No Sci-Fi Nightmare After All" (Anon, 1977).

By 1978, Congressional interest in regulating genetic engineering across the board had evaporated. Moves designed to dismantle the original NIH controls, which restricted genetic engineering to specific weakened cloning hosts like E.coli K12, accelerated. The original discourse that emphasized "containment" of genetically engineered organisms disappeared. A heated exchange in May 1979 between two biologists at the Massachusetts Institute of Technology, Jonathan King, a founding member of Science for the People, and Nobel Prize winner David Baltimore, nicely expressed the difference between those like Baltimore, who aimed for fast development of genetic engineering and those like King who advocated caution and continued physical and biological containment by using the weak laboratory strain of *E. coli* (Wright, 1994, 375–376).

Baltimore argued that the risk assessment results showed that genetic engineering was safe. King responded: "Only if it is contained [physically and biologically]."

Baltimore: But it is contained.

King: Only if you guys vote that it's a hazard. If you vote that it is not a hazard, it doesn't have to be contained.

King recognized that the weakening of the NIH controls opened up genetic engineering for dispersal into the laboratory and the environment and the use of many different organisms, including those which could survive outside the laboratory. The discourse of "containment of possible hazards" was giving way to a discourse that emphasized the "safety" of genetic

engineering. Coincidentally, research designed to genetically modify plants began in this period. The first report of such a plant—a tobacco plant containing a marker gene for antibiotic resistance—appeared in 1983 (Bevan, et al. 1983).

By the time Ronald Reagan was elected on a strong anti-regulation platform in November 1979, multinational agrichemical companies like Monsanto were gearing up to develop genetically engineered (GE) plants. (The first field tests of GE plants in the United States occurred in 1987.) In anticipation, the Reagan administration took the view that genetically engineered plants and their products could be regulated in the same way as conventionally bred plants and their products. The Food and Drug Administration would be used for food safety, the Department of Agriculture for plant safety, and the Environmental Protection Agency for the safety of plants that incorporated genes for pesticides or for increased tolerance of pesticides (Marden, 2003, 738, n.17). I'll focus on the role of the Food and Drug Administration in regulating food from genetically engineered plants.

With the imminent appearance of food products from genetically engineered plants (the first product—the FlavrSavr tomato appeared in 1992), the George H. Bush administration, under the guidance of the White House Office of Science and Technology Policy and Vice President Dan Quayle's Council on Competitiveness, produced more detailed guidance for the regulatory agencies from 1991 to 1992 (Marden, 2003, 739–742). In essence, two main positions emerged from this guidance: First, the Bush administration claimed that there was "no conceptual distinction" between classical breeding techniques and genetic engineering of plants; second, the administration, while acknowledging the need for assuring safety, also assured the fledgling agbiotech industry that it would "minimize regulatory burden."

In the early 1990s, it was left to the FDA to square the general policy of the Bush administration not to impose an unnecessary regulatory burden on the emerging agbiotech industry with the original safety purposes of the 1930 Federal Food, Drug and Cosmetics Act that defined its regulatory roles. With respect to food, that role was to assure that novel ingredients in food were safe by subjecting them to rigorous testing. Exceptions to this practice were additives that were well known to be safe (for example, certain widely used food preservatives) and which therefore fell in a category known as "generally recognized as safe," or GRAS. In a series of papers, the FDA Commissioner argued that the GRAS exemption could also be applied to foods produced from genetically engineered plants because these plants were no different from foods produced from plants developed with classical breeding techniques. Of course this assumption raised a crucial question: could it really be claimed that genetically engineered plants were the same as classically bred plants no matter the source of novel genes or where such genes were introduced into the plant genome? It was left to the industry to decide that question as well as whether it would consult with the FDA about the answer (Marden 2003, 52, 56). The message to the industry was that foods from GE plants would generally be GRAS and no such consultation would be necessary.

It was difficult for the general public to wrap its mind around the verbal juggling that produced this soothing result. At this stage, there was little public questioning of the Bush administration's policy. However, the FDA's own scientists had serious doubts about the policy loopholes through which the food products of genetically engineered foods could travel without regulatory burden. In 1998, the discovery process resulting from litigation against FDA by a public interest group, the Alliance for Bio-Integrity, revealed that, in 1991 and 1992, many FDA scientists, including the director of the FDA's Division of Toxicological Review and Evaluation and the FDA Compliance Officer, questioned whether foods from genetically engineered plants should be left without review or testing (Druker, 2015, 135–137; Alliance for Bio-Integrity website):

"There are at least two situations relative to this document in which it is trying to fit a square peg into a round hole. The first square peg in a round hole is that the document is trying to force an ultimate conclusion that there is no difference between foods modified by genetic engineering and foods modified by traditional breeding practices. This is because of the mandate to regulate the product, not the process...The processes of genetic engineering and traditional breeding are different, and according to the technical experts in the agency, they lead to different risks" (Linda Kahl, FDA Compliance Officer, January 8, 1992).

"What if the inserted DNA is from a non-food source and encodes a protein product that is toxic to certain organisms? Wouldn't knowledge of the toxicology of this protein product be necessary to ensure safety?" (Carl B. Johnson, Ph.D., Additives Evaluation Branch, January 8, 1992)

"My general conclusion is that this issue turns the conventional connotation of *food additive* on its head. It also conveys the impression that the public need not know when it is being exposed to '*new food additives,'* for lack of a better descriptor" (Mitchell Smith, Ph.D., Head, Biological and Organic Chemistry Section, January 8, 1992, emphasis in the original.)

"All the above marker genes [e.g., genes that produce coloration or light emission] produce proteins that are new with respect to plants. Because the background exposure to these proteins…would be negligible…, they should be considered to be new proteins in the human diet and be subjected to safety evaluation. Because the marker genes are inserted randomly in the plant genome, each insert behaves essentially as a separate gene…" (Members of the Division of Food Chemistry and Technology and of the Division of Contaminants Chemistry, November 1, 1991.)

"The document is inconsistent, in that it says (implies) that there are no differences between traditional breeding and recombinant, yet consultations and premarket approvals are

being bantered around when they have not been used for foods before. In fact, the FDA is making a distinction so why pretend otherwise.

"The unintended effects cannot be written off so easily by just implying that they too occur in traditional breeding. There is a profound difference between types of unexpected effects from traditional breeding and genetic engineering which is just glanced over in this document". (Louis J. Pribyl, Ph.D., FDA Microbiology Group, February 27, 1992).

"A genetically engineered plant may contain an identical profile of expected plant toxicant levels as is normally found in a closely related, natural plant. However, genetically modified plants could also contain unexpected high concentrations of plant toxicants. The presence of high levels of toxicants in the bioengineered plant food could occur by two or more mechanisms…The task of analysis of all major toxins in genetically engineered plant food includes the assessment of both expected toxicants and unexpected toxicants that could occur in the modified plant food". (Edwin J. Matthews, Ph.D., Center for Drug Evaluation and Research, October 28, 1991).

"It is unlikely that molecular and compositional analysis can reasonably detect or predict all possible changes in toxicant levels or the development of new toxic metabolites as a result of genetic modifications introduced by [genetic engineering]…Until sufficient data and experience with the new techniques…have accumulated, the possibility of accidental changes in genetically engineered plants justifies a limited traditional toxicological study with the edible part of the plant" (Samuel Shibko, Director, Division of Toxicological Review and Evaluation, January 31, 1992).

These statements show that many of the FDA's scientists strongly dissented from the agency's policy. Yet their views were ignored. As the Head of the agency's Biological and Organic Chemistry Section summed up their collective critique of the FDA's policy: "Ignorance is not bliss". (Mitchell Smith, Ph.D., January 8, 1992).

Despite this strong critique by the FDA's own scientists, the agency did nothing to modify its claim that GE plants are not substantially different from plants that are conventionally bred and therefore that the food from these plants can be considered GRAS. In doing so, it suppressed knowledge of possible chemical changes in genetically modified foods that could be harmful to humans. A later investigation by the public interest organization, the Center for Science in the Public Interest, confirmed the lack of collection of detailed knowledge about the content of GE foods (Gurian-Sherman, 2003). Voluntary submissions of data from companies that requested consultations about their products lacked detailed tests of possibly harmful substances such as toxicants and allergens or lacked sufficient detail about tests that were carried out. Requests from the agency for further information were ignored in 50 percent of the cases. And the agency did not pursue any testing of its own. As the CSPI report concluded: "The FDA consultation process does not allow the agency to require submission of data, misses obvious errors in company-submitted data summaries, provides insufficient testing guidance, and does not require sufficiently detailed data to enable the FDA to assure that GE crops are safe to eat…The FDA's current voluntary notification process (even if made mandatory) is not up to the task of ensuring the safety of future GE crops". (Gurian-Sherman, 2003, p.18, ii).

In summary, knowledge about the possibility of adverse effects from genetically modified micro-organisms and from the food products of genetically modified crops has been suppressed by avoiding the experiments and test procedures required to assess such questions. The opposition of the agbiotech industry to the finding of Ignacio Chapela and David Quist that genes from GM corn had spread to traditional varieties in Mexico shows how a further suppression of knowledge of contamination of valuable "landrace" corn was experienced within the biotech community (Quist and Chapela, 2001).

This suppression of knowledge of the nature and environmental impacts of agbiotech contrasts with the generation of knowledge in the practice of agroecology. The social and ethical foundations of these two paradigms of agricultural knowledge differ profoundly. While agbiotech corporations deny knowledge of its problems in many ways—including those discussed in this article—knowledge of agroecology, both its successes and its problems, is freely shared. Other levels of comparison are suggested in Table 1 and could provide the basis for further investigation and analysis.

John Vandermeer has been a pioneer in the development of agroecology as a field and as a practice in many ways. As the papers for this Festschrift demonstrate, through his own research and publications, through nurturing generations of students and inspiring colleagues, through his work with farmers and researchers in Central America, and as a founder of the New World Agriculture and Ecology Group, he has stimulated, advised, and provoked us to think about agriculture in terms of its science, history, culture, and politics (for example, Vandermeer, 1989; Carroll, Vandermeer, and Rosset 1990; Perfecto, Vandermeer, and A. Wright, 2009; Vandermeer, 2010). In directing the Science and Society Program at the University of Michigan's Residential College for many years, I benefited from John's support for a program that brought natural and social scientists together to develop courses addressing science-society questions along those lines. Thank you John for inspiration that combines commitment, fun, and love!

REFERENCES

Alliance for Bio-Integrity website, www.biointegrity.org/FDAdocs/index.html, "FDA Scientists Discuss Various Safety Concerns," accessed October 10, 2016.

Anonymous, 1977. "No Sci-Fi Nightmare After All." *New*

York Times. July 24, 1977.

Bevan, M.W., R.B. Flavell, and M.D. Chilton, 1983. "A chimeric antibiotic resistance gene as a selectable marker for plant cell transformation." *Nature* 304, 340–45.

Carroll, R. J., J. Vandermeer, and P. Rosset. 1990. *Agroecology*. London: Macmillan.

Druker, S. M. 2015. *Altered Genes, Twisted Truth.* Salt Lake City: Clear River Press.

Gurian-Sherman, D. 2003. "Holes in the Biotech Safety Net: FDA Policy Does Not Assure the Safety of Genetically Engineered Foods," Center for Science in the Public Interest. January 1, Washington, D.C.

Lin, B., M. Chappell, J. Vandermeer, G. Smith, E. Quintero, R. Bezner-Kerr, D. Griffith, S. Ketchum, S. Latta, P. McMichael, K. McGuire, R. Nigh, D. Rocheleau, J. Soluri, I. Perfecto. 2011. Effects of Industrial Agriculture on Climate Change and the Mitigation Potential of Small-Scale, Agro-ecological Farms. CAB Reviews: Perspectives in Agricultural, Veterinary, Nutrition, and Natural Resources. Vol. 6: no. 020:1–18.

