Linda Houston Houston 1

Professor Snyder Writing 222

18 November 2016

Should Genetically Modified Mosquitoes Be Used to Eradicate

Mosquito Borne Diseases?

For centuries humankind has been plagued by many diseases caused by a persistent and dangerous insect - the mosquito. Eradication has been mostly ineffective by chemical insecticides, and sprays often kill other un-targeted insects and harm the environment. Scientists have been developing several different ways to approach eradicating mosquitoes through genetically modified research. They have concentrated on two species of mosquito that cause devastating and debilitating diseases. The one type of mosquito, the Aedes aegypti, is responsible for Dengue Fever, Yellow Fever, Chikungunya, West Nile, and now Zika. The other prevalent mosquito Asopheles gambiae, is responsible for malaria.. It has been calculated that mosquitoes are the cause of half or more of the deaths of humankind. (Specter, “The Mosquito Solution” 40). Mosquitoes kill 725,000 people a year and are considered the number one killer of humans.(Gartner 1).

Mosquito diseases are wide spreading throughout the world. Malaria, concentrated mainly in Africa, was found in DNA taken from children at a Roman archaeological site dating back to 450 A.D. ( Honigsbaum 283). This disease killed Tutankhamen in 1324 B.C. and Oliver Cromwell in 1658. ( Perry 17). It is dated back for thousands of years by the Chinese. (Gates

Foundation). Malaria occurs due to the parasite protozoan genus Plasmodium, which enters human blood from the bite of a mosquito, and is transmitted from one human to another as the mosquito bites another human being. ( Mosby’s 1138). The ensuing disease is fierce, and in three stages: The parasites attack the liver and red blood cells causing strong chills two weeks later.

The white blood cells, working to kill the parasites, cause the body to feel very hot and delirious. Thirdly, after these symptoms go away, one perspires with headaches and goes into a quiet period. Following this period, the repetition of the sweat and chills return. ( Honigsbaum 14).

The diseases transmitted by the Aedes aegypti mosquito are numerous and, like malaria, can cause death. (Specter, “The Mosquito Solution”40 ). The Oxitec company does a thorough job of describing these diseases.( Oxitec - Oxford Insect Technologies is a company formed originally by a group British scientists who have developed a genetically modified mosquito.)

Dengue Fever affects four million people a year, and is the fastest growing disease. It can be fatal; 25,000 people a year die from it. The symptoms are severe. They are flu-like, with very painful joint pain, nausea, and vomiting. Blood vessels can break, and there can be bleeding form the mouth and nose. Another disease is Yellow Fever and is similar to the above with fever, muscle pain, nausea, headache, and vomiting. If it gets into the toxic stage, one does not recover and dies. A third disease is Chikungunya and is also a rapidly growing disease. The symptoms are, again, joint pain that can last for months. It can lead to viral encephalitis and one can die.

Also prevalent is Zika. Zika is the current, fast growing disease. It appeared in 2015 in Brazil, and started in Uganda in 1947. The symptoms are mild , or not at all. Or, the symptoms can be fever, rash, muscle and joint pain, headache, and conjunctivitis. It has been proven to cause

Microcephaly in babies ( they are born with small heads and brains) and Guillan -Barre syndrome ( Immune systems attack one’s body and the limbs “tingle”, then paralyze.) (Garter 2).

To try to eradicate these diseases, pesticides have been used for many years, starting in the 1940s. Pesticides have worked on some mosquitoes in the past, but over time the insects develop a resistance to the pesticide. More and stronger pesticides can be used, but eventually, biologically, the insect develops immunity. DDT was used on Aedes aegypti and almost eradicated the mosquito fifty years ago, but now the WHO (World Health Organization) says the species has increased 30 times since 1965. (Specter, “The Mosquito Solution” 38). Rachel Carson was quick to document the horrors brought to the environment by DDT in her 1962 book *Silent Spring*. One of many examples she presents is the prolific killing of stream insects by DDT, and the consequential dying off of salmon. : “But now the stream insects are dead, killed by the DDT, and there is nothing for a young salmon to eat.” (Carson 131). DDT, in massive use during the 1950s and 1960s, eventually put the American eagle on the extinction list. The insecticide had caused the eagle’s eggs to have shells that were too soft, and the young died as a consequence. (Carson 118-122). People particularly noticed this disaster because the eagle is our country’s mascot. Many other wildlife were effected as well, especially within the marshes and estuaries.

