

Critical Conversation on Genetically Modified Mosquitoes

Summary of Discussion



Overview

On May 23-24, 2019, iSEE hosted academic, industry, nonprofit, government, and NGO representatives in downtown Chicago's University Club for a conversation on the issues and potential solutions surround genetically modified mosquitoes (GMMs).

This safe space for a frank, unattributed discussion was a positive step toward exploring the public health risks and concern regarding genetically modified mosquitos, and the benefits and potential negative effects of introducing them into the environment.

Keynote speaker May Berenbaum, University of Illinois at Urbana-Champaign Professor of Entomology, got the conversation started the evening of May 23, and three panel and breakout sessions continued the discussion the next day.

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About This Document

The following sections outline the major talking points of each of the three topical discussion sessions. This is by no means a comprehensive

listing of the ideas shared, but is a summary of the points participants spent the most time talking about. Your personal notes from your table discussion may differ in emphasis. Our aim was to supplement your notes with a look into the multitude of viewpoints and opinions expressed about the nature of the problem and its possible solutions.



Session 1: What are the public health, ethical, and cultural considerations for the use of GMMs for disease control?

The first session of the Critical Conversation centered on understanding the diverse web of stakeholders involved in or impacted by the use of GMMs for disease control.

The session began with a panelist discussion between Mark Benedict (Centers for Disease Control and Prevention), Natalie Kofler (*Editing Nature*), and Karen Tountas (Foundation for the National Institutes of Health Inc.).

Early community engagement strategies, interdisciplinary collaboration, accessible data, and the need to further explore ecological and geographical research were major conversation themes. Specific communities in dire need of disease control — vs. environmentalists' anti-GMO discourse — was an issue identified within the groups. This problem led participants on paths to address how to communicate about GMOs and how to communicate with the actual individuals who might benefit from GMM research and trials.

Major Talking Points

Risk Assessment

- Performing risk assessments on each diverse community is important.
- Both long-term and short-term risks need to be understood.
- Would it be a better practice to have a third-party entity conduct the risk assessment, and would it make communities more comfortable if the assessment were conducted locally?

Informed Consent

- We need to explore a common definition of consent — and what consent looks like.
- Communities impacted must be given all info from and during assessments and/or experiments.
 - Additionally, this should be done prior to, not after the fact.
- Building beneficial case studies from one community might help educate other communities.
- Should the use of GMMs in a community be subject to a communitywide referendum?

Ecology

- It will be easier to make decisions with a strong and more robust understanding of the ecological impacts of GMMs.
- A database/library of all ecological research on this subject and related subjects would help to understand what has been researched — and what needs to be researched still.
- Due to genetic and ecological constraints, it is unlikely that gene drive would cause mosquitoes to go extinct.
- If it is not a keystone species, it might be a good candidate to eliminate.
- We need to consider unintended spread.
 - If we release GMMs into a community, will there be consequences, like lethal mutations?
 - How will one community opposed to GMMs react to a next-door community that allows GMMS?
- Ethical concerns: Will alleviating human suffering be at the cost of environmental harm?

Education and Outreach

- We will need to understand and address bias when distributing information.
- The language used must be dependent on the community.
- Communication and outreach needs to be clear, it needs to be transparent, and involved parties need to provide continuous support.
- The public might be skeptical when for-profit companies are involved — and trust issues will exist if it is a for-profit endeavor.
 - However, the technology to create GMMs is expensive, and the nonprofit and for-profit sectors rely on each other.
 - These two roles and relationships need to be explained to communities.

Questions/Suggestions to Explore

- How do we develop practical guidelines that address practical challenges on the ground?
- Is gene driving going to be for profit?
- Where is government funding (WHO, NIH, CDC) on this issue? What is already being done by these organizations?
- Once the technology is developed, who is going to pay for it?
- What are the views of GMMs in other countries?

- How do you deal with changing governments and communities?
- Should we continue to uphold the concept of double-blind experiments?
- How can communities be educated about the technology?
- How do you build trust with community governments?
- Can we have a community-driven system rather than a top-down approach?

Session 2: What are the obstacles to long-term success in the use of GMMs for disease control?

