Genetic Control in Historical Perspective:
The Legacy of India's Genetic Control of Mosquitoes Unit

By Rebecca Wilbanks

An ambitious project seeks to apply the latest research in genetics to the problem of mosquito-borne illness. Scientists hope to reduce the mosquito population and drive down the burden of disease by releasing genetically manipulated mosquitoes into areas where mosquito-borne illnesses are endemic. With support from international organizations and the Indian government, scientists from prestigious institutions in the UK and the US work with their Indian counterparts and public health officials to set up research and field stations outside New Delhi. Teams of health education professionals and social scientists are dispatched to engage the local communities, seeking permission to set mosquito traps and release lab-reared mosquitoes in and around people's homes. Articles in the Indian and Western press suggest that this biological technology could finally turn the tide in the war against malaria and other mosquito-borne illnesses. However, five years into the project, it becomes the object of vehement debate within the Indian parliament and diplomatic contretemps between the US and India. In 1975, the project is terminated ahead of schedule.

In the last decade, genetic strategies for mosquito control have been making headlines again. The first field trials of genetically modified mosquitoes produced using molecular biotechnology were released in 2009 by the British company Oxitec in Grand Cayman.[1] The advent of CRISPR gene editing systems in 2012 made genetic drive technologies—which work against natural selection to spread a gene through a population—increasingly feasible, and gene drives have been implemented in mosquitoes in a laboratory setting.[2] Target Malaria, a multi-national research consortium originally based out of Imperial College London and funded by US-based philanthropies, has been preparing for the potential use of gene drives in several African countries. The Tata Institute for Genetics and Society, funded by the Indian philanthropy Tata Trusts, brings together US and Indian researchers to work on gene drive technologies, also with a focus on malaria; UC San Diego is the "lead unit of the Institute."[3]

The genetic control research of the 1960s and 70s differs from work being carried out today. An earlier generation of researchers used cross-breeding, radiation, and chemical treatment to alter chromosome structure and generate mutations in mosquitoes, rather than targeting particular genes. But then as now, the work was understood as the cutting-edge application of genetics to suppress a wild population.[4] And today, genetic control technologies are primarily developed in high-income countries, while low-income nations in the Global South with a high burden of mosquito-borne illness—similar in many respects to India in the 1970s—are considered as sites of deployment.[5]

This paper examines the Genetic Control of Mosquitoes Unit (GCMU) in India as an earlier episode in the history of genetic control. The GCMU was a joint project of the World Health Organization (WHO) and Indian Council for Medical Research (ICMR) that operated from 1969-1975 and conducted the first large-scale trials on the genetic control of mosquitoes. It involved international scientific collaboration during the Cold War and was attentive to relationships with local communities at release sites. The unit was shut down largely due to national security concerns. Its consequences continue to ramify today, demonstrating how genetic control research is entangled in geo-politics and the legacy of colonialism. The case of the GCMU points to the way that a backdrop of military interest in the technology can impede trust in international collaborations, the challenges of shared decision-making in the context of structural inequality, and the long-term consequences of projects that foster mistrust.

History of the GCMU

The WHO began exploring the genetics of insect vectors of disease in the early 1960s, following the success of radiation-sterilization in controlling the screw worm in the US in the 1950s. Insecticide resistance was a growing problem, and awareness of the environmental and health costs of insecticides was growing. Following a 1967 WHO meeting on the topic, a WHO committee suggested India as a host country for research and field testing, in part because of the availability of US Public Law-480 international development funds (known as the "Food for Peace" program).[6]

In 1969, the World Health Organization (WHO), the Indian Council of Medical Research (ICMR), and the US Public Health Service initiated work at facilities in Delhi. Researchers conducted studies on the population dynamics of *Culex quinquefasciatus* and *Aedes aegypti*. In laboratories, they sterilized mosquitoes using chemicals and radiation. They bred mosquitoes that had "cytoplasmic incompatibility" with native strains,[7] and others with chromosomal translocations that would similarly render the offspring of lab-reared strains and wild-type strains inviable. Significant work focused on techniques for rearing large numbers of mosquitoes and separating mosquito larvae by sex, as effecting change in wild populations required the release of large numbers of altered insects. Field releases began in 1971, building on prior but smaller scale releases in Burma and the Florida Keys. At one point, the project included 16 senior scientists and 139 technicians and staff who conducted experiments on both *Culex quinquefasciatus* and *Aedes aegypti*.[8]