Today, we see similar consequences when Naled is sprayed against the Zika carrier Aedes aegypti. This September, an area was sprayed in South Carolina and thousands of bees were killed. (Washington Post). Insecticides are not necessarily healthy to human beings as well. This fact is acknowledged with the strong cautions mentioned on the FDA website, in relation to workers who do the spraying.(FDA).

Moreover, mosquitoes are very hard to deal with. They lay eggs everywhere that there is

the slightest amount of warm water. They are notorious for depositing their eggs in old tires, backyard pools, in a small cap of water, and even inside the house. Eggs can be laid anywhere, but insecticides can not go everywhere. (Specter, “ The Mosquito Solution” 38).

There is a strong need for different ways to control and eradicate the mosquito. History, as well as the current time, shows us that insecticides are not working, and not working over the long run. Scientists have been diligently seeking to discover and develop new methods to combat these horrible diseases. Three of these methods, listed below, are promising and viable.

The Gates Foundation has been on the malaria eradication path for many years. One of their many aspiring goals is to wipe out malaria completely. (Gates Foundation). Along with an international group of donators, the Gates Foundation has backed scientists who have modified the Aedes mosquito so that they will become infected with a bacteria called Wolbachia. This bacteria is already found naturally in sixty percent of insect species and does not harm humans. Trials have been conducted in several countries such as Brazil, Australia, and Vietnam, and these infected mosquitoes have been shown to reduce the Dengue Fever disease in humans. This method is described as “vaccinating mosquitoes” and will be implemented in early 2017 in Brazil and Columbia. (Mundasad).

A second type of GMO research now in progress is titled CRISPR - ‘clustered regularly interspaced short palindromic repeats’.(Specter, “DNA Revolution”36). Molecular geneticists are now able to “.....precisely alter, delete, and re-arrange the DNA of nearly any living organism, including us.” (Specter, “DNA Revolutin” 36). Cas-9, a natural enzyme used by bacteria is manipulated to cut DNA by use of a RNA guide. Following this action, with the DNA sequence

cut out, any replacement can be inserted in the CRISPR. This procedure, although seemingly science fiction, is being done in many labs everywhere, as the scientists experiment and use it to better crops, animals, and people. It is really simply a new procedure of an old performance; for thousands of years humankind has crossbred plants and crops to develop new and better products. One lab, under the direction of Anthony James, is working to change the Aedes mosquito, and has succeeded. The gene altered anopheles male mosquito is sterile, and within a few generations of the mosquito’s life line, all would be sterile. ( Specter, “DNA Revolution” 41).

The third mosquito eradication process to mention is engineered by British Oxford scientists who eventually formed a company named Oxitec (now bought out by American company Intrexon). This genetically modified mosquito is sterile, and therefore, self-destructive. Researchers worked off an older implemented idea of sterilizing the mosquito with radiation. The Sterile Insect Technique (SIT), using radiation, was first started in the 1950s.(Oxitec). Working off this premise, Oxitec was able to make a genetically modified mosquito by inserting a gene into the male that will cause the larva of the female to die off and to not mature. The male mosquito is developed in the lab and then released into the infected area. The male mates with the wild female, and passes on the destructive gene to the larva. Both male and female mosquitoes do not live longer that 4 to 10 days. There is no danger to humans or animals because it is the female mosquito that bites, not the modified male. Also, The DNA is not in the saliva of the female or male. To further distinguish the difference between the two sexes, the male mosquito is tagged with a flourescent marker. The male is also noticeably smaller than the female. (CNN).