Our second session identified several barriers that must be addressed, considered, and managed to move forward with GMMs. Public perception, uncertainty, regulation differences between countries, and a robust understanding of the opposition were the focus of. The panel strongly advocated to allow engagement to be driven by the communities where trials would be initiated — and to allow an active, democratic participation of citizens in the GMO decision-making process. The panelists: Andrew Hammond (Imperial College London), Jennifer Kuzma (North Carolina State University), and Ana Kormos (University of California at Irvine Malaria Initiative).

Discussions on communication were clear and prevalent throughout the day: not just one scientist to another, or to one community, but community to community. Mosquitos fly. They bite. What if one community is on board with a GMM initiative but another is not? What sorts of ecological impacts would this have? And how would this alter relationships between governments?

Major keywords and talking points

Obstacles to Overcome and Unintended Consequences

- It's going to take time to figure out unintended consequences. People do not understand the cause and effect.
- Species complexities are so rich we cannot yet use gene drive accurately to address it.
- Gene drive is still considered quite extreme, and the technology is very expensive.
- If we eliminate one vector, it could lead to evolution in another vector.
 - Symbiosis is a spectrum.
 - Changes in one biome could cause changes in pathogens.
- Controlling pathogens leads to different risks than controlling for mosquitoes.
- Climate change must be a factor in risk assessments.

Fostering Trust Through Communication

- How can trust be cultivated, and who are the stakeholders?

- There are already trust issues with western culture and technology due to previous exploitation.
- People are suspicious of groups that are paying or being paid to do research, and the worry is that these groups might use technology or information negatively.
- Environmental groups will certainly weigh in with concerns.
- Influential voices are trusted and can have a large impact
 - This might be a good way to distribute important information.
 - Funneling information in education may be too political (teaching in schools).
- Good science must be promoted — about the science and the process. Scientists must communicate beyond the facts.
 - We need to reach out to all, not just those who support.
- It is important to promise realistic goals and outcomes to the general public.
- People base their trust on past experiences, which may be a hurdle to overcome.
- Personal stories have strong values.
- People do not like new things — or change.

Recognized Needs

- Countries must be assertive and say, “We need to be a part of the conversation.”
- The Gates Foundation needs to hire people who provide diverse viewpoints and representation for affected communities.
- Systematic repression of information must be cut out.
- Agencies need to understand and recognize their biases.
- Research must go straight from development to implementation.
- We must test in areas without disease in developing countries.
- A communications expert is a necessity.

Questions and Suggestions to Explore

- What are the risks for GMMs?
- Is it correct to use gene drives as the solution to save lives?
- What’s the most effective early engagement?
- How do we deal with some regions accepting GMMs — and neighboring ones not?
- Can we address the gap of behavior change as part of the solution?
- Could this technology be used as a bioweapon?
- If we are so concerned about eradicating mosquitoes, then why not worry about other species?
- How far is CRISPR craze driving gene drive onslaught?
- How do we view gene drive?
- Do we make the information about technical details of the technology available to the community?
- What is the shape of public health?
- Do we need to be coordinating our efforts with other health initiatives?
- When do we stop engagement if interest is slow or nonexistent?
- Do we really have a robust regulatory structure?

Session 3: What are possible regulatory and other strategies to overcome these obstacles while accounting for the diversity of GMM technologies and for ethical and environmental concerns?

The last session merged the questions asked in Sessions 1 and 2. We've identified obstacles and cultural/ethical concerns; now what? The panelists — Steven Juliano (Illinois State University), John Leventhal (New York Supreme Court), and Christophe Boete (Universite de Montpellier) — introduced several issues for the room to mull over. To understand the ecological impact that the modification or eradication of mosquitos may have, we may look to the studies of invasive species that are not products of genetic engineering. Historically, when species introduced to an area have spread faster than thought and with unintended consequences. Communications (an emerging main theme) was hit again, as well as the role that public health officials should play in introducing GMM to a community.

Major keywords and talking points

Analyzing Risk

- A comprehensive risk analysis must be completed to understand which risks are acceptable.
 - It is nearly impossible to pre-empt all the risks making it impossible to actually complete a comprehensive risk analysis.
- It will be difficult to predict the trajectory of spread in a population where it was unintended.
- Need to incorporate risk factors of other diseases that the mosquitoes can spread.
- A risk analysis should occur at each new step in the process.
- Some effect may be statistically significant but not biologically significant.
- To alleviate risks, different groups should work on GMM technology and see if they arrive at the same conclusions.
 - Regulators and scientists should both be doing independent risk analysis.
 - Scientists must explain how they developed the risk analysis — and explain the analysis, too.
- Quantifying the whole process is impossible, but we could identify weak links.
- Original GMM risk never delved deep enough.

