An ecological auto ethnography of a Monarch Butterfly

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Introduction

As I sit in the beautiful sunshine here on the central coast of California, I look around and see that there are far fewer of my family than there used to be. I begin to wonder how much longer my kin will be able to continue our existence. I am a Monarch Butterfly, or Danaus plexippus for those who are more focused on scientific nomenclature, and one among a rapidly dwindling species of butterflies in North America. I am taking this opportunity to provide you with the background on how we got to be a threatened species and what are the factors that have caused and continue to cause our decline. In doing so, I will also provide some context on what used to be the life of our species including details of our annual migration and the changes to our habitat here in North America. In doing so, I will discuss the impact of the regulatory environment on the continuation of our way of life.

Our habitat and annual migration

We are unique among butterfly species on Earth due to the multi-generational migration that we undertake over the North American continent spanning Canada, the United States and Mexico. The process of migration from Canada and the northern states of the United States begins in late summer to either the mountains of central Mexico or the California coast where we spend the winter months. Those of us that survive the winter will then return to the Southern region of the United States that was traditionally the region where milkweed plants which are our main food source, used to be found. The females of our species lay their eggs only on milkweed plants and then these eggs hatch into caterpillars, which feed on the milkweeds, leading to their metamorphosis into butterflies. Until the start of the 1990s this used to be a rather routine process for us since there was plenty of milkweed to be found among the landscapes of the Midwest region of the United States. Things started to change for us at this time with the introduction of what is referred to as genetically modified crops. I will elaborate on the havoc that this has caused in our lives a little later.

Our eggs are laid singly, on the underside of a young leaf or on a flower bud and take three to eight days to develop and hatch into larvae (caterpillars).Larval monarchs take nine to 14 days to go through five instar stages before pupating. Our larvae in the final stages of development stop feeding to search for a location to form a pupa, or chrysalis, the last stage of development before their emergence as adults. At the end of metamorphosis, our adults emerge from the chrysalis, expand their wings and fly away. The body mass of our fifth stage caterpillars increases about 2000-fold from first stage instars. Our larvae must eat constantly to ingest enough milkweed to increase in mass so dramatically within a few weeks. We then continue our northern journey in search of newly emerging milkweeds. This migration continues on throughout the year during which time the process of laying eggs, these eggs turning in caterpillars and then into butterflies is completed several times until what you would call our “great-great-grandchildren” in relation to those of us who would have left our winter home each year in the spring return to the overwintering sites the following autumn.

An area of 56,259 hectares (ha) is protected as the Monarch Butterfly Biosphere Reserve in Mexico and its core area of about 13,551 ha includes our wintering forest habitat where we migrate each fall from Canada and the United States to the states of Michoacán and Estado de Mexico (WWF, 2016). Our population in the Rosario and Sierra Chincua colonies make up our entire breeding stock for the

eastern United States and Canada. After wintering in Mexico, we then begin our mass migration north from Mexico each spring, flying north, until we stop to lay eggs in the south of the United States. Those of us who survive this stage are born and continue the journey, and by summer we reach as far north as Canada.

Severe weather conditions over the mountains of the state of Michoacán, west of Mexico City which are home to two-thirds of our population in our Mexican sanctuaries, in the year 2002 was the most catastrophic event in recent memory with the death of around 220 to 270 million monarch butterflies (Yoon, 2002). This was a devastating blow to our extended family from which we have never recovered since it left us vulnerable to the changes in weather caused by climate change which has been further compounded by increasing deforestation in and around our winter habitat in Mexico (WWF, 2015; 2016).

Because forest trees can act as an umbrella against the rain and a blanket that can retain heat, scientists and conservationists have been warning for years that the thinning of the forests in the relatively small area we have chosen for our habitats could threaten our existence by increasing our exposure to these elements (Yoon, 2002). The severity of the weather with a combination of rain followed by freezing temperatures had a major role to play in the extend of loss of life among our colonies in Mexico in 2002 (Yoon, 2002). It goes without saying that deforestation has also played a significant role since trees in the forest have tended to provide us with protection by acting as a blanket that can store the heat that we generate by our action of being clumped together in close knit communities (Stevenson, 2015). Thus, the loss of our population in 2002 could be attributed to not only climate change (Zipkin et al., 2012; Lemoine, 2015), but also the loss of about 50% of the pristine forest cover in the mountains of central Mexico over the past 50 years (Brower et al., 2002).