To obtain the cooperation of people living in the villages around Delhi where mosquitoes would be released, the research team also conducted a "health education" campaign. Project employees sought to determine "communication channels" of the village, identifying formal and informal community leaders, and endeavored to speak to members of each household. They interviewed villagers to understand prior conceptions about mosquitoes and disease transmission and sought to educate them about the role of mosquitoes in malaria and about the project goals. The ultimate goal was to "motivate them to become as innovators for the program."[9] In 1973, an ad was posted for an anthropologist with a post-graduate degree and at least 7 years of experience, fluency in Hindi and/or Punjabi, and experience working in village and urban populations in Northern India who would "evaluate community response" and "maintain community support" through "effective public relations."[10]

Directly impacted populations had no formal say in whether or how the project went forward, though the agency of communities was tacitly acknowledged, as researchers were aware of a 1962 project had shut down due to local opposition. Publications discussed the need for "cooperation" that could be given or withheld, and the project continued to invest in community relations as it grew.[11] Articles published in 1974 reported that "good relations have been maintained with the villagers even though the releases in certain of the villages have been much more prolonged than originally planned."[12] Community members were said to tolerate even the "great inconvenience" of releasing mosquitoes inside houses and near kitchens.[13]

Criticism of the project first appeared in a 1972 newspaper article entitled "Science or Neo-Imperialism" by an anonymous "Scientific Worker." The article claimed that mosquito larvae treated with the chemosterilant and known carcinogen thiotepa had been placed into wells where they were polluting the water supply. Such a practice, the author maintained, would never be permitted in the US. It was true that irrigation wells (though not drinking wells, according to project's defenders) were used for breeding and release of mosquito larvae in the early years of the project. A 1974 publication indicates that this practice was stopped because project researchers found that "residues of thiotepa are still detectable by gas chromatography" at the pupal stage, and because research pointed to better survival with the release of adult mosquitoes.[14]

More broadly, the article argued that Indians were not full partners but only "recipients" of the research without substantial influence over the project. A second investigative report by the science journalist K. S. Jayaraman, published in 1974, further developed this critique by questioning the role of the US military in the GCMU and several other scientific collaborations taking place at the time. Jayamaran contended that several of the GCMU's choices—from species of mosquitoes studied to selection of test sights—were puzzling in light of India's epidemiology, but in line with US interests in bioweapons. These allegations would be ridiculed in the US newspapers—"Indians Call Sterile Mosquitoes CIA Agents," jeered the Washington Post—while a post-mortem in *Nature* suggested that better communication between scientists and the public could have staved off "appalling misunderstandings."[15] However, the Indian parliamentary committee tasked with investigating the project concurred with Jayaraman, concluding: "The benefits, if any, that are likely to occur to India are…not immediate but only potential. On the contrary, the project is of far greater importance to any country which might want to develop an effective Biological Warfare system."[16] The committee's findings also supported the idea that ultimate control of the project rested with the US: as per the funding agreement between the WHO and the USA, the US Centers for Disease Control had to approve the appointment of project leaders, who were largely US government scientists.[17]

Concerns about covert operations in India reflected a history of intelligence operations by colonial powers dating back to the East India company in the 18th century.[18] The allegations also resonated because of the ways in which infectious disease research had already been militarized. In the decades preceding the GCMU, the US had pursued the weaponization of yellow fever, which is carried by *Aedes aegypti*.[19] The GCMU's work with *Aedes aegypti* raised suspicions about bioweapons connections because yellow fever is not endemic to India, whereas malaria—a greater threat—is not carried by *Aedes aegypti*. Although *Aedes aegypti* was part of the transmission pathway of dengue in India, dengue was perceived to be mild; moreover, some hypothesized that the population's widespread exposure to dengue prevented the closely related yellow fever virus from gaining a foothold in India. Thus, targeting eradication of dengue was seen as questionable.