Technology

- It is important that the first use of gene drive is not for profit. The corporate environment needs to be separated from the science.
 - Competition between companies can cause missteps, which could have a negative impact on the public's view of GMMs.
- One approach may be to engineer variants that are self-limiting to mitigate risks of unintended consequences.



Panel Takeaways

- It is impossible to predict ramifications because we don't know the questions.
- Diversity is essential so that various factors can be investigated related to GMMs.
- Introduction of GMMs is a different ballgame:
 - Selection of pathogens and selection of fields and species should be evaluated.
 - GMMs should be released only in places with significant public health crises.
 - We must define local community.
 - Any technology needs to be OK'd socially, culturally, federally, and scientifically.
- Both sides need to engage and discuss the issues.
- GMM goes beyond biology and disease.
 - The technology has a lot of transnational impacts.
 - It has become a debatable issue due to presence of different entities — but that hasn't made it transparent.
- Regulatory agencies have a lot of responsibilities.
- Countries have to work together and not be isolated.

Questions/suggestions for later research

- What would happen if we had developed this technology 30 years ago?

Conclusion

The Conversation wrapped up with a session encouraging participants to team up and provide commentary on large posters around the room. This information summarizes many of the main discussion points reiterated through the day, and ends with potential steps for moving forward.

1. New insights into your understanding of the key issues based on other perspectives you heard today

- Be prepared for the courts to decide.
- Multiple levels of community engagement are important.
- There is a significant emphasis on risk assessment.
- Most significant ecological relationships of concern can be identified, and they do not depend on a particular technology.
- The social/political/cultural issues involved with GMMs are complex.
- Transboundary issues suggest that self-limiting gene drives could help solve the issues.

2. Main points of divergence

- Are democratic principles, inclusion, etc., necessarily compatible with human health issues? Example: anti-vaccine communities.
- What is the ethical basis of driving a species extinct (intentionally)?
- Are voluntary guidelines and self-regulation the best — or only — way?
- Can risk uncertainties be known sufficiently to release GMMs?
- What are the virtues of suppression vs. replacement?
- Is gene drive the best option?
- Local/national vs. global oversight will be an issue.

3. Research Priorities

- Scientists should explore self-limiting gene drives and technologies.
- We must emphasize the social science of societal governance and risk.
- New ecological impact studies (not the EPA kind — new ones) are needed.
- Gene drive/GM efficiency studies are needed.
 - We must explore resistance/reversion rates.
- Safety characteristics have to be defined.
 - We will need field trials — Phase II
- Meaningful test systems in containment are needed for gene drives.
- There is a need for basic research on ecology/evolution of target vectors and pathogens.
- We must create risk assessment methods and expand the suite of risk assessments employed.
 - Those include social risks, economic risks, trust in government institutes, and long-term future impact.
 - And we have to define the scope of risk assessment

4. Uncertainties and Unknowns

- Lots of stuff (that's why we are here).
- Will we ever trial this technology?
- We must learn how to develop a method to quantify uncertainty that can be flex for yet-to-be made tech.
- Where will the sustained funding originate? And who will control it?
- How to enforce?
- What will the legal precedents be?
 - And we must prepare for the inevitable litigation.

5. Other priority initiatives

- We need a massive global campaign for science literacy.
 - This includes peer-reviewed and grey literature.
 - It is important for the younger generation (to introduce science to younger folks).
- Engagement and informed consent are key to pre-development, development, testing, and post-release monitoring and surveillance.
- The role of industry and funding must be defined.
 - We must explore profit motives, ego, non-profit agendas, and the Hero complex.
- Do we need a new global entity to guide GM mosquito tech? How does it get funded, structured, and enforced?

6. Community Continuation

- iSEE will create a listserv for participants.
- iSEE will assist organizers in preparation of white paper.
- iSEE will assist organizers in fashioning a policy/opinion piece for a scientific outlet.
- We want to expand the network to engage other stakeholders.
- We want to develop a unique, multidisciplinary risk assessment and cost-benefit process.
- Participants would like web-based resources for this expanding community.
 - That might be a web-based, real-time map of research activities (science and social science), funding, and regulations — to have a view of the status of the field and to identify concentrations of power and expertise.