Marden, E. 2003. "Risk and Regulation: U.S. Regulatory Policy on Genetically Modified Food and Agriculture." *Boston College Law Review*. 44, 733–787.

Perfecto, I, Vandermeer, J. and Wright, A. 2009. *Nature's Matrix: Linking Agriculture, Conservation and Food Sovereignty*. London: Earthscan.

Quist D. and I. Chapela. 2001. "Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico." *Nature* 414, 541–543.

Rensberger, B. 1976. "Debate Shifting Genes Nearing a Critical Phase." *New York Times,* May 15, 1975.

United States, National Institutes of Health. 1976. Enteric Bacteria Meeting, Bethesda, Maryland, August 31. Transcript. Excerpts in S. Wright, 1994, Appendix A.

Vandermeer, J. 1989. *The Ecology of Intercropping Systems*. Cambridge: Cambridge University Press.

Vandermeer, J. 2010. *The Ecology of Agroecosystems.* Sudbury, MA: Bartlett and Jones.

Wikipedia. 2016. "Genetically Modified Food Controversies." October 4, 2016.

Wright, S. 1994. *Molecular Politics: Developing American and British Regulatory Policy for Genetic Engineering, 1972–1982.* Chicago: University of Chicago Press.

JOHN VANDERMEER, THE BLUEFIELDS GROUP, AND PARTICIPATORY ACTION RESEARCH: MODELING LOVE THROUGH ACTION

By

Ginger Nickerson

From 1990 to 2007, John and Ivette brought students to the Atlantic Coast of Nicaragua to study the impact of Hurricane Joan. Those of us who conducted our research there called ourselves the Bluefields group.

I chose to use a Participatory Action Research (PAR) approach for my master's thesis. In its ideal form, PAR is a process by which the people affected by a problem are engaged in all steps of the research process, which results in action that improves their daily lives.

John and the rest of the Bluefields group challenged me to explore the pros and cons of PAR: How might my work make a difference in people's lives? What was the best way for me as a natural-resource scientist to engage in social science? But what had a deeper impact on me was seeing how John and Ivette constructed the expeditions to Bluefields. While they would never claim to be doing PAR, John and Ivette put many of the political principles of PAR into action, often more thoroughly than many people who claim to do PAR.

- They partnered with local institutions, like CIDCA and URRACAN
- They ensured expeditions had equal numbers of Nicaraguan to gringo students and were conducted in Spanish
- They spent as much of the funds as possible in the local communities vs. in the United States
- And they supported Nicaraguan students who wanted to pursue graduate studies in United States and Canada

Watching John and Ivette put these principles into practice, even when it was messy, demonstrated to me what it looks like to try to address power dynamics in research.

For my thesis, I partnered with a Costena colleague who worked for CIDCA, Noreen White.

We started out wanting to do an agroforestry project. But because we were using a PAR approach when our community advisors said they wanted us to work with their youth, we said yes.

1. We ended up training the students to take photos and interview elders in the community.
2. About how fishing, farming, hunting, logging and bush medicine were affected by the war, the hurricane, transportation and other factors.
3. The Action was the creation of a book for use in the village school.
4. Part of the deep learning for me was being challenged to see the significance of my actions and my privilege in a different way.
5. John and Ivette created an environment where talking about the power dynamics inherent in research projects was the norm. In this way, they, and Noreen, gave me the lenses to see power dynamics in research relationships.
6. If I had advisors who talked the talk but did not walk the walk, I would not have learned as much from them. John walks his talk—in the classroom, in his relationships with his students, and in the way he considers how research projects will impact local communities. I think the reason he is able to translate talk to action is his fierce passion: John not only believes intellectually in people, justice and equity…?
7. John is one of the most heart-directed and passionate people I know. He lives his life in alignment with his love for humanity, for justice and equity. Watching him live out that love through his actions has been one of the transformative experiences of my life.

TRIBUTE TO JOHN VANDERMEER AT THE SYMPOSIUM IN HIS HONOR

By
IVETTE PERFECTO

John, today you heard from some of the many people that you have influenced. I hope this puts an end to your whining about how your students don't ever listen to you.

But seriously, when I think about your influence on others I can't help but think about your influence on me, and I can't think of anyone that has been touched as deeply by you than me. I think back to when I arrived in Michigan as a very young and naïve student; I was 25 (and Kiko was 2 years old). I had no idea of the exciting life that was ahead of me. I came to the "belly of the beast" to get a Master's degree and leave as soon as possible. Little did I know that I would stay for the next 36 years! I came to the United States with all the preconceived notions about the "ugly-gringos", as someone who grew up in the last remaining colony of the United States. For me, the gringos were pale as paper, unemotional, selfish, narrow minded, ignorant of almost everything, and most of all uninteresting. But then I met you, and you introduced me to a wonderful community of people who wanted to change the world. And I realized that the ignorant and narrow minded was me.

It's been 36 years since we met. You have been my teacher, mentor, friend, colleague, comrade, companion, lover, as of a few years ago, my husband. Our partnership is a big part of who I am and I hope that it is also a big part of who you are. But we are here to celebrate you, not us.

I really admire your passion for science and social justice. And it is that passion that has inspired so many of your students. Several times today we heard about John's legendary lack of sleep. Well, John, I guess it is true, you may have to work harder, sleep less. You can't retire since you have not accomplished everything you set out to do. Capitalism still exists! There is still poverty and war. In short, we have not achieved utopia yet. But, listening to all the talks today I am not worried. I am confident that those that influenced you, like Dick Levins, and those that you have influenced will continue weaving the fabric of a more just society. And eventually we will get there.

I know how much you love this quote from Bertolt Brecht, so I will end with it:

"Hay gente que luchan un día y son buenos. Hay otros que luchan un año y son mejores. Hay quienes luchan muchos años, y son muy buenos. Pero hay los que luchan toda la vida, esos son los imprescindibles."

There are people who fight one day and are good . There are others that fight for a year and are better. Some fight for many years and are very good. But there are those who struggle all their lives, these are the essentials.

John, gracias por ser inprescindible!

ECOLOGY ON THE HEELS OF THE DARWINIAN REVOLUTION: HISTORICAL REFLECTIONS ON THE DIALECTICS OF ECOLOGY

By
John Vandermeer

One would be justified in assuming that the history of ecology is simply a small subtheme within the context of the Darwinian Revolution writ large. Most ecology textbooks tell it this way, with Haeckle inventing the term, Clements and Tansley debating the biome or ecosystem, Gause/Lotka/Volterra mathematizing basic processes, Lindeman and Odum bisecting the field, and the ascension of Robert May to the final throne. That seems to be a standard historical narrative, leading to the assumption that no further interrogation is required. But as a historian of science, Margaret Jacob noted, "The interrogation of things that seem to require no interrogation is where science begins, but it is also where history gets written."[1] In this spirit, I seek to interrogate the intellectual history of the scientific field of ecology.

Politically, the Darwinian Revolution began a new chapter in the Enlightenment, one with contradictions that have yet to be properly acknowledged. Harvard historian Steven Shapin (1996) has observed that our fellow citizens retain pre-Enlightenment world views (e.g., belief in ghosts and the supernatural), even faced with the evident materialist revolution encoded in Darwinism, a fact worth the considerable reflection it in fact has received. But another, less acknowledged, revolution loomed large at the end of the nineteenth century. The Darwinans, by which I mean pretty much all of those who would call themselves zoologists, botanists, or geologists, began a new scientific chapter—ecology. Less than a decade after the publication of "The Origin," Earnst Haeckel elaborated on Darwin's substantial musings on what anyone today would recognize as "ecology,"[2] and, in 1869, made perhaps the first clear statement of what the field actually is, during his inaugural lecture to the philosophical faculty of Jena, where he said:

> ". . . by ecology we mean the body of knowledge concerning the economy of nature—the investigation of the total relations of the animal both to its inorganic and to its organic environment; including, above all, its friendly and inimical relations with those animals and plants with which it comes directly or indirectly into contact—in a word, ecology is the study of all those complex interrelations referred to by Darwin as the conditions of the struggle for existence."[3]

Two years later, Eugeneus Warming defended his doctoral dissertation. Warming, held by many to be the true father of ecology,[4] followed in the footsteps of such notables as von Humboldt and Wallace in making extensive trips to tropical field sites in his youth, the most important of which was a three-year stay in Brazil. Expanding on von Humboldt's famous observations of vegetation zones, Warming's teaching of plant biology resulted in his book, "Plant Communities, Fundamentals of Ecological Plant Geography," published in 1895. Although Haeckel's description seems more relevant to modern ecology with its emphasis on interactions, Warming's detailed descriptions of the natural patterns of vegetation is undoubtedly a far more important historical focus for the early emergence of ecology as a practical science with the beginning of a new century.

In searching for the historical "father" of ecology, it is arguably the combination of von Humboldt, Wallace, Darwin, Haeckel, and Warming that form that parent, the folks I will refer to as the "early ecologists." Indeed, as Haeckel effectively argued, ecology is just a branch of Darwinism, which itself owed much to von Humboldt and the latter's influence on Warming was certainly profound, to say nothing of the influence of Wallace on Darwin himself. Further, to my mind, the fingerprint of all of this can be gleaned from a reading of chapter 3 of "Origin." Thus, ecology was either part of, or effectively on the heels of, the Darwinian Revolution. However, far more important to its development were the subsequent influences emanating first from a major figure in British botany, Arthur Tansley, and second, the complex political forces surrounding WWI and its aftermath. It is the unusual intellectual odyssey of the early career of Tansley that eventually merged with the political forces surrounding the needs of Empire after WWI, and the politics of the post-war years that need to be fully understood to appreciate the trajectory of ecology from its beginnings to where it stands today.

Tansley reads Warming

Three years after its publication, the 27-year-old Arthur Tansley read Warming's extensive tome about what we would today call plant ecology (Warming called it ecological plant geography). In an important way Warming's approach differed from the program laid out by Haeckel. Whereas Haeckel was concerned with how organisms interacted with one another

and in turn with their environment, Warming interpreted readily observable patterns of occurrence of plant associations from the point of view of the ecological forces that created them, with a focus on the relevant physicochemical factors. The approach attracted Tansley, who had long been a student of vegetation patterns in Great Britain. Warming's approach clearly offered an intellectually satisfying way to study these patterns.

An impressive organizer of scientific workers, Tansley started the influential "The New Phytologist" in 1902, which he initially funded out of personal accounts. Two years later he articulated a plan for the detailed survey of the vegetation of the British Isles, emphasizing the connection to underlying physicochemical factors, but also acknowledging what would later be known generally as vegetational succession. This plan recognized early the fact that the observed vegetation in Great Britain was strongly influenced by the long history of human activity, and did not constitute what the final "climax" communities would be like. Nevertheless, the search for evidence of the nature of those climax communities would constitute part of the goals of the survey.

After teaching for 14 years at the University College of London, Tansley secured a lectureship at Cambridge where, along with eight other enthusiasts, he formed the British Vegetation Committee. Under Tansley's leadership the committee organized the first British Phytogeographic Survey in 1911, perhaps the first organized ecological survey, setting the stage for similar activities for the next century. Through the activities of the committee, its members became connected with botanists around the world, especially with ecologically minded botanists in America, thus cementing at an early stage in the history of the subject an intellectual symbiosis between British and American ecologists. Especially important at this time was Tansley's association with the American plant ecologist Fredrick Clements, with whom he had a substantial disagreement, as discussed below.

Tansley's career prior to the outbreak of WWI can be summarized as standard intellectual development, from the inspiration of Warming to the practicalities of setting up the British Vegetation Committee (from which eventually would emerge the British Ecological Society). WWI, devastating to all Europe, was a turning point for Tansley, partly because of his personal journey but perhaps more importantly because of the political conditions that emerged post war.