Houston 6

Oxitec has done several testings of their mosquitoes - their “Biological Control”.(Oxitec).

They claim up to 99% control. This information is gathered from four different trials that they have carried out over the years. These trials were in the Cayman Islands, Malaysia, Brazil, and Panama. Seventy million modified mosquitoes have been released conducting these trials.(Alvarez). The Cayman Island testing was done in the Fall of 2009, with help from the Gates Foundation ( $19.7 million). (Enserink). Three million G.M.O. mosquitoes were released in to the wild on sixteen hectares. The population was eradicated by 80% in two months. In Brazil, a testing started in April 2014 was performed in Piracicaba, a city in San Paulo. Cases of Dengue among the people there fell from 133 a year to 1 a year. The lab in the Brazilian city of Campinas produces two million modified mosquitoes a week. (Fereeira).

The small Floridian community of Key Haven might be the first United States area to test the Oxitec mosquito. Now that Zika has traveled north from South America and the islands in between, there is concern within the States about the spread of Zika. The FDA reviewed Oxitec information, and Public Comment period closed in May of this year. (FDA). The trial is now on the November 8th ballot. (Keymosquito).

The outcome of the ballot will be interesting. There has been much resistance to and fear of the Oxitec modified mosquito in this community. People are afraid of a humankind change to the natural world. Their fear is understandable. Their fear is founded in not enough information, in not enough given understanding of the scientific process, and in not enough time to adjust to such a dramatic change, or respectively, in change to the environment.. It is much easier to accept things the way they are naturally, than to have the oppressive burden of trying to completely comprehend what exactly will happen in the future with the release of the modified mosquito.

The officials of the town of Key Haven have tried repeatedly to make sure everyone is informed and taught just what exactly the mosquitoes would do. The official spokesperson for Oxitec, scientist Derrie Nimmo, has gone door to door to talk with the residents, and has held open meetings to inform and teach residents. People show genuine interest, but then sometimes leave the meetings early, without all the knowledge in hand, or with the insistence that the mosquitoes will pass on the new genetics to their children. People are also afraid that the real estate in the area will not be valuable if it is known the mosquitoes have been released. (Gartner).

Change is extremely difficult when our lives are touched by science beyond our control .

We worry. We want life to be better; we want to rid the world of awful diseases, but we are cautious, and we wonder how far humankind should go in its ability to cause change. Questions to genetically modified organism safety become answered with responsive and proven science. The questionable ethics of concern for changing what is naturally a part of the natural world *should* be a concern, a huge concern, and the questions have to be a part of the process. Given this, once something has been proven safe, like the genetically modified mosquito, then it is time to step forth and proceed behind the established true fact that science has discovered. It is just as much a determent to society at large to *not* move forward, then to not question something new and changing to our natural world. Nature changes on its own, but if we can slightly change a negative that has occurred, to actually better the world, then this step is valuable, permissible, and positive.

Given the above, if we sat still and did nothing, we would still be living in the “dark age”.

It is humankind’s destiny to move forward. We humans have the ability to change a course of nature through our curiosity that leads to scientific research that leads to answers. We are not out

to “play God” but merely to help change, though our knowledge, devastating and life threatening situations. Is this morally wrong? Should we not develop vaccines, or new flower colors, or rid our environment of a disease-carrying mosquito? Yes, discoveries must and should be taken in increments of time. Yes, all caution should and must be established. Trials must occur. “Scarey” steps must sometimes happen. It is true, we do not always know exactly what will happen with our experiments, but we should not, therefore, not experiment. Careful, slow steps are the safeguard. Ethical and moral cognitive thinking is the safeguard. The answers lie in the step forward, the exploration, the brave decision to better the world.