There is hope for improvement since starting in 2003 the WWF-Telcel Alliance, in partnership with local communities and the Mexican federal and state governments, have supported both the conservation and management of our habitat through the reforestation of 24,273 acres with more than 10.73 million trees (WWF,2015). However, we live a precarious existence since even a small area of deforestation has a large impact on our population. Despite progress elsewhere the loss of about 19 hectares of habitat in the rural hamlet of San Felipe de los Alzati in the state of Michoacán due to logging has been compounded by the impact of drought and pests (Stevenson, 2015). However, our problems are not limited to the issues that we face in our wintering habitat in Mexico. A larger issue that needs to be understood is the loss of our breeding habitat in the United States due to the expansion over the last twenty years in the cultivation of crops which are resistant to genetically modified (GM) herbicides (Brower et al., 2012).

The impact of the growth of industrial agriculture

While considering the factors impacting the continued existence of my species, it is pertinent to begin by looking at the system of agriculture in North America that consists of the use of chemical inputs such as fertilizers and pesticides. The problem is that the monetary cost which is often the only consideration for you humans does not as yet include the impact of these farming practices in terms of environmental degradation which is one among the principal causes of the reduction in the numbers of my species. The system of agriculture that has been introduced in the past one hundred years is the basis for an industrial form of food production which replaces local markets and local cultures that have traditionally been places of crop diversity, promoted through the ingenuity of indigenous farmers that enabled the survival and growth of my species through the conservation of seeds and plant varieties (Shiva, 2000).

Farmland biodiversity is an important characteristic when assessing sustainability of agricultural practices which have promoted the numbers of my species, but has seen a drastic fall due to the

adoption of herbicide resistant crops almost twenty years ago (Tappeser, Reichenbecher and Teichmann, 2014). Glyphosate and its related herbicides are the most widely used in the world and apart from being toxic to plants, have adverse effects on mammals, some invertebrates, aquatic species and the soil micro flora and are particularly toxic to amphibians (Tappeser, Reichenbecher and Teichmann, 2014). An estimated amount of 239 million kg of additional herbicides were applied due to the rising dependence on glyphosate in the whole period of 1996-2011, with herbicide resistant soybean accounting for two thirds of the total increase (Tappeser, Reichenbecher and Teichmann, 2014). Despite this, the industrial method of farming is actively promoted by the large transnational corporations (TNCs), governments and civil society organisations alike accompanied with the rhetoric of a responsible approach to business (Craig and Amernic, 2004). There is however clear evidence that intensive high input farming is one of the main drivers of ongoing biodiversity losses in agricultural landscapes that has made it increasingly challenging for the continuation of my species (Tappeser, Reichenbecher and Teichmann, 2014).

Another important constraint to ensuring our continued survival has been the loss of soil fertility which is a prerequisite for the abundance of the milkweed that is our main source of sustenance. So in order to ensure that we have sufficient food, there is a need to prioritize the maintenance and regeneration of soil fertility which is linked to promoting the soil organic carbon (SOC) (Bationo et al., 2007). Since the increasing intensification of agriculture along with increase in the usage of pesticides is causing a loss in biodiversity including the loss in the numbers of my species, a way to mitigate this would be to get more humans to learn about sustainable agricultural practices (Pretty and Bharucha, 2014; 2015; Tappeser, Reichenbecher and Teichmann, 2014).

Industrial agriculture is harmful to the survival of my species since it involves the clearing of forests and tree covered land for the purpose of cultivation, along with promotion of inappropriate fertilizer use among other unsustainable practices which will increase the emission of GHG and worsen the process and extent of climate change (Bationo et al., 2007). As noted earlier, climate change was the cause for the most extensive loss of the population of my species during the severe weather conditions in Mexico in 2002. Industrial agriculture makes extensive use of fertilizers and pesticides which in turn require the use of larger amounts of water, along with an associated decrease in the organic inputs to soil (Sanderman and Baldock, 2010; Meersmans et al., 2011). Further, this industrial system of agriculture involves insufficient crop rotations in a seasonal fashion with damage caused to the soil structure through rampant intensive soil tillage leading to soil compaction which causes a depletion of SOC and soil biodiversity (Brady et al., 2015; Meersmans et al., 2011). Unfortunately, all of these have had an adverse impact on the existence of milkweed which is the only source of food for us.

In the context of the development of modern industrial agriculture in the USA, its impact consisting of an extensive use of fertilizers and pesticides and the resulting loss in soil fertility is that it requires extended fallow periods for the soil to regenerate itself (Follett, 2001). This is part of the planning process of the Unites States Department of Agriculture (USDA) and the US Department of the Interior's Bureau of Land Management, where there is land left fallow that is called "set-aside land" (McGranahan, Brown, Schulte and Tyndall, 2015). What this means for the survival of my species is that each year larger and larger areas of the United States Midwest are becoming fallow indicating that the milkweed that used to grow in these areas does not grow anymore.