The political environment surrounding WWI: Imperial assumptions from Churchill to Lenin

World War I was, in a sense, the final outcome of the Napoleonic wars. From the French Revolution to Waterloo, much of Europe was engaged in fighting, effectively a "world-war" preview. The many skirmishes (Wikepedia, at this writing, lists 69 "minor" European wars) after this preview, viewed from the present day, were rehearsals for the immense carnage of WWI, with its ghastly trench warfare. When it finally ended, the world, rightly, could not imagine falling into such a nightmare once again. In his influential "The War That Will End War,"[5] for example, H. G. Wells noted:

> This is already the vastest war in history. It is a war not of nations, but of mankind. It is a war to exorcise a world-madness and end an age. . . . not just another war—it is the last war!

With the end of that war came a sensible expectation that the world, now having come to its senses, would heretofore be more stable. Although there was no need to say it out loud, there nevertheless was a tacit and universal assumption that "there is no alternative" to the current world order, with especially the British as the new Leviathon securing the stability of the world commonwealth.[6] It would seem that the end of WWI generated as much hubris for the West as did the Reagan/Thatcher regimes of the 1980s. The "white man's burden" was sanctimoniously accepted as the "responsibility" of Empire, an awesome responsibility for making the administrating of far-flung colonies as efficient as possible, something the Lord had laid at the feet of the British People, who constituted the most advanced civilization ever to have peopled the earth.

As plans were being made, both direct and indirect, to construct the new post-war world, a major issue was the consolidation of Empire. Great Britain emerged with a sense of responsibility to manage its vast holdings wisely. The proverbial empire on which the sun never sets was in another sense a chaotic behemoth that defied British sensibilities of order and efficient management. Yet there was a sense of responsibility that flowed from the assumption that the war had ended global hostilities, that the path forward had been set in stone, and that the British Empire, like it or not, was here to stay. This permanence was optimistically codified "permanently" at the Paris Peace Conference when the Permanent Mandates Commission (PMC) established rights and responsibilities–the rights of people of the colonies and the responsibilities of the Empires. Although the PMC specifically referred to the formal "mandates" that emerged from the partitioning of world geography effectively as spoils of war, its spirit permeated all "colonies" of all empires. The Empire had the responsibility to manage its Colonies such that "the well-being and development of such people (humans who lived in the colonies) form a sacred trust of civilization." Administered by the newly formed League of Nations, the PMC was to receive annual reports from the colonial powers on their treatment of colonial subjects. In this way, the structure of empire was established, especially important for Britain and France, effective in legal theory, and in practice taking the form of a new civilizing mission of the empires. The end of all wars, after all, required a new vision of managing the empire, and the PMC was the legal manifestation of that vision, although it was certainly within nineteenth century British self-characterization to see this "white man's burden" as the responsibility of the truly civilized. As Winston Churchill

noted at the time:

> the consciousness of dominion over subject races must alone increase the self-respect of every Englishman.[7]

The critical question became how to organize that far flung and highly diverse collection of colonies that, like unruly children, seemed unreasonably chaotic. And accepting the "responsibility" means keeping order and prosperity in every one of the far-flung colonies. There were minerals to watch over, land to put into productive agriculture, plants that could be mined for chemicals, people that had to be "taken care of." The geology, from rare minerals to fossil fuels, the biology, from plants to indigenous people, all now the unchallenged property of the empire, needed to be managed responsibly. And the sense that history had basically come to an end with WWI set London on a new course of "rational management" of its empire. As articulated by Helen Tilley:

> . . . imperial management and control, . . . forced British officials and other interested parties to grapple actively with transnational and inter-territorial trends. Ideas of heterogeneity and diversity . . . were ever present in their discourse and became integral to the logic of empire building. It also meant . . . drawing upon burgeoning disciplines, such as ecology and anthropology . . .[8]

In his masterpiece "Imperial Ecology," Peder Anker lays out the general pattern of management concerns that drove the decision-makers of the times, especially with regard to potential natural resources. Much of the story takes place in South Africa, although, as Helen Tilley notes (see the above quote), the entire African continent was an "ecological laboratory."[9] The post-war period saw General Jan Smuts rise to the position of prime minister, notable here not so much for his previous extensive military record, but for his love of botany and his general philosophical position of "holism." His holism was perhaps eclectic and in modern terms might better be called hierarchy. Indeed, the famous phrase by Hegel that "the truth is the whole" rings true in many modern circles as a recognition of the interconnectedness of all things political AND ecological. It is something of a rallying cry for those who today wish to promote a deeper political analysis of ecology, especially in the context of its relationship to the environmental crisis.[10] Smuts, on the other hand, saw holism as a justification for the social order, a natural bias due to his various positions in South Africa extending from the Boer Wars to formal Apartheid. As a botanist, Smuts was an expert on savannah grasses and understood the basic ideas of ecological succession as well as anyone. Perhaps his theory of holism derived from nothing more than that understanding, but it extended to other spheres, especially to the relationship among the human races. As much as pioneering plants gave rise to intermediate seres and eventually to a climax (the understanding of ecological succession at that time) Smuts' theory of "personology" treated the evolution of human types as an ecological/evolutionary process, with clear potential for justifying a racial foundation for political organization. His stated "biological" conclusion was that Africans had "stopped evolving" because of the African climate.

John Phillips 1935, also formally trained as a botanist, was an acolyte of Smuts, and spent a great deal of time and effort promoting the theory of holism in ecology. His position on the "native" people echoed that of Smuts. For example,

> . . . the Good Lord had willed them [black South Africans] to be 'creatures' (schepsels) of the ruling race. They were the hewers of wood and drawers of water, for whom the white man had a responsibility before God.

The assumption of inferiority of native Africans certainly penetrated the ideas of holism, especially as it related to "managing the empire." Ironically, it is likely that ecologists, racists and non-racists alike, of the early 20th century were far ahead of today's ecologists in linking basic ecological principles with sociopolitical issues, despite a thriving contemporary academic field called political ecology.[11] Given normal assumptions of the times, theories such as those expounded by Smuts and Phillips would have been seen not so much as predictive propositions, but rather as an explanation of what many thought to be obvious basic data—the inferiority of the native African population. Phillips might also be an important early source of the idea of conceiving of the ecosystem as another type of organism, especially seeking to leverage the general knowledge of ontology in developmental biology to make sense of ecological systems.[12] This framing would eventually see great popularity among the followers of American ecologist Clements as described below.

The colonial administration, led by Prime Minister Smuts, was understandably paternal about the South African situation and, unlike other colonies where local nationals headed the overseas colonial offices, South Africa was not simply administered from London, but rather had its own ideas of independence. Smuts originally gained his military title from his time fighting with the Boers but was obviously European in racial category. The "organization" of South Africa was thus a point of contention in many spheres, most notably in what today would be called ecology—to organize properly you would need to know what you have, which is to say, proper inventories need to be established.

Scientific interests in Cambridge were not silent on this issue. While nods would have to be given to local "white folks" who ostensibly were the rulers of what London still regarded as a colony, ultimate authority would have to come from the center, and ultimate authority on all things academic would have to come from someplace like Cambridge. Tansley was a major player in this contest. As the chief organizer of the expansive British Botanical Survey, he began the process of organizing the botanical survey of South Africa. Perhaps

because both Smuts and his lieutenant Phillips were also botanists, a certain competition evolved.

At about the time all these contradictions were working themselves out, an important work appeared on the international political scene, Lenin's masterpiece of the time, "Imperialism: the Highest Stage of Capitalism." It is worth noting that at the end of the nineteenth century the very word imperialism did not have the pejorative connotation it later attained[13] (Fieldhouse, 1961). On the one hand, it simply referred to the notion that British colonies should be discouraged from any sense of independence, while on the other hand, it carried a connotation of responsibility to care for the "uncivilized" parts of the world (i.e., the societies in the colonies). The few "anti-imperialists" in Britain were that way because imperialism was expensive, a "waste of money it entailed on armaments, in the cost of colonial governments, and in the danger of international conflicts over intrinsically unimportant territories which it would be wiser to leave alone."[14]

Thus, by the end of WWI, conventional wisdom of British imperialism held that the Empire was *a divinely-inspired responsibility that the chosen people needed to embrace*, especially in the political processes that were assumed, since WWI, to be set in stone for ever after. Lenin's account, on the contrary, was an extension of the basics of Marx, extending the dynamics of capitalism to its monopoly and financial stage, with the need for expansion abroad. He thus set Empire within the classic categories of class struggle and surplus value creation, with the *fundamental rules of capitalism working themselves out to the ultimate formation, Imperialism*. So, by the late teens and early 1920s, two narratives about Imperialism had come to be. Imperialism was thought to be "mature" and the needs of imperialism were to be tended to by academics and technical experts—the very point of being an academic or technical expert. Academics beholden to Imperialism (the vast majority) were "not bad people" (perhaps a contentious point), given the times, but were only trying to make Imperialism work "the way it is supposed to."[15] After all, history had come to an end. The alternative, steeped in the evolving traditions of Marxism**,** viewed the human population as groups united or semi-united by common interests and frequently common enemies. These "classes" would forever be in "struggle" with one another. Academics adopting a Marxist perspective took it as given that the Imperialist system itself needed to be destroyed.

Given this obvious contradiction, it is worth noting the activities of Lancelet Hogben at that time. Hogben, a well-known leftist biologist and statistician, took the Marxist point of view that the Imperialist system itself should be destroyed, of course. He was teaching in South Africa, at the same time that Tansley was debating Smuts and Phillips, about the proper visioning of botanical surveys. Going against the grain, Hogben welcomed native Africans into his classes and even had a secret safe-room in his house where black activists could hide from the police. Hogben had insights about both biology and statistics and had a remarkable exchange of letters with R. A. Fisher (not a Marxist, to say the least), about genetics. While he said little about what would have been, at the time, ecology, he was remarkably perspicacious about the structure of genetic systems, anticipating the modern idea of gene recipes and structures such as chaperone genes.[16] He also wrote extensively and critically about the then-popular eugenics movement.

Tansley, on the other hand, was the more typical academic of early 20th century Great Britain. His debates with Smuts and Phillips had a great deal to do with how the general botanical surveys should be envisioned, with the Smuts/Phillips side emphasizing an idealistic notion of the ecology of an area being like an organism, with its developmental properties and the corresponding sense of maturation. These ideas were not very different from the ideas of American ecologist Clements, who was a frequent correspondent with Tansley. While Tansley seems to be credited with the proper footing of ecology in the materialist framing (as opposed to the idealist notions of Smuts, Phillips, and Clements), in other ways he was clearly a product of this times politically. While he could hardly be classified with the overtly racist Smuts and Phillips, he had underlying assumptions typical of the members of the Imperialist community. For example, he noted in 1920:

> The habitat is an essential part of the concept of the [plant] association, for it is one of the primary determining factors of the existence of the association. Individuals of the constituent species may, and frequently do, exist outside the association habitat, just as individual Englishmen or Americans or Frenchmen may live in a community of negroes, or as hermits on a desert island. But neither the community of negroes nor the desert island is part of the habitat of the English or American or French community as communities. (Tansley, 1920, p. 129)

The underlying assumption is astonishing from a contemporary point of view, that an Englishman living among Africans is somehow as a hermit on a desert island. Such attitudes were, of course, common and set the stage for how imperial powers viewed their "responsibilities."