It is proposed / we propose that now is an excellent time to test the Oxitec mosquito in the community of Key Haven, Florida. The state has experienced 300 cases of the Zika virus as it spreads north from South America via the Aedes aegypti mosquito, and now is the time to halt this terrible disease. Other trials have been effective and harmless. Why would we want to sacrifice another baby to microcephaly when we have a valuable and safe solution right before

us? Bland, in his Guardian article, quotes famous Harvard scientist E.O.Wilson on the anopheles gambiae mosquito: “ Keep their DNA for future research,” he writes, “and let them go.”(qtd. in Bland 1). Here is a sensible answer. If you are afraid, know that the DNA of the mosquito that has killed so many millions of people can be saved and not destroyed. So, if you are worried about the world being without this particular species of mosquito in the future, or if the future shows we still need this mosquito, it could eventually be brought back.

It is important to realize, as well, that there are 3,000 mosquito species or more in the world - but most do not bite humans, or carry diseases to them. (Oxitec). The mosquito, as a prominent insect in the world, would not be wiped out by the genetically modified mosquito.

Mosquitoes would still be a part of the food chain for other animals, and an important part of the environment. The genetically modified Aedes aegypti mosquito would not be responsible for destroying all the mosquitoes, but rather a small area where they would be released . Mosquitoes do not travel far naturally. The areas covered by the genetically modified Aedes aegypti mosquito would be, in addition therefore, small and inclusive. This trial is an important and viable step on the path to the eradication of many debilitating and fatal diseases in the world.

Think positive. Vote! And vote in the future!

Works Cited

Alvarez, Lizette. New York Times. “A Mosquito Solution (More Mosquitoes) Raises Heat in Florida Keys.” 19 February 2015.Web. 17 Oct. 2016.

Bill and Melinda Gates Foundation. “Malaria: Strategy Overview.” 2015. Web. 17 July 2015. Bland, Archie. The Gaurdian. “Should we wipe mosquitoes off the face of the Earth?”. 10

February, 2016. Web. 30 Oct. 2016.

Carson, Rachel. *Silent Spring*. Boston: Houghton Mifflin Harcourt. 1962. Print. CNN. March 2016.

Gartner, Lisa. Tampa Bay Times. “Mutant mosquitoes could fight Zika in Florida, but misinformation spreads.” 3 August 2016. Web. 30 Oct. 2016.

Enserink, Martin. Science Magazine. “GM Mosquito Trial Strains Ties in Gates-Funded Project.” 16 November 2010. Web 19 Oct. 2016

FDA. “Oxitec Mosquito.” 05 Aug. 2016. Web 17 Oct. 2016.

Ferreira, Flavio Devienne. MIT Technology Review. “Inside the Mosquito Factory That Could Stop Dengue and Zika.” 17 February 2016. Web 17 Oct. 2016.

Honigsbaum, Mark. *The Fever Trail: In Search of the Cure for Malaria.* New York: Farrar, Strous, and Giroux. 2003. Print.

Keysmosquito.org / Florida Keys Mosquito Control District. “FDA Releases Final

Environmental Assessment for Genetically Engineered Mosquito.” and Florida Keys Mosquito Control District.

*Mosby’s Dictionary of Medicine, Nursing, and Health Professions.* St. Louis: Mosby Elsevier. 7th Edition. 2006. Print.

Mundasad, Smitha. BBC. “Mosquito army released in Zika fight in Brazil & Colombia”. 26 Oct.

2016. Web. 30 Oct. 2016.

Oxitec. “Health.” “How is Oxitec’s Mosquito....” Web 16 Oct. 2016

Perry, Alex. *Life Blood: How to Change the World One Dead Mosquito at a Time.* New York: Public Affairs Perseus. 2011. Print.

Specter, Michael. National Geographic. “DNA Revolution.” August 2016.

- - -. The New Yorker. “The Mosquito Solution; Can Genetic Modification Eliminate a Deadly Tropical Disease?” 9 July 2012.

Washington Post. 1 September 2016. Web.20 Oct.2016