This has made it increasingly difficult for us to find food as we make our annual migration across North America. Thus, with these types of practices, industrial agriculture with its monopoly power within the agriculture industry which is further strengthened by patents over seeds and industrial chemicals is destroying biodiversity and hence is the greatest threat to the continued survival of my species among others. The industrial method of farming currently incentivizes monocultures and cash crops and is one of the main drivers of ongoing biodiversity losses in agricultural landscapes (Altieri, 1983; Shiva, 1997) which has contributed to the overshooting of the biodiversity planetary boundaries

(Rockström et al. 2009). Monocultures by their very nature of representing uniformity without diversity are vulnerable to ecological catastrophe while compromising the survival of nature's diversity by promoting large scale species extinction (Shiva, 1997).

As a result of the growth of industrial agriculture across the United States, the habitat of my species has been significantly reduced and degraded especially due the significant increase in the use of genetically modified crops that are meant to be resistant to the use of pesticides. This is because our main food source, the milkweed which is the only plant on which we lay our eggs has not been modified to withstand the use of such crops. The primary threat that we face is the loss of our food source the milkweed caused by the widespread planting of genetically engineered, herbicide-resistant corn and soybeans in the Corn Belt region of the United States along with the planting of genetically-engineered cotton in California.

In the Midwest region of the United States, where the majority of my species originates, the adoption of genetically modified crops which involves the increasing use of glyphosate, the pesticide developed by Monsanto has led to severe loss of Milkweed (Hoppe, 2010). In the Midwest region of the United States, genetically modified corn and soybeans were introduced in the 1990s by the Monsanto Corporation under the brand name Roundup Ready soybeans introduced in 1996 and Roundup Ready corn introduced in 1998. These varieties of both soybean and corn are genetically modified to survive when glyphosate (Roundup) is applied and now comprise 94 percent of soybeans and 89 percent of all corn grown in the United States (Benbrook, 2012).

Glyphosate is being applied both more intensively than before as well as to larger and larger areas of the area in the Midwest of the United States that we consider home. Since 1995 when Roundup Ready soybeans were introduced, there has been a significant increase in the total glyphosate use on corn and soybeans besides the additional use of neonicotinoids since the year 2002 which has meant an all-out attack on milkweed and hence on our habitat (Douglas and Tooker, 2015). Additional loss of our habitat is being caused by the rapid conversion of grasslands and other milkweed-containing land types to corn and soybean fields to produce biofuels under US biofuels policy despite an attempt by the US government to create Conservation Reserve Program (CRP) lands in the Midwest of the United States. The conflict between one US government policy and another has led to my species losing a large percentage of milkweed from our habitats due to the shrinkage of CRP acreage by 11.2 million acres (30 percent) since 2007, with more than half of the decline taking place in the US Midwest, which has lost 6.2 million CRP acres (Hoppe, 2010).

In the period 1999 to 2012, it is estimated that there was a 64 percent decline in overall milkweed in the US Midwest, due to changes in the use of croplands (Pleasants, 2015). Because milkweed that used to grow among crops used to be four times as much as the milkweed available in other settings, the loss of milkweed due to the fundamental changes made to both the way corn and soybean are cultivated in terms of the increased density of these plants within the genetically modified fields has had a disproportionate impact on the numbers of my species so that as of 2012, it is estimated that our numbers in the US Midwest have decreased by 88 percent compared to 1999 (Pleasants, 2015). What I have just presented to you is a rather scary picture of the situation that our species is facing in North America since we are under attack by the forces of industrial agriculture. In this situation we are rather helpless and this is despite the creation of institutions such as the Environmental Protection Agency (EPA). It might make you wonder, what role if any does the EPA play in the protection of the habitat of species such as my own? To answer this question, it would be important to consider the regulatory environment in the United States which has allowed the creation of GM crops which are the basis of the chemical attack on my species.

Impact of the regulatory environment on our way of Life

In this final section of my auto ethnography, I would like to bring to your attention the debate surrounding the approval of genetically modified organisms (GMOs) within the international food system. As you have seen from the situation in the Midwest of the United States where genetically modified soy and corn have decimated the food supply for my species and put under risk our continued survival, I would like to make the case for changes to the regulatory system in the United States since in my opinion that is the most important change that if made would promote the survival of my species.

In doing so I will specifically engage with the accountability of the United States food and drug administration (FDA) and the environmental protection agency (EPA) which have approved genetically modified foods for human consumption based on the concept of "substantial equivalence". Before I can explain what "substantial equivalence" is, I would like to first explain to you what are genetically modified organisms (GMOs) or Herbicide-Tolerant Crops. Farmers often use broad-spectrum herbicides, which kill nearly all kinds of plants to control weeds. Scientists have applied biotechnology to create crops that are resistant to certain herbicides. Herbicide tolerant crops contain new genes that allow the plant to tolerate these herbicides. The most common herbicide-tolerant crops (cotton, corn, soybeans, and canola) are those that are resistant to glyphosate, an effective herbicide used on many species of grasses, broadleaf weeds, and sedges.