Post WWI and Tansley's intensive psychological apprenticeship

In 1920 Tansley published two works that represent something of a culmination of his thoughts. The first is well-known to ecologists, a long essay on the classification of vegetation, in which he noted:

> . . . the complex of interactions between plants and their environment does lead to a certain degree of order in the arrangement and characters of the resulting vegetations. The human mind is irresistibly impelled to express this order in some systematic form, . . . further, a systematic form is indispensable

> as a framework into which to fit our investigations on the concrete phenomena of vegetation. . . . We must never conceal from ourselves that our concepts are creations of the human mind which we impose on the facts of nature, that they are derived from incomplete knowledge, and therefore will never *exactly* fit the facts, and will require constant revision as knowledge increases. (Tansley, 1920, p. 120, italics in original)

The reference twice to the human mind is striking given his longtime interest in the field of psychology. It is arguably the case that his understanding of Freud's concepts of the development of personality was influential in his developing ideas about vegetation communities and, ultimately, in his conceptualization of the "ecosystem." But the 1920 paper is most influential for his clarification of the idea of the ecosystem as an organism, something Clements had made popular and something that had come to be central to the ideas of "holism" as articulated by Smuts and supported by Phillips. In contradistinction, Tansley notes:

> The treatment of vegetation as consisting of natural units, . . . seems to involve their consideration as organic entities. Clements ('16) has stated this view in its extreme form with great clearness and ability, and has worked it out in great detail. . . . [however] It does not follow, because vegetation units may be usefully treated as organic entities, that they *are* organisms... . On the other hand it does not follow because such deductions are inadmissible that the comparison with organisms is valueless, or that it may not lead us to a sound basis of classification, (Tansley, 1920, p. 122, emphasis added).

Tansley's fascination with psychology, especially social psychology, is dramatically reflected in what is effectively a build-up to the conceptualization of the "ecosystem." Having rejected the idea that a vegetation complex could be literally an organism, he goes on at some length about human communities as "usefully described, considered and studied" as organic entities. He goes on to stipulate:

> "A human community, like a plant community, consists of separate individuals with independent powers of existence, growth and reproduction. But taken together these individuals make a new whole, a unit of higher order . . . Human communities are . . . closely adapted to the general conditions of their existence just as individual solitary organisms are; and the characters of different communities depend largely, though not wholly, on the differences of these conditions, just as do the characters of individual organisms." (Tansley, 1920, p. 123)

He goes on with a set of caveats to make clear that any comparison between "human communities" (and, he adds, other animal communities) and plant associations can be only very approximate since they are clearly very distinct. This clear demarcation allows us to rightly claim that Tansley's ecosystem is quite different from the "ecological community as an organism" idealism of Clements, Smuts, and Phillips. Tansley became the legitimate scientific materialist while the others acquired the label of idealist, with their insistence on "organism."[17]

Tansley's 1920 work, in many ways what he must have thought of, at the time, as his "swan song" in ecology, is historically important for two reasons. First, as has been so frequently noted, herein is the germ of the idea of the ecosystem, a key conceptual category that persists to the present. Second, and perhaps more important, is his prescience in thinking of emergent properties in the ecological context. In his own words,

> …plant communities may still be regarded as quasi-organisms, or organic entities, for on the one hand they are composed of organic units, and on the other they are certainly entities, in the sense that they behave in many respects as wholes, and therefore have to be studied as wholes.[18]

The second work of Tansley's published in 1920 was his less-remembered book, "The New Psychology and its Relation to Life." As told by Tansley himself,[19] he had a dream that was so upsetting that he spent considerable time trying to analyze it which led him to "a resolve to read Freud's work." After considerable study of Freud he reported that "my interest in the whole subject was now thoroughly aroused, and after a good deal of thought I determined to write my own picture of it as it shaped itself in my mind." The result was his 1920 book, which became a best seller in England and was at least a notable contribution in the United States. So intent was he on understanding psychoanalysis (and, I would argue, psychology in general). Tansley offered himself up for analysis in a three-month session with Freud in 1921 and two years later resigned his position at Cambridge to pursue psychology full-time. As he noted in a letter to Clements:

> The last year or two I have been pursuing both [psychology and ecology], and . . . the double pull is a considerable strain.[20]

Such analysis makes it clear, I argue, that Tansley's framework draws simultaneously from his considerable knowledge of the field of social psychology as much as from his considerable knowledge of plant geography, in both cases, of course, as they existed at the time. Blurring the distinction between what would come to be called the science of ecology and what would effectively be social psychology and its allied field sociology, Tansley, thus set the stage for the future development of what has come to be known as political ecology.[21] But more importantly, the developmentalist ideas of Freud regarding the ontology of personality and the mind,

coupled with how such development related to the development of human societies pushed Tansley to his expression of ecological construction, as mentioned above. The concept of the "ecosystem" thus emerged as a counter to both the then-dominant morphological basis of plant geography and the effectively idealistic notions of "organism" of Clements and Phillips and especially the holism of Smuts.

The Americans: Clements and the organism versus Tansley's ecosystem

During the immediate post-war period, there was considerable ecological work being done in North America also. Victor Shelford, working in Illinois, and Frederic Clements, working in the North American southwest, were more or less following along with their British contemporaries in the attempt to make sense of obvious patterns of vegetation formations. Clements is frequently credited with developing the idea of ecological succession and its essential component the climax community, although it might be suggested that many of his contemporaries had already incorporated those ideas into their thinking.[22] What he is most noted for, as suggested above, is the idea of the ecological system as an organism.

Whether or not Clements was directly influenced by Kant's organicism, it is worth noting that such thinking was very common in those days (indeed, Tansley's deep study of psychoanalysis may have been so influenced, as suggested by his detailed response to Clementsian "biomes as organism"). Certainly his extensive fieldwork impressed upon him the changing character of vegetation. It is something made evident from direct field observations, to be sure, but also informed by qualitative theory allowing interpretations of what likely had happened in particular situations, which is to say how particular vegetation formations got to be where they are. It would thus seem natural to think of the process of development in real organisms as being quite similar to the "development" so evident in detailed study of vegetation patterns. His contemporary and coauthor Victor Shelford, for example, could clearly see how one vegetation formation (a sere) could be replaced by another and how such vegetation changes would produce similar changes in associated animals.[23] During the period before, during, and after WWI, Kant's notion of organicism was popular in European philosophical circles and it is likely that such thinking would have influenced American ecologists also.[24]

Undoubtedly such observations and their interpretations had long been common in indigenous knowledge systems. Indeed, traditional farmers who leave fields fallow to "rest" the land, effectively acknowledge the idea of ecological succession. I have personally heard farmers speak of the development of fallow vegetation as if it were a developing child eventually reaching adulthood. Regardless of such deep origins, Clement's ideas of succession and the climax community as an ideal organism were introduced to the western intellectual world in 1904 and 1905 in his two most famous books. Reading his description in the light of readily available observations of different vegetation formations, it is evident to every field biologist that his framework seems to make ultimate sense. Yet, there is a certain philosophical perniciousness to the idea. Tansley discusses this idea in great detail in his famous 1920 *Journal of Ecology* paper.[25] First, in an elegant framing that suggests where it all comes from, Tansley notes:

> . . . it is clear, even to the most superficial observer, that the complex of interactions between plants and their environment does lead to a certain degree order in the arrangement and characters of the resulting vegetations. The human mind is irresistibly impelled to express this order in some systematic form, . . . [which is] indispensable as a framework into which to fit our investigations on the concrete phenomena of vegetation.

Yet he was careful (as perhaps contemporary ecologists should take note) to note:

> We must never conceal from ourselves that our concepts are creations of the human mind which we impose on the facts of nature, that they are derived from incomplete knowledge, and therefore will never exactly fit the facts, and will require constant revision as knowledge increases.

He then goes on to categorize the ways in which vegetation may be so categorized, including a long section on Clementsian notions of succession and climax, and, more importantly, on what it means to be an "organism." He notes, quite simply and with historical acumen:

> It does not follow, because vegetation units may be usefully treated as organic entities, that they are organisms:

Noting that a true organism is a self-contained unit, which vegetation formations are not, he goes on to consider the human "community" as perhaps an alternative metaphorical framing that could be philosophically essential. Human communities consist of individuals that are not contained in a real "body" in any sense, but that interact with one another in a way that emergent structures are clearly recognizable. Noting that a human community is not really an organism either, Tansley suggests that we may consider it, nevertheless, as a "quasi-organism". He then asks whether plants, given different species interacting in similar ways, generate such an emergent structure that might be usefully thought of as a quasi-organism? But he then notes how humans have determinative powers, predict the future (imperfectly to be sure), and with agency, determine the conditions of their community. He notes that:

> In a plant community we know nothing of such psychical awareness. . . . [forcing us to conclude

> that] plant communities are less like organisms than are human communities, for they lack especially the most important nexus binding the members of a human community to one another, and replacing the nexus which, in a true organism, is provided by its close physical unity and the unity of control deriving ultimately from its homogeneous nuclear and cytoplasmic equipment.

In effect Tansley argues persuasively that the plant association is not only not an organism, it is not even a quasi-organism.

It is only after this long and detailed critique of the idea that a plant community could be usefully thought of as an organism (or quasi-organism), that Tansley goes into what has become a central organizing feature of contemporary ecology, the idea of the ecosystem.[26] While never actually using the term in this particular article, he clearly posits it as an answer to both the Clementsian idea that the plant association is determined by climate and edaphic factors (the organism idea), and the idea that plant species associations are determined exclusively through their interactions with one another. He incorporates both the physical and biotic forces impinging on the plant association, in clear recognition of contemporary notions of "ecosystem." It was not until 15 years later that he actually described the ideas presented in 1920 with the word ecosystem.[27]

Current notions of the ecosystem, especially in the subfield known as ecosystem ecology, deviate to some extent from its original intent. In 1942 Raymond Lindeman published his highly influential paper "The trophic-dynamic aspect of ecology" which drew attention to nutrient flows and energy transfers in ecosystems, followed by extensive work by Howard and Eugene Odum using the concepts to characterize ecosystem properties, to some extent taking the emphasis that early plant ecologists had placed on the effect of the inorganic forces on the organic ones and reversing it to focus on how the organic forces effect the processes of nutrient cycling and energy flow in the ecosystem. The result has been, to some extent, a refocus on the physicochemical aspects of ecology to the detriment of considerations of the biological organisms themselves.[28]

The Environmental Movement and the Influence of Rachel Carson

Usually thought of as outside of the intellectual traditions of academic ecology, the work of Rachel Carson needs at least a mention. She is, of course, regarded as the founder of the modern environmental movement, with the publication of "Silent Spring," attacked by right-wing ideologues in its day, but standing the test of time to become a still-relevant classic. But beyond that fame, Carson's previous two books set a different stage.[29] To those of us who had read them before we read "Silent Spring", Carson's prose and her insights emphasized the complexity of nature. Subjects that today seem commonplace in contemporary ecology (e.g., trait-mediated indirect interactions, multidimensional networks) were covered with examples in both of these books. While the focus was on the oceans, the ecology presented was complex and reminiscent of what many of us felt we had already observed in nature. They were, in my view, prescient.

From Hogben to Lewontin and Levins: constructivism and dialectics as guiding principles

Lancelot Hogben entered this narrative, as noted above, in contradistinction especially to Smuts and Phillips, but, perhaps more importantly and in a deeper intellectual sense, to Tansley and others like him. Hogben took on what Marxists of the age argued, that it was not that Imperialism should be made more "efficient," but rather that the imperial project itself was the problem, something contemporary proponents of "sustainable development" might wish to comptemplate. This is Hogben's direct connection to the narrative here. But the indirect connection was perhaps far more important.

Hogben's politics were worn openly. In addition to his support for the black liberation movement in South Africa, he was a major opponent of the eugenics movement then ascendant in the West. He was a conscientious objector during WWI and, in solidarity with his mathematician and feminist wife Enid Charles, he adopted a radical feminist point of view.[30] This political perspective propelled him to something of a popularizer of science and led to his most famous book "Mathematics for the Million" which sold more than half a million copies during his lifetime.

Hogben was fundamentally a biologist and statistician whose work ranged widely, diffusing a great deal of scientific work such that he is not recognized for any particular major contribution to either biology or statistics. Yet there is a body of work that is arguably prescient, if not recognized explicitly either at the time nor by subsequent historians. Partly in response to the infamous last chapter of Fisher's "Genetical Theory of Natural Selection," Hogben noted the impossibility of disentangling genetic from environmental effects, precisely inventing the didactic technique of the norm of reaction, as it was later called.[31] While Hogben persisted in his critique of the hereditarian point of view as applied to human beings, he also invented something that was not really appreciated until much later, specifically in 1967, as detailed below. That invention was the explicit recognition of what some call the "constructionist" point of view, what I shall call the environment/organism dialectic, in which the organism and environment are dialectically related to one another.