In 1969, the same year that the GCMU started up, the US government officially renounced offensive bioweapons research. However, the military continued to be interested in data on the ecology and dispersal of disease-carrying animals. The Pentagon had a particular interest in tracking the epidemiology of vector-borne diseases such as Japanese encephalitis that threatened US military operations in Southeast Asia. The GCMU research was called into question alongside a Pentagon-funded project called the Migratory Animal Pathological Survey (MAPS) that involved researchers in India and other countries across Asia. Migrating animals such as birds moved through adversarial territories, areas of geopolitical dispute, and across nuclear testing sites, ferrying disease agents and possibly radioactive particles back and forth.[20] Their cargo could provide useful intelligence or the means to carry out a biological attack. One member of India's parliament quipped of MAPS, "there is a lot more to bird watching than just bird watching."[21] As India strove to remain neutral in the Cold War, international collaboration in ecological surveys came under scrutiny.

Unlike MAPS, the GCMU had no direct ties to the Pentagon. However, commentators were aware of ties between the US Public Health Service and military researchers. In addition to collaborating on the production of shellfish toxin for the CIA, the Public Health Service received funds from the Pentagon and shared information with Fort Detrick researchers.[22] It did not seem far-fetched that the Pentagon might take an interest in the work conducted at the GCMU. A bioweapons expert stated the problem succinctly in 1975: "BW [bioweapons] and public health interests are totally inextricable, and perfectly acceptable civilian work often has military implications."[23] Even if the project was not conceived by the US military, critics argued that these connections could call into question India's neutrality.

International Development, Science, and Politics

The political dimensions of humanitarian aid were hard to miss in the Cold War. As part of the "Food for Peace" program, India incurred debt to the US for the grain shipments which they repaid in Indian currency; these "PL-480 funds" were earmarked by the US for the purposes of supporting development projects, and the operation of American businesses in India.[24] In addition to providing influence through "strings-attached" funding, the food imports themselves were used as leverage by US administrations. The debt itself stood as the "great symbol of American intervention in Indian life" during this period, according to Daniel Moynihan, the American ambassador to India from 1973-1975; calculations suggested that the US ledger was slated to grow to up to a third of the Indian monetary supply.[25] Cultural studies scholar Kanika Batra writes that "to those growing up in this period, the imports marked a shameful episode in Indian postcolonial history" tangible in the wheat itself, which differed in "quality, color, and taste" from Indian varieties.[26] In 1974, when the GCMU program was debated in Parliament, the program was sensitive enough that the fact that PL-480 funds had been used to support the research was posed as a damaging insinuation.[27]

If humanitarian aid was clearly part of the Cold War calculus, so too was a nation's scientific portfolio, as illustrated by the juggernaut of nuclear research. India's first nuclear test, two months before the Parliament took up the issue of the GCMU at a site not far from one of the GCMU's testing sites, shadowed discussions. The origins of the GCMU lead back to nuclear science in another way: research into radiation-sterilization of insects was initiated by the WHO together with the UN's International Atomic Energy Agency, an organization set up to support peacetime uses of nuclear technology following Dwight Eisenhower's "Atoms for Peace" speech. The association encouraged applications of radiation in agriculture, medicine, and international development. With the program, US policy around nuclear science pivoted from absolute secrecy to offering a degree of information sharing (having already lost its short-lived monopoly on nuclear know-how with the Russian bomb) coupled with non-proliferation agreements (while at the same time continuing to build the US arsenal).[28] India's nuclear test, the result of a weapons program built on the "bedrock" of expertise, infrastructure, and materials obtained under Atoms for Peace, was a severe blow to the idea that this policy could contain nuclear research to non-military uses only.[29] The program's nuclear connections highlight the political charge of research associated with death and destruction yet also invested with hopes of progress and prosperity.