The EPA, however does not regulate these crops. Rather, the USDA regulates the crops and the EPA regulates the herbicide, which is also referred to as a pesticide wherein species such as my own are the pests that can be killed (sic). The EPA regulates pesticides, including genetically engineered pesticides, using two laws. The first of them is called the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This act provides the legal requirements for the EPA's registration process for all pesticides. With regard to biotechnology, the EPA's jurisdiction under FIFRA covers regulation of the new substance and DNA in the plant when it is pesticidal in nature. The second law is called the Federal Food, Drug, and Cosmetics Act (FFDCA), as amended by the Food Quality Protection Act (FQPA). The FFDCA requires the EPA to set tolerances, or exemptions from tolerances, for the allowable residues of pesticides that are applied to food and animal feed.

Before a pesticide can be marketed and used in the United States, FIFRA requires that the EPA evaluate the proposed pesticide thoroughly to ensure that the pesticide will not pose unreasonable risks of harm to human health or the environment. In the case of genetically modified plants, the EPA considers many factors by conducting studies that assess the risks to human health as well as studies that assess risks to non-target organisms and the environment. Pesticides that pass the EPA's evaluation under FIFRA are granted a license or "registration" that permits their sale and use according to the requirements set by the EPA to protect human health and the environment.

In making regulatory decisions, the EPA evaluates the risks of pesticide use and balances these risks with the benefits derived from pesticide use. It is important to understand that the regulatory system that has compromised the survival of my species is a combination of a regulatory partnership between the EPA, USDA and the FDA. In this regulatory system, the USDA's Animal and Plant Health Inspection Service (APHIS) is responsible for protecting American agriculture against pests and diseases.

The APHIS regulates the field testing of genetically engineered plants that may be the products of biotechnology. The USDA's regulatory jurisdiction includes the regulation of herbicide-tolerant crops, which do not fall under the EPA's jurisdiction because these crops do not produce pesticides. The

FDA which is a part of the Department of Health and Human Services assesses food safety and nutritional aspects of new plant varieties. The FDA bases its biotechnology policy on existing food law and requires that genetically engineered foods meet the same rigorous safety standards required of all other foods.

The FDA also sets labelling standards for foods and enforces the tolerances of allowable pesticide residues that the EPA establishes. This is the scary part for my species and should be scary for humans as well, since instead of mandating that dangerous chemicals that harm my species and yours should not exist, this partnership between the EPA and the FDA creates a legal loop hole as you humans like to call it. This legal loop hole means that since the regulatory agencies have allowed for and set the tolerances for certain dangerous chemicals such as the pesticides that can be used in the context of GM foods, the presence of these dangerous chemicals under the tolerances provides a legal protection to the companies that produce them. The only aspect that the companies need to ensure is that the existence of these dangerous chemicals is kept below the tolerance defined by the FDA and the EPA.

As long as the companies are able to follow this requirement, their liability for damage to humans and death to species like my own will go unquestioned and they can continue as they have since the introduction of GMOs making profits at the expense of our lives. Keeping this information in mind, we can now begin to understand how food safety is defined using the concept of substantial equivalence. Substantial equivalence holds that the safety of a new food, particularly one that has been genetically modified (GM), may be assessed by comparing it with a similar traditional food that has proven safe in normal use over time.

As part of a food safety testing process, substantial equivalence is the initial step, establishing toxicological and nutritional differences in the new food compared to a conventional counterpart—differences are analysed and evaluated, and further testing may be conducted, leading to a final safety assessment. Substantial equivalence is the underlying principle in GM food safety assessment for a number of national and international agencies, including the Canadian Food Inspection Agency (CFIA), Japan's Ministry of Health, the US Food and Drug Administration (FDA), and the United Nations' Food and Agriculture Organization (FAO) and the World Health Organization

The U.S. Food and Drug Administration says that consuming GMOs is safe. There have been no human studies on the long-term health impact of consuming GMOs, only animals' studies, as is typical in determining the safety of food. Anti-GMO groups like Green America and Center for Food Safety point to published studies that say there are signs of toxic effects in animals that ate genetically modified crops and say more research needs to be done. GMO critics also raise concerns about the health effects of the toxin inserted into corn DNA to make it insect-resistant, and about glyphosate, the main herbicide used on GMO crops. GMO proponents contest those studies, and say other research shows that the products are safe. They say that GMOs are simply a technological extension of the plant breeding people have done for centuries. Unfortunately, while this debate rages and the court case brought against the Monsanto Corporation by the state of California goes through a slow legal process, the time for species such as my own is running out. I know that you humans will not act until your own lives and those of your families are threatened. I hope that you will pay greater attention to the regulation of these dangerous chemicals in time to save my species from extinction.

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