The environment/organism dialectic can be seen as emerging, at least in part from Hogben's detailed examination of experimental results, and especially in his correspondence with R. A. Fisher.[32] That the environment partially determined phenotypic characteristics was certainly realized well-before Hogben and Fisher debated its significance. But the difference between these two thinkers is informative,

both epistemologically and politically. Fisher was a strong supporter of the eugenics movement and a vociferous opponent of socialism, precisely the opposite of Hogben. Indeed, a quick read even today of the last chapter of Fisher's 'The Genetic Theory of Natural Selection" is instructive for its tone, implicitly assuming a kind of naturalistic or genetic element to the class-based society of twentieth century Britain. Hogben, with his epistemological toolkit influenced by an underlying Marxism, looked at contradiction as the point source of resolving contradictory issues. Thus, Fisher viewed the influence of the environment as a troublesome additional variable that needed to be factored out of genetic experiments and, by implication, an "unimportant" variable to be minimized in the analysis of whatever traits are of interest. In contrast, Hogben saw the clear additive effects of genetics and environment, but was most concerned with understanding their interaction (what Fisher referred to, apparently demeaningly, as a nonlinear effect). Without doubt, Hogben was ahead of his time and the profound meaning of the environment/organism dialectic has yet to be fully realized, although it keeps reemerging in modern evolutionary biology,[33] and is a crucial element in much of ecological theory, although in a completely different form.[34] As in the currently popular idea of niche construction,[35] the organism is a dialectical whole comprised of its environment and its genetic heritage, while its environment is partially a product of the organism itself. These ideas, important in modern ecology, were effectively foreseen by Hogben in the 1930s.

While Hogben kept producing a steady stream of both popular and scientific papers well into the 1960s, an independent major event occurred in 1967 at the University of Syracuse, New York. Richard Lewontin, then at the University of Chicago, organized a symposium dedicated to the proposition that the three academic disciplines of Ecology, Evolutionary Biology, and Developmental Biology had so much in common that they should be thought of as three elements of effectively the same discipline. The documentation from that symposium is less than enlightening,[36] but having attended myself, I attest to its major influence on both the audience and presenters. Front and center was a sense of the need to consider the organism/environment dialectic as a centerpiece of a new biology. Robert MacArthur spoke of the need for developing a formal mathematical theory of the ecological niche, and Richard Levins spoke of the evolutionary process operative in a variable environment, with Lewontin himself promoting the idea that the organism develops in an environment and that environment is constructed in part by the organism developing in it.[37]

This historical narrative ends with the brilliant work of Richard Levins (1930–2016), most all of which can be seen as fitting into the general framework of the organism/environment dialectic. Just listing the subject matter of his extensive theoretical explorations is in a sense viewing much of the theoretical foundation today recognized in ecology. From the famous Levins equation of metapopulation theory,[38] to his long term insistence on the direct study of "complexity"[39] (reflected today in ecology's entrance into the burgeoning field of complexity science), to the representation of the ecological community as the "community matrix" with its eigenvalues dictating stability conditions,[40] to loop analysis (effectively a precursor to the currently popular network analysis),[41] to the as yet unresolved issue of limiting similarity and species packing,[42] to the currently popular ideas of indirect interactions[43] and the importance of stochastic factors. In all of this development, to say nothing of his contributions to political theory and public health, he always insisted on the dialectical method as the most profound epistemological methodology, reaching a milestone in his collaborative effort with Lewontin in their "The Dialetical Biologist" with a quote from the nineteenth century Engles, which I repeat to also end the current essay:

> Dialectics constitutes the most important form of thinking for present-day natural science, for it alone offers the analogue for, and thereby the method of explaining, the evolutionary processes occurring in nature, inter-connections in general, and transitions from one field of investigation to another.
>
> Engles, 1878

NOTES

[1]Jacobs, 2000.

[2]Especially chapter 3 of The Origin is actually an excellent introduction to some basic ecological concepts. Darwin's famous recounting of how clover is dependent on cats certainly anticipates modern ideas of direct and indirect interactions, trophic cascades, and niches.

[3]Quote taken from Stauffer, 1957.

[4]See, for example, Goodland, 1975.

[5]Taken from Project Gutenberg Australia. http://gutenberg.net.au/ebooks13/1303671h.html

[6]Recalling the influential, although now discredited, analysis of Thomas Hobbs in his "Leviathon, or The Matter, Forme and Power of a Common-Wealth Ecclesiasticall and Civil."

[7]Quoted in Wheatcroft's review of James' book "Churchill and Empire" (2014).

[8]Hellen Tilley, 2011.

[9]ibid.

[10]Richard Levins' 80th birthday celebration had as its principle theme, "The truth is the whole."

[11]While a rather large number of scholars identify as political ecologists, it is my sense that they emphasize the social side to a great degree. Integrating the natural and social aspects of ecology is a challenge that the field needs to step up to.

[12]These ideas rekindled some important positions earlier elaborated by Kant. Especially important was the idea of organicism as so clearly presented by Jennifer Mensch (2013), as central to Kant's analysis.

[13]Fieldhouse, 1961.

[14]Fieldhouse, 1961 p. 188.

[15]It might be relevant to note that this sort of "work within the system" attitude seems to be a constant of history. Today, for example, the realities of post-communist neoliberalism are, to say the least, harsh for the majority of the world's population. Yet, rather than concluding, as many Marxists would, that the neoliberal capitalist system is the thing that has to be changed, the refrain is, as it always has been when power seems to be challenged, "be realistic." Jingles such as, "Don't let the perfect be the enemy of the good" and others keep reminding political actors that only unrealistic idealists would seek confrontation with political power, no matter how illegitimate.

[16]Although some of the words Hogben used were overtaken by modern terminology, his emphasis on the limiting factors in the genotype to phenotype transition are relevant yet today, even if different terms are used. For example, he recognized two general forms of limiting factors—intra-limited and extra-limited. Some of the intra-limited forms were termed "bedfellow" genes, while the extra-limited factors were generally those imposed by the environment, both intra- and extracellular. The dialectical thinking here is evident: intra- verses extra-contradiction, for example.

[17]Simberloff, 1980; Levins and Lewontin, 1980; 1994.

[18]Tansley, 1920 p. 125.

[19]Cameron and Forrester, 1999.

[20]As quoted in Golley, 1996, p. 209.

[21]See, for example, Rocheleau et al., 2013; Escobar, 1998; 1999; Durham, 1995. The professional journal *Political Ecology* is clear testament to the field's vitality.

[22]It is also worth noting that his wife, Edith Schwartz, had a Ph.D. in botany and was his regular companion during all of his field work. As is so frequently the case, female companions in those days clearly would have had an impact on the development of their husbands' ideas, but are rarely themselves given much credit.

[23]See, for example, Shelford, 1907.

[24]This idea is worth considerable further research. Mensch speaks of the general influence of Kant's ideas on the intellectual developments of the period, but any explicitly ecological application seems not to have been explored as of this writing.

[25]Actually, Tansley's treatment is mainly biological. For a more philosophical critique, see Simberloff, 1980.

[26]In this same work Tansley also criticizes Gleason's notion (a critique that would apply to the future work of Whittaker also) that plant species seem to operate completely independently from one another, clearly siding with Clements at least on the issue of plant associations themselves being real.

[27]In particular, on page 299 of Tansley (1935), he notes: "Our natural human prejudices force us to consider the organisms (in the sense of the biologist) as the most important parts of these systems, but certainly the inorganic 'factors' are also parts—there could be no systems without them, and there is constant interchange of the most various kinds within each system, not only between the organisms but between the organic and the inorganic. These ecosystems, as we may call them, are of the most various kinds and sizes."

[28]This, perhaps controversial, point of view was stimulated by conversations with my colleague Mark Hunter.

[29]"The Sea Around Us" and "The Edge of the Sea"

[30]It is worth noting that Enid Charles was herself an intellectual and certainly had much influence on Hogben, yet her life and true influence has yet to be explored, both in terms of the influence she may have had on her husband and her independent work. In her case it is clear that her work involved both mathematics and politics. She did work on fertility rates in the United Kingdom, noting that the trends at the time indicated that the U.K. was looking to a depopulated future, one of the many statistical arguments made against the Malthusian position. This work certainly must have contributed to her husband's genetic arguments against eugenics. Her independent work with the WHO has never been studied completely, but from the overview presented by Sylvia Wargon (2004) it might well be the case that she was an early contributor to the general fields of rural sociology in the Global South, a subject worthy of much future study.

[31]Hogben, 1933.

[32]Tabery, 2008.

[33]Laland et al., 2015.

[34]Vandermeer, 2004; 2008.

[35]Odling-Smee et al., 2003.

[36]Lewontin, 1968; but see Wilson, 1969.

[37]Lewontin (2001) would later develop these ideas into a general semi-popular framework in The Triple Helix, presaging the current debate in evolutionary biology regarding the extended evolutionary synthesis (e.g., Laland et al., 2015).

[38]Metapopulation theory has become a center piece of much of ecology today, extended and expanded by Hanski (1999). The original work, barely cited for more than a decade, was Levins, (1969).

[39]In my long-term interactions with Levins, one of his persistent themes was complexity, from my time as his post doc in 1969 in Chicago, throughout our long-term collaboration and friendship, complexity was always central to his way of thinking about science and politics. A few relevant publications include Levins, 1968; 2006; Levins and Lewontin, 1985; Lewtontin and Levins, 2007.

[40]Levins, 1968a: See especially chapter 3 on the community matrix.

[41]Levins, (1974) is the basic outline of the idea, followed up by Levins and Puccia (1988). Then in Puccia and Levins (2013), the idea is put into practice with a large number of examples.

[42]The standard reference is Macarthur and Levins, 1967. Extensive discussion of the concept followed, e.g., Abrams 1975; 1983; Kinzig et al., 1999; Stubbs and Bastow Wilson, 2004.

[43]Levins, (1979) is a complicated article, but anticipates both the effects of nonlinearities and stochasticity. It anticipates more recent theoretical work such as that of Barabás et al. 2012. It also represents a very abstract approach to the large literature on indirect interactions (e.g., Werner and Peacor, 2003).

REFERENCES

Abrams, P. 1975. Limiting similarity and the form of the competition coefficient. *Theoretical Population Biology*, *8*(3), 356–375.

Abrams, P. 1983. The theory of limiting similarity. *Annual review of ecology and systematics*, *14*(1), 359–376.

Barabás, G., Pigolotti, S., Gyllenberg, M., Dieckmann, U., and Meszéna, G. 2012. Continuous coexistence or discrete species? A new review of an old question.

Cameron, L. and Forrester, J. 1999. 'A nice type of the English scientist': Tansley and Freud. In *History Workshop Journal* (Vol. 1999, No. 48, pp. 64–100). Oxford University Press.

Durham, W. H. 1995. Political ecology and environmental destruction in Latin America. *The social causes of environmental destruction in Latin America*, 249–64.

Escobar, A. 1998. Whose knowledge, whose nature? Biodiversity, conservation, and the political ecology of social movements. *Journal of political ecology*, *5*(1), 53–82.

Escobar, A. 1999. After nature: steps to an antiessentialist political ecology 1. *Current anthropology*, *40*(1), 1–30.

Fieldhouse, D. K. 1961. 'Imperialism': An Historiographical Revision. *The Economic History Review*, vol. 14, no 2, p. 187–209.

Golley, F. B. 1996. *A history of the ecosystem concept in ecology: more than the sum of the parts*. Yale University Press.