Atoms for Peace was rhetorical propaganda as well as a strategic gambit to support non-proliferation. During the Cold War, US actors posed a "republic of science" as a counter to the secrecy and enclosure of international politics. For the US, the image of free and open science was, ironically, used as a tool of statecraft, promoting the US as a bastion of intellectual freedom; US scientists collaborating with foreign counterparts played roles that were both diplomatic and intelligence-gathering.[30] Yet the view of science as outside politics resonated with the scientific community both in the US and internationally. The Indian health minister defending the project before parliament drew on a rhetoric of a science that knows no borders, maintaining, "the findings of research are the property of science and as such the property of any country whatsoever"; "these literatures are open literatures;" and "in matters of science or in projects for human health…we consider all countries—America, USSR, Japan—friendly countries."[31]

Critics, however, were not satisfied with "a justification of the [scientific] relevance of GCMU," nor were they mollified by appeals to the republic of science. The project may well have had scientific and public health merit, they argued, yet given the double-edged nature of scientific research, "scrutiny of the 'sensitive and security aspects' of research projects should not be viewed in a narrow formal sense involving only military installations or military information."[32] As indicated by the MAPS controversy, information about animal vectors of disease or the susceptibility of different populations to disease could be both relevant for public health and "sensitive" in relation to national security. Critics successfully framed the GCMU as a threat to India's "sovereignty:" "interference" in India's internal affairs by a superpower that threatened the country's self-determination.[33] Supporters of the project made the case that strengthening India's scientific capacity would enhance its international standing, but this argument failed to win points in face of claims that India was more of a "recipient" than an equal partner in the research.

The parliamentary debate oscillated between disavowal of the political and a hyper-politicization that assumed that science was masking covert interests. The ICMR representative's insistence that the project had no political content and no motives other than supporting public health and advancing scientific inquiry only served to further inflame the critics, whose sensationalist accusations included the suggestion that the program was a front for the CIA to test biological weapons. Assertions that "American money, American penetration, and American interference are going on under cover of research" were part of an idiom invoked by India's political class and found in popular culture more broadly that saw the "secret actions of the CIA" behind every development in Indian life.[34] By the 1970s, the misdeeds of the CIA in developing countries such as Chile were well known, and allegations of CIA infiltration in India were used by various political factions within India to stoke nationalist and anti-US sentiment for political gain.

In the case of the GCMU, allegations of hidden influence from foreign agents mirrored concerns about the imperceptible effects of molecular manipulations: one Communist Party representative spoke of "the question of DNA being experimented upon…particularly in the lower strata of animals which can spread and cause havoc of which the humans beings are not aware that they might be affected."[35] The "scalar narratives" woven in parliament, connecting microbes, mosquitoes, migrating birds, and military ventures, served as an attempt to grapple with the political and economic relations between India and wealthier nations enacted by different technological projects.[36] These concerns were expressed but not fully contained in inquiries into whether Indian scientists "initiated" and "vetted" the research, whether foreign funds were inducing Indians involved with the project towards actions not consistent with national self-interest, and whether the long-term effects of the project would be to benefit foreign companies more than public health.

These and other questions raised by GCMU critics—including the regulatory and oversight capacity of the host country, the risk-benefit ratio, and the exploitation of variability in regulatory regimes for commercial gain—are familiar concerns in discussions of the ethics of transnational research today. In the intervening years, research ethics has developed frameworks that attempt to address these issues through policies that incorporate benefit-sharing and capacity-building in lower- and middle-income countries. From a vantage point informed by the current literature, the GCMU program clearly fell short in many ways. The program did not offer any clear benefits to residents of the communities that served as test-sites. Their engagement strategy was based on the discredited (but by no means disappeared) "deficit model," which is predicated on a one-way flow of information from scientists to the public, and assumes ignorance is the main barrier to acceptance. No public deliberation about whether or how to go forward was attempted. Despite the development of frameworks for identifying and addressing ethical challenges in transnational research, inequalities between those in the nations spearheading the research and those where it will be implemented remain, along with similar questions about power and justice.

Implications for the Present

The end of the Cold War, the rise of private foundations and public-private partnerships in global health, changes in both genetic control technologies and engagement strategies, and different contextual factors specific to each project complicate analogizing from the case of the GCMU to work going on today. At the same time, the case study draws attention to some through lines between the past and the present:

1. Actions that breed mistrust have long-term consequences.

As India considered a new generation of genetic control methods in 2016, actors involved in the GCMU project used their experience to warn against adoption of the technology. Jayaraman, the journalist who published the exposé alleging military connections, and P.K. Rajagopalan, an Indian scientist who worked at the GCMU, write: "Given the hidden dangers and India's previous experience with the GCMU, one would hope the Indian Council of Medical Research will reject any fresh move to revive the genetic control approach." They view the closure of the GCMU as a laudable "turning point in the history of the Indian Council of Medical Research (ICMR)" from genetic to environmental methods of mosquito control.[37]

In 2020, the story circulated anew when human rights lawyer Nandita Haskar—who first heard about the GCMU as a child, while her father was a senior advisor to Indira Gandhi—resurfaced the allegations as an example of a "true" conspiracy story.[38] Rajagopalan responded with his own recounting of the story in the magazine *Frontline.*[39] This historical memory has perhaps contributed to the fact that recent genetic control projects have not advanced beyond caged field trials in India in recent years, despite a partnership between Oxitec and an Indian biotech company to develop the technology.

Those involved in genetic control research and in the design of public deliberation should be aware of the way previous projects disproportionately assigned design and decision making of the project to foreign actors, as the mistrust fostered by the GCMU continues to reverberate over the decades.

2. Military connections, whether direct or indirect, complicate international collaboration and should be avoided, or at least made transparent.

One factor present in the GCMU case and in current projects is a background of military interest and involvement. Like nuclear technology, gene editing is widely understood as a "dual-use" technology, just as research at the GCMU was recognized to have both public health and military implications. Gene editing was classified as a weapon of mass destruction by James Clapper, the US Director of National Intelligence in 2016.[40] Discursively, gene drives have been framed by nuclear technology. The authors of a paper describing the first use of a CRISPR-mediated gene drive named the process a "mutagenic chain reaction," recalling the nuclear chain reaction. Scientists as well as critics of the technology have drawn analogies to nuclear technology to describe its power: the possibility of widespread effects stemming from a localized action.

As in the GCMU project, a background of military research on these technologies means that critics can trace indirect links between public health projects and military-supported work. DARPA is the largest public funder of gene drive research in the world.[41] US researchers pursuing public health applications of gene drives are supported by the military as well as NGOs such as the Tata Trust. DARPA's broader interests in synthetic biology include entomological and agricultural applications; their "Insect Allies" program was criticized by a group of scientists for a project that would use insects to spread viruses to crops in order to genetically modify them through horizontal gene transfer, an approach the authors argued blurred the lines between offensive and defensive purposes.[42] This background of military research could lead to a perception, as in the case of the GCMU, that public health projects could provide useful information to the US military—even if the project is not primarily aimed at a military application.

While framing research as impacting national security makes it a political priority and can help secure resources, applying the security framework in public health and genetic control research complicates international collaborations. Moreover, there are consequences for allowing the military to take the lead in longer-term responses and research, not only for reasons of public perception but for the trajectory of technology development itself, as funders are instrumental in setting priorities for research.[43] University of Hawaii gene drive researcher Floyd Reed, drawing on the history of the GCMU and military research in the Indo-Pacific, criticizes the allocation of funding that has resulted in DARPA spearheading gene drive research. He argues that "humanitarian goals need to be administered and controlled by humanitarian organizations and conservation goals need to be administered and under the control of conservation organizations."[44] These recommendations are essential. The GCMU case shows that even indirect linkages between military and civilian organizations can harm the credibility of public health projects.

3. Narratives of covert foreign influence draw attention to structural inequalities.

While the allegations against the GCMU were taken seriously by many in India, western publications tended to dismiss the charges. Advocates of public deliberation may similarly be tempted to dismiss the idea that scientific projects conceal hidden interests as conspiracy mongering in light of widespread mis- and disinformation around public health issues such as vaccination. While it is important for organizers of public deliberation to provide factually accurate information, it is also important to pay attention to the ways in which narratives are a means of communicating situated experience, as noted in the essay "Narratives in Public Deliberation: Empowering Gene-Editing Debate