Goodland, R. 1975. The Tropical Origin of Ecology: Eugen Warming's Jubilee. *Oikos, 26*(2), 240–245. doi:10.2307/3543715

Hanski, I. 1999. *Metapopulation ecology*. Oxford University Press.

Hogben, L. 1933. The limits of applicability of correlation technique in human genetics. J. Genet. 27:379–406.

Jacobs, M. C. 2000. The truth of Newton's science and the truth of science's history: Heroic science t its eighteenth-century formulation. In Osler, M. J. *Rethinking the scientific revolution*. Cambridge University Press, 2000.

James, L. 2014. Churchill and Empire: A portrait of an Imperialist. Pegasus Books.

Kinzig, A. P., Levin, S. A., Dushoff, J. and Pacala, S. (1999). Limiting similarity, species packing, and system stability for hierarchical competition-colonization models. *The American Naturalist*, *153*(4), 371–383.

Laland, K. N., Uller, T., Feldman, M. W., Sterelny, K., Müller, G. B., Moczek, Jablonka, A. and Odling-Smee, J. 2015. The extended evolutionary synthesis: its structure, assumptions and predictions. In *Proc. R. Soc. B* (Vol. 282, No. 1813, p. 20151019). The Royal Society.

Levins, R. 1968. Ecological engineering: Theory and Technology. Review of Watt, K. Ecology and Resource Management: A quantitative approach. Quarterly Review of Biology, 43:301–305.

Levins, R. 1968a. *Evolution in changing environments: some theoretical explorations* (No. 2). Princeton University Press.

Levins, R. 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. *Bulletin of the Entomological society of America*, *15*(3), 237–240.

Levins, R. 1974. Discussion paper: the qualitative analysis of partially specified systems. *Annals of the New York Academy of Sciences*, *231*(1), 123–138.

Levins, R. 1979. Asymmetric Competition Among Distant Taxa. *American Zoologist*, 19(4), 1097–1104.

Levins, R. 2006. Strategies of abstraction. *Biology and Philosophy*, *21*(5), 741–755.

Levins, R. and Lewontin, R. 1980. Dialectics and reductionism in ecology. *Synthese*, *43*(1), 47–78.

Levins, R. and Lewontin, R. C. 1985. *The dialectical biologist*. Harvard University Press.

Levins, R. and Puccia, C. J. 1988. The controlling factor in biological communities. *Coenoses*, 149–154.

Levins, R. and Lewontin, R. C. 1994. Holism and reductionism in ecology. *Capitalism Nature Socialism*, *5*(4), 33–40.

Lewontin, R. (ed) 1967. Population Biology and Evolution: Proceedings of an international symposium, Syracuse, N.Y., Syracuse University Press.

Lewontin, R. C. 2001. *The triple helix: Gene, organism, and environment*. Harvard University Press.

Lewontin, R. and Levins, R. (2007). *Biology under the influence: Dialectical essays on the coevolution of nature and society*. NYU Press.

Macarthur, R. and Levins, R. 1967. The limiting similarity, convergence, and divergence of coexisting species. *The American Naturalist*, *101*(921), 377–385.

Mensch, J. 2013. Kant's organicism: Epigenesis and the development of critical philosophy. University of Chicago Press.

Odling-Smee, F. J., Laland, K. N. and Feldman, M. W. 2003. *Niche construction: the neglected process in evolution* (No. 37). Princeton University Press.

Phillips, John. 1935. Succession, development, the climax, and the complex organism: an analysis of concepts: part III. The complex organism: conclusions. *Journal of Ecology,* 23(2): 488–508.

Puccia, C. J. and Levins, R. 2013. *Qualitative modeling of complex systems*. Cambridge, MA: Harvard University Press.

Rocheleau, D., Thomas-Slayter, B. and Wangari, E. 2013. *Feminist political ecology: Global issues and local experience*. Routledge.

Shapin, S. 1996. The scientific revolution. *University of Chicago Press*, 1996.

Shelford, V. E. 1907. Preliminary note on the distribution of the tiger beetles (Cicindela) and its relation to plant succession. *The Biological Bulletin*, *14*(1), 9–14.

Simberloff, D. 1980. A succession of paradigms in ecology: essentialism to materialism and probabilism. *Synthese*, 1980, vol. 43, no 1, p. 3–39.

Stauffer, R. C. 1957. Haeckel, Darwin, and Ecology. The Quarterly Review of Biology 32: 138–144.

Stubbs, W. J. and Bastow Wilson, J. 2004. Evidence for limiting similarity in a sand dune community. *Journal of Ecology*, *92*(4), 557–567.

Tabery, J. 2008. RA Fisher, Lancelot Hogben, and the origin (s) of genotype–environment interaction. Journal of the History of Biology, 41(4), 717–761.

Tansley, A. G. 1920. The classification of vegetation and the concept of development. The Journal of ecology, 118–149.

Tansley, A. G. 1935. The use and abuse of vegetational concepts and terms. Ecology, 16(3), 284–307.

Tilley, H. 2011. Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870 – 1950.

Vandermeer, J. 2004. The importance of a constructivist view. *Science*, *303*(5657), 472–474.

Vandermeer, J. 2008. The niche construction paradigm in ecological time. *Ecological modelling*, *214*(2), 385–390.

Wargon, S. 2004. Legacy of Enid Charles, 1894–1972. Canadian Studies in Population, 32.2: 137–153.

Werner, E. E. and Peacor, S. D. (2003). A review of trait mediated indirect interactions in ecological communities. *Ecology*, *84*(5), 1083–1100.

Wheatcroft, G. 2014. Imperial Son: 'Churchill and Empire; NYT Sunday Book review,. Aug. 15, 2014.

Wilson, E. O. 1969. Populafton Biology and Evolution. Proceedings of an international symposium, Syracuse, NY, 1967. Richard C. Lewontin, Ed. Syracuse University Press, Syracuse, 1968. x+ 206 pp., illus. $8.

Science with Passion and a Moral Compass

In honor of John Vandermeer, his ongoing work and legacy

From May 6 to 8, 2016, over 200 people gathered in Ann Arbor to celebrate the achievements in science and activism of Professor John Vandermeer. For this VandyFest, two days of talks, discussions, and meetings were accompanied by social gatherings on and around the campus. The symposium on Saturday and Sunday featured 50 speakers, including many of John's former and current students, collaborators, and colleagues. Followed by a banquet. The theme of the symposium was "Science with Passion and a Moral Compass." People attending the symposium came from many parts of the United States, Mexico, Panama, Nicaragua, Spain, and Japan. Banquet photo credit: Linda Perfecto

Casey Taylor, Deborah Letourneau, Lesli Hoey, Julie Jedlicka

Kate Ennis, George Livingstone, Doug Jackson

Aldo de la Mora, Lilian Kline, Estelí Jimenez, Aaron Augsburger

Sonia Auilar Araya, Eduardo Somarriba

Kristen Nelson, Margaret Reeves, Andy Kaufmann, Guest, Ann Larimore

Noah Fulmer, Pranav Yajnik, Gordon Fitch, Gavin Taylor

Gavin and Lily Fink Shapiro, Eliott Jackson, Nathalie Lambrecht

Vivian Valencia, Alex Golden, John Graham

Doug Boucher, Jon Pruitt, Jerry Urquhart, Sally Gladstone

Brian Schultz, Lisa Bradshaw

Aina Bernier, Hunter Van Valkenburgh, Edmund Russell, Tom Will

Rachel Long, Kevin Li, Beatriz Otero, Carlos Anderson

Sioban Harrow, Iñigo Granzow de la Cerda, Scott Peacor

Angela Dillard, Alan Wald, Kim Hunter, Katheryn Savoie, Joseph Graves Jr.

Krista McGuire, Moshe Rhodes, Paul Foster

Paul Dunlap, Mercedes Pascual, Brian Hazlett

Tom Dietsch, Brent Blair, Sarah Cohen

William Alexander, Susan Wright

John Guitar, Paul Glum, Loren Trimble, Liz Wason

John Soluri, Erika Schreder

Luis Garcia-Barrios, Shalene Jha, Gustavo Lopez Bautista

Kim Hunter, Katherine Savoie, Sally Gladstone, Allen Hruska

Peter Rossett, Cruz Phillips, Michael Hansen, Chela Vázquez

Sunny Power, Katherine Yih, Jack Spence, Doug Boucher

Ben Juliano, Chatura Vaidya, Noah Fulmer, Theresa Ong, Pranav Yajnik

Jaime (Kiko) Morales, Cass Vandermeer, John Vandermeer, Ivette Perfecto

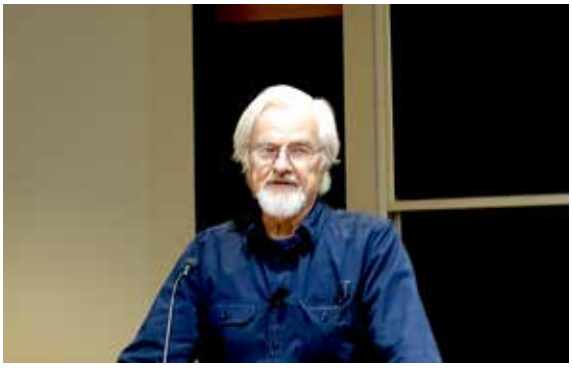
Luis Fernando Chaves, Senay Ytbarek, Uriel Kitron

David Allen, Katie Goodall, Anat Balasen, Karla Peña, Mariana Valencia

Cathy Bach, Bill Durham, Deborah Goldberg, Rob Colwell

Zach Hajian-Farooshani, Beatriz Otero, Ivette Perfecto, Catherine Badgley

Ivette Perfecto



John Vandermeer

Theresa Ong, Doug Jackson, David Allen, Senay Yitbarek

Hannah Perfecto, Eric Perfecto, Linda Perfecto, Jason Vandermeer, Chloe Vandermeer. , Cass Vandermeer, Erin Black, John Vandermeer, Ivette Perfecto, Jaime (Kiko) Morales, Diana Slaney, Rachel Perfecto

Heidi Liere, Shaline Jha, Bruce Ferguson, Krista McGuire, Eduardo Somarriba, Stacy Philpot, Iñigo Granzow de la Cerda

Brian Schultz, Julie Jedlicka, Margaret Reeves, Phillis Engelbert, Katherine Yih

Peter Rosset, David Alonzo, Catherine Badgley, Jahi Chappell, Angus Wright

John Soluri, Edmund Russell, Helda Morales, Doug Boucher, Joseph Graves, Jr.

E-TRIBUTES TO JOHN BEFORE AND AFTER THE SYMPSIUM IN HIS HONOR

Joseph Alley (on Facebook and twitter)

Aprobado para que aparezca en la biografía
Standing ovation for John Vandermeer from over 100 past/present students and collaborators, who traveled across the country and world for this occasion. Muchas gracias, Juancito, for all the encouraging, inspiring, berating. And most of all, for your unflinching belief in your students' potential. You have touched our lives in so many ways that you don't know. Certainly mine. #vandyfest—con Ivette Perfecto, Linda Marin, Katherine Ennis y 13 personas más en Ann Arbor.

Miguel Altieri

Hola Ivette y John,

As we told you we will be in Japan, unable to join your fest...but we will be there in spirit honoring the inspiring work of John...that as he knows, I usually understand the first two pages of his papers due to my quantitative handicaps... nevertheless great work...you have influenced so many people to become rigorous scientists but also truly committed political activists.

Ha sido un honor conocerte, John. Saludos y felicidades.

Dave Andow

Dear John,

Congratulations and best wishes for the upcoming Vandy Fest! I wish I could be there to see you and Ivette again (after many years now), meet up with your former students and friends, many who I have not seen for some time, and share in the fun that everyone will have.

I remember well the biannual dust-ups between the Cornell and UM chapters of NWAEG over farmers or farmworkers, as if there was a correct answer. Also the trip to Nicaragua to set up the collaboration between NWAEG and the new Sandinista government during early 1981. Peter Rosset and I escaped the OTS course to join you and the others, which was an adventure in itself. But most, I remember the feelings of hope throughout the country, despite the clear limitations. I also remember our many interactions over the ensuing years, always animated by your enthusiasm, whether it be about Atlantic lowland tropical forest recovery after a devastating hurricane, the advantages of polycultures and shade-grown coffee, or the arcane topic of chaos in predator-prey dynamics.

Many of my colleagues advised me to focus my professional activities on one major topic, and by doing this, I could have a successful academic career. But by your example, I could see that there were other paths that could be followed, and I am thankful for your generosity and friendship.

Maria Antonia Mayona (January 21, 2016)

Hi Ivette,

Passionate, disciplined, and opinionated (argumentative).

Three words that describe John's personality and legacy through his students and mentees. Reading all the abstracts it seems obvious that everyone has John's touch on your research and jobs. He has profoundly inspired all of us, and he even transferred his passion for Latin American ecological-political issues to U.S. scientists with no previous connection with Latin America. As an Educator in Nicaragua working with rural primary school teachers, students, and community members, I'm still searching to understand what motivates an individual to have a positive environmental behavior: economic, health, and/or personal satisfaction.

Inge Armbrecht (May 8, 2016)

Querida Ivette,

Quiero unirme a estas voces de admiración y aprecio por John, a quien tanto queremos! Lamento no haber podido estar en persona para este sentido y merecido homenaje a nuestro John, pero el sentimiento es igual de fuerte a traves de la distancia! Un gran abrazo para John y a ti!

Lisa Bradshaw (May 13, 2016)

Hola Ivette,

Beyond energized, the weekend was so inspiring. I continue to be blown away by the depth and breadth of John's (and your) impact across people of so many disciplines and different paths. And it was great to see all those familiar faces from years gone by. I'm really excited to be back in the area and have the opportunity to be challenged, encouraged, and probably much else, close up and in person.

Thank you for all the work in organizing the event and establishing the fellowship -awesome idea. I look forward to seeing the website.

Bill Durham (June 1, 2016)

Here's my little tribute to John from Saturday night. Thank you all for organizing and taking part in the Vandy Fest: I enjoyed it so very much, and loved seeing old friends and meeting new ones. It was a great feeling all in all: take some and pass it on.

Bruce Ferguson (May 11, 2016)

John,

Mine was among the less emotive talks, but I hope you know that I am eternally grateful for all that you and Ivette did for us as students - and continue to do for us as colleagues - through your teaching, guidance, criticism, friendship, and example.

I also consider myself extraordinarily fortunate to form a part of this international academic family, some of whom are old friends and others I met for the first time last weekend. Thank you to the organizing committee for bringing us together.

Marcos Ferguson (May 12, 2016)

Bill Friedland

Dear John & Ivette:

Belatedly I want to send congratulations to John and Ivette for the masterful and continuing efforts to bring agroecological and social justice orientations into modern agriculture from the U.S. to Central American and Caribbean agriculture and societies. Thereby serving as model builders for agriculture elsewhere in the five continents.

I haven't been as close to NWAEG as I might have wished but it has always been encouraging in my own word to know that there are sturdy comrades, and countless students and colleagues carrying on valuable activities. You have served as models for me and many others who have worked for similar goals here in California.

Best wishes and hopes for a continuing struggle.

Luis Garcia Barrios (May 10, 2016)

Dear Peter,

Thank you for sharing with all of us this personal message to John. In a message like this is where the frontier between the individual and the community dissolves for the good of all.

Luis Garcia Barrios (May 11, 2016)

Muchas Gracias Ivette !Fantástico e inolvidable fin de semana. Against all odds, as John said in his email: "We are doing the revolution", and its been rewarding in so many ways!

Doug Gill

Although I shall be unable to attend, I extend my heartiest congratulations to my dear friend/colleague John on the occasion of this grand celebration of his truly remarkable career! Accolades from his many admirers are all well deserved! Hugs and Cheers.

Galio Gurdian Kaufman

Querida Ivette:

He estado siguiendo por esta vía todos los esfuerzos y preparativos para la celebración del gran John Vandermeer. Al igual que Linda, que hubiese gustado muchísimo estar con Uds., físicamente. Lo estaré de corazón. John y vos son y han sido parte de mis grandes mentores a quienes mucho admiro y aprecio. Esa combinación de John, de ser científico y ser comprometido con este mundo que nos ha tocado vivir, es una combinación excepcional.

John, y su casa, Darrow House?? gracias a las recomendaciones de Bill y Kathy Durham, Vicky Sork quienes vivieron conmigo en sus años de estudiantes de doctorado en El Salvador, previo a la guerra, fue mi hogar en los primeros días que estuve aprendiendo Inglés en Ann Arbor, Michigan. Los años de la revolución en Nicaragua, con Science for the People, fueron extraordinarios por la solidaridad de Uds.

John y vos, son maestros de generaciones que hemos tratado de seguir el ejemplo de Uds. Un gran abrazo desde esta Nicaragua, tan dulce y tan dolorosa.

Pat Gurin

John,

I had let Ivette know that Jerry and I are off to Chicago tomorrow for our granddaughter's graduation for master's in public health. She is the child we have raised since she was two and so of course we need to be with her. But as I have kept up with the plans for the weekend for your wonderful event, I am really bummed, both missing being there because of my love and admiration for you and because of a great desire to be part of the gathering community who stand for all the right things in the world. Please know that I will be there is spirit.

Doug Gurian-Sherman (May 10, 2016)

John,

As always, you are entirely correct in your observations! Seriously, except that I think that you underestimate your importance in the process. I have so often seen colleagues fall short on all of the things you discuss and kind of minimize from the perspective of being obvious or easy (mentoring, encouraging, opening doors, substantive dialogue, listening....). Essentially, you have helped foster, building on Levins, Lewontin and others, a community that values justice and equity as integral to physical science. All of that is no small thing.

And on top of that, your own research work is so impressive in advancing all of this.

Don't worry, I am not falling into the "great man" hypothesis of history (I don't dignify it as a theory...even in the conventional usage!). As you note, it is the community that makes all of this work. But you (and the Perfectomeer duo) are an incredibly important part of that community, and I have no doubt that it would have been greatly diminished without you. As someone who has been in some ways on the periphery of that community, it was an honor to participate in your festschrift.

Eric Holt-Gimenez (May 9, 2016)

Dear John and Ivette,

I watched these preparations from afar. My warmest wishes to you. I hope the celebration was everything you hoped for and more.

E-TRIBUTES TO JOHN BEFORE AND AFTER THE SYMPSIUM IN HIS HONOR CON'T.

Steve Hubble

Greetings from China. Just a note to say how sorry I am to miss John's thing. He is a wonderful friend and colleague, and I hope he continues to enjoy an active career in science guided by his fabulous moral compass.

Joseph Hunt

Dear John and Ivette,

I won't be able to come, but I retain fond memories of your meeting on food sovereignty following Dick's celebration. Thank you for making me feel welcome at UM.

Warm wishes and congratulations for the well-deserved festivities about to wash over you both. A rare partnership that inspires and coheres.

I once asked Dick about his legacy, and your names popped up instantly. He sometimes doubted the teaching side in treacherous proximity to Harvard's Slough of Despond, but he brightened up when talking of you both.

By contrast, Dick and Rosario loved my mushroom quiche.

My place in the universe thus assured, I was comfortable nodding when he said that John and Ivette were amazing contributors to knowledge and the virtuous, bracing path but even more so as celebrators of the young minds you shaped around new definitions of inquiry and meaning.

Marchia Ishii-Eiteman

Hey John,

Just wanted to send you very big warm wishes on the occasion of your Festschrift. I'm so sorry to miss it. Unlike lucky Margaret, I'm stuck at a really awful two-day "global food summit" at UC Irvine put on by the UC system. (I gave a talk on agroecology last night, which is why I'm here instead of in Ann Arbor - where I'd much rather be!) With much appreciation for all the inspiration and brilliance you bring to the movement.

Esteli Jimenez-Soto (June 1, 2016)

Hola Ivette,

Muchas gracias por compartir este articulo. No tuve la oportunidad de ir a LASA este año (tal vez el proximo en Peru!), asi que me viene perfecto leer esto. Tambien muchas gracias por la excelente reunion organizada en Ann Arbor, realmente estuvo fenomenal y Ann Arbor es hermoso, ojala vuelva pronto.

Ivette, te voy a mandar un cheque hoy para pagarte la alimentacion en la finca de este año y parte del año pasado. Puedes mandarme tu direccion por favor?

David Kaimowitz (May 5, 2016)

Dear Ivette,

I am extremely sorry that I will not be able to join you, John, and all of the other friends for this wonderful event. I truly would have loved to be there. At the very least, though I wanted to publicly express my huge admiration for the many years of fabulous work of both John and you yourself. The two of you have been and are amazing examples of a quite unusual combination of science at the service of progressive values and presented and taught in a way that connects with students' minds and hearts. The fact that you have sustained the work over decades and across continents, and nurtured a whole generation of disciples makes it that much more impressive.

My hat it off to John—and to you—and I will certainly be present in spirit.

Stuart Ketcham (May 8, 2016)

Congratulations, John!

Salutations, Ivette and all NWAEGgies I too wish I could be there, but am swamped with grading and other end-of-semester activities. Thank you for being amazing models of socially conscious scholarship and activism! And for being such generous friends!)

James Lerma Montoya

En verdad que estoy bastante conmovido por el homenaje a John. Aunque no fui alumno directo suyo, he recibido su influjo a través de sus mensajes y artículos. Es el holotipo del científico nato, que junta conocimiento con rebelión y los manifiesta ante los hechos y circunstancias que encierran injusticia e inequidad. Bravo por él. Les deseo el mayor de los éxitos durante la celebración. Por favor pasa a él mi humilde pero sincero reconocimiento. Abrazos.

Brenda Lin (September 22, 2016)

John,

I have always valued you as a mentor and friend for your honesty, integrity, and willingness to be direct and open. Your ability to "tell it like it is" while finding the humor in life is an aspect of your personality I respect and appreciate. But most of all, I like eating with you. I like that you will over-order with me when there are more things on the menu that look good than can actually fit in our stomachs. And I like the fun conversations that go with all that food. I wish I could have been in Michigan to celebrate your festschrift, but I will definitely see you soon for another meal.

Gustavo Lopez Bautista (May 11, 2016)

Jon e Ivette. Muchas gracias por todo lo que hacen por los demás y especialmente por mi. Nunca dejó de sorprendeeme de lo que hacen. En todos estos años de conocerlos he aprendido a ver la vida desde otro angulo. Otro concepto diferente y a saber que un mundo diferente es posible. Ver todo esa gama de conocimientos reunidos en un sitio y por el mismo motivo. Me obliga a mejorar mi compromiso con el proyecto. con los demás y conmigo mismo. Gracias. Y gracias a todos.

Linda Marin (May 5, 2016)
Ivette,

Hubiese sido maravilloso estar con ustedes para celebrar a John. Desafortunadamente no puedo estar allí en cuerpo, pero lo estoy con el corazón. Por favor dale un gran abrazo a John de mi parte y disfruten mucho de esta memorable celebración.

Con cariño.

Doyle McKey
Ivette,

As I wrote you several months ago, I won't be able to make the trip over from France. I know this is going to be a great occasion, and I wish I could have been there. John has been a source of inspiration since my very first foray into tropical biology in an OTS course, then later at Ann Arbor, then during your sabbatical time here in Montpellier. Have fun, and I look forward to reading the results!

Ernesto Mendez (April 30, 2016)

All Ron's words reflect exactly my thoughts and feelings about John and also Ivette. First, I would have loved to attend the "pachanga." But most important is the desire to share and celebrate with everyone the great inspiration, to my agroecological journey, which John Vandemeer has been inspiring, since my discovery of the field in the early 90's and to the present.

Jeremy Moghtader

I am really bummed to miss this amazing event to celebrate John. His and your influence on who I am and how I view and interact with the world was formative for me and something for which I am deeply grateful.

Thank you for all you have done for so many students before and after me. You all have truly created something special.

Maywa Montenegro (May 7, 2016)
Dear Ivette and John,

Like others who have expressed their gratitude and well-wishes on this listserv, I salute you both from afar. As a relative newcomer to the field, I can see in close hindsight several critical junctures that led me to where I am now. Many of these crossroads are stippled with signs bearing your imprints: Nature's Matrix, agroecology alternatives to land sparing/intensification, "complex traditions" of indigenous and Western knowledge, NWAEG.

Few ecologists frame their papers in terms of food sovereignty and social justice, or illuminate science as a political and cultural activity. I have marveled at your Forest Transitions models seen through Hecht's peasant perspectives, metapopulation theory legitimating campesino practice, and partnerships with historians to tell agricultural science as a path-dependent, contingent process. In real time, I've cherished the now-and-again conversations we've shared over scientific reduction(ism), Lewontin and Berlan's hybrid seeds, and the funny thought experiments on ideal GMOs: bred at the Che Guevara participatory-open-source-biotech-experiment station!

And then, of course, your teaching and mentorship have percolated through progeny Perfectomeerkats, several of whom have touched my trajectory in ways big and small. From Shalene Jha who first welcomed me to Berkeley (and to this thing called NSF) to David Gonthier who just recently taught me a little about Azteca ants (and a little more about patient pedagogy). From Peter Rosset who opened my eyes to the world of La Via Campesina to Jahi Chappell who tuned my ears to the cynical logics of "feed the world" discourse. Such "extension training" reaches learners in expanding circles beyond even your recognized kin. To borrow from a dear friend, "Onward into your next decades of producing knowledge that helps advance human dignity!"

Helda Morales (May 11, 2016)

Thank you so much for organizing a wonderful event! It was a fun, moving, inspiring learning experience.

Many thanks for each of you,

Ronald Nigh (April 30, 2016)
Querida Ivette,

Me encantaría estar para celebrar a John. Por favor transmítele un gran abrazo de me parte. Como a muchos me ha sido una gran inspiración.

Thomas O'Donnell (May 24, 2016)
Hey John,

Unfortunately I could not be at your Feschrift. I would have loved to be there and hear all the talks. The weekly meetings at NWAEG and all the pizza and beer over several years back in AA while exchanging opinions and engaging in anti-war and other social struggles with you are a special sort of memory. You created a great community - scholarly, social and otherwise. I hope you keep it up for many many years more!

Meanwhile, here's something in recognition of a socially conscious, fellow life-long meat eater:,
https://www.facebook.com/uniladmag/videos/2278378625518517/

Mercedes Pascual (May 10, 2016)

Mil gracias Ivette!
Fue increible todo el fin de semana; me alegro de haber odido venir. Me dejo pensando en tantas cosas...

Linda y Eric Perfecto (May 11, 2016)

Thanks, Ivette and John! We are still talking about what a wonderful weekend it was. So nice to catch up with all of the family, as well as Jerry and Catherine. We really enjoyed the symposium - quite a glimpse into the fascinating work that you both do and the many lives that you've touched.

Thanks also for putting us up at the Palmer House - it was a real treat to stay once again in that unique setting. Congratulations, John!

E-TRIBUTES TO JOHN BEFORE AND AFTER THE SYMPSIUM IN HIS HONOR CON'T.

Dianne Rocheleau (May 6, 2016)

Dear Ivette,

I wish I could be there with you and John to celebrate his decades of politically informed and relevant ecological science and leadership in agroecology. I have also long admired the unique collaboration that both of you have created and sustained, reaching from Ann Arbor into distant lands from Puerto Rico, Nicaragua and Cuba to Mexico and across the planet through your teaching, mentoring, research and tireless networking across scientific, environmentalist, political activist and policy domains. I am inspired by and grateful for his and your contributions to Science for the People, NWAEG and valuable networks of politically engaged scientists who have expanded the vision of various scientific communities, kept them more honest, and produced exemplary high quality ecological analysis to inform and support agriculture and resource management that feeds the people and the web of life. Un gran saludo a los dos.

Peter Rosset (May 10, 2016)

John, The more I think about the it, the more I realize how decisive you were for me. You didn't make me political, or even a marxist, as I had already been both, as a teenager. But I had been wandering lost for 6 years in an apolitical wilderness. Who knows if I would have found myself within you and your team.

You, and your recruitment agents (Mike Hansen and Katerine Yih) discovered and nurtured my talent as a Leftist. You in particular became like my second father, and best friend-conscience-mentor-professor-older brother- comrade in struggle- and academic colleague. It is hard to believe you played so many roles for me. And for SO MANY other people. I actually felt a bit jealous seeing that I was not the only one! Hahahahaha

I wanted to cry when I hugged you goodbye, but I controlled myself in a very manly fashion.

John, thank you so much in so many uncountable ways.

Tatiana Schreiber (May 8, 2016)

Hello Ivette, John and all:

In the midst of grading at the end of the semester I too could unfortunately not attend, but I too send you best wishes for a fabulous celebration which you are now completing...what a wonderful way to support John and Ivette's work and all the many people there (and all those who couldn't go but are there in spirit!) who have learned so much from it and from your mentorship along the way. I read Reconstructing Biology and it helped frame everything I have done since...I still prescribe Breakfast of Biodiversity to many students and Nature's Matrix to many more... Thank you thank you thank you! I look forward to hearing some of the ideas and synergies that I'm sure will have emerged from this gathering of so many folks doing the work that seems to become ever more critical each day. Felicidades!

Brian Schultz (May 11, 2016)

John (et al.),

Of course all that you added below is also a big part of your charm and why we also like you so much (except for the actually very rare times when you are both A&A). I appreciated and remember well how you and your lab, way back when, welcomed me and also made me feel quickly fully involved when I came over from the dark side (sociobiology) to join the polycult. So you may have fallen into a Monty-Python-Life-of-Brian sort of infinite loop ---"only the true Messiah denies his Divinity"... But if you like and don't mind, I can help you move the spotlight by suggesting a bit of NWAEG triage recruiting here?

Many people there were NWAEG of course, some may not really want/ought to be and just know you in some other way like pure modelling perhaps, but some there probably are not NWAEG and should be. Anyone on the bulk e-mail lists in that category could/should e-mail Ivette or John to get on the NWAEG list, since A2 maintains it.

Your note here did not include vandyfest@umich.edu in these bulk mailings, but perhaps you/we should send an invite to NWAEG for any appropriate suspects if you haven't already? Thanks yet again for all.

Eduardo Somarriba (May 11, 2016)

It was indeed an unforgettable weekend. The opportunity to meet John and many friends all at once is something memorable. Thanks to you Ivette and to the supporting team that made all this possible. As John use to say "Hasta la Victoria". Saludos y abrazo a todos. Eduardo.

Jack Spence (May 11, 2016)

Dear John and Ivette,

For this outlier (neither Michigan alum, nor ecologist) the weekend events were informative, impactful and politically inspiring. And there was nothing about wallowing in high minded importance. Humor, some of it puncturing balloons abounded throughout.

Some things were familiar. Is Doug Boucher capable of making an uninteresting observation? Peter is as pointed in his political astute commentary as he was when I first met him in the early 1980s.

We began the weekend with luck - a half hour conversation with Angus on the bus from the airport. And ended it at lunch with an old junior high school friend of Katherine's - lunch at The Lunch Box that is with a chance to observe the anti-capitalist's business, to converse with her about her organizing times in and about Nicaragua.

Thanks so much John for your amazing career and thanks Ivette (and Katherine Yih, and Theresa Ong and all the others who did so much - just being themselves really - to create such a wonderful weekend.

Ann Thrupp (May 8, 2016)
Hello Ivette and John,

I'm also sending warm congratulations and sincere gratitude! So sorry that I was not able to be there. It's wonderful that you are having this important celebration. It's also inspiring to read and know about the outpouring of appreciation among the NWAEGies and beyond. Thank you for all you have done and continue to do!

Liz Wason (May 11, 2016)
Hi Ivette,

I'll add my voice to the mix and say that the weekend was inspiring, moving, and expertly organized. I wonder if you could also pass along information about ordering block prints of Gordon's carving--I'd love to put one on my wall, support John's fellowship, and maybe get a few prints for friends.

Jake Weiner

I do not have many personal heroes, but John Vandermeer is on the short list of individuals about whom I can use that word. He is one of the most brilliant ecologists and one of the most principled individuals of his generation. I'm not much of a mathematician, but I know that if you multiply the probability of an individual being each of these things, you get a very tiny fraction. His talent and energy could easily have taken him to the very top of the scientific establishment, but he chose instead to dedicate his career to science and to social justice without compromise. To put it in more colloquial terms, he has achieved great things in science and for social justice.

Susan Wright (May 10, 2016)

Thanks to John, the inspiration for a wonderful celebration and meeting of minds! It was like no other meeting on academic ground that I've ever witnessed but of course it wouldn't be since NWAEG is so much more than academic… Special thanks to the OG for all you did to produce order out of the chaos of the unruly! (Maybe John has a theory to explain that.) And to all NWAEGies for an unforgettable meeting that ran on Commitment, Fun, and Love,

Gerald Urquhart (May 11, 2016)
Theresa,

I never got a chance to say thank you for all your work at VandyFest. I don't know who the other organizers were, but your leadership of the day of talks was flawless (and usually it is a true trainwreck when you have all those speakers). Everything about Saturday was an event beyond what I could have imagined and so professionally done but so personal seeming

Unfortunately, I was not able to be there for Sunday but would have loved to have seen John's speech. I will look for it online.

John Vandermeer (May 10, 2016)
Dear Colleagues/Compañero(a)s/Comrades:

For those of you who were at my festschrift last weekend, thank you all for your incredible outpouring of praise for me. As an unrepentant arrogant asshole, I could not have been more pleased.

But, more seriously, that outpouring was actually quite unexpected. I think I mostly expected a somewhat more muted and academic set of discourses "John told me about intransitive loops," "John gave me the contacts that let me pursue my career," "John helped me navigate academia," for example. But you all said so much more, and so much more than I expected. I was, and am, overwhelmed. Yet, again at the risk of false humility (which most of you know I am not capable of anyway), thinking purely analytically about it, there truly is way more of YOU affecting ME than ME affecting YOU. I mean, seriously, what have I done? I sit in my office and chat with you, and when I do so, you effectively tell me what my next paper or political activity should be. I go into the field with you and you tell me the next place my research should go. I walk the picket line with you and you tell me what is wrong with the political project I currently engage in and which one I should be pursuing. So what exactly is it that I do? I let you be my sounding board. And where would I be without your patient willingness to tell me when I'm wrong? You are inevitably the anti-thesis to my thesis, and as you all know, it is the negation of the negation that ultimately matters.

I know some of you will say that I opened the door (physical and metaphorical) for you, and yes, I know that is true. But who the hell is not able to do that? Especially when I know that my own well-being (emotional, academic, political) ultimately depends on what you tell me, why would I close the door in the first place? And how is it anything other than my own selfishness that keeps that door open? Where would my goals and ideas come from? Who would I plagiarize if it weren't for you all?

In the end, as far as I've been able to process the weekend so far, it is all Dick Levins' fault. Dialectics not only characterizes the world, it characterizes my relationship with each and all of you, and each of you with all the others. There is a synthesis that comes from you're disagreeing with me, with your challenging me (and me challenging you). But that synthesis is not just between me and you. It is a process among all of you also. The community (or "lab" as Ed Russell so elegantly expressed it) seems to be a dialectical whole, with continual evolution/revolution, critically transitioning to greater heights of action and understanding. So, adelante compañeros, you are in the process of making the revolution. And thank you so much for allowing me to be a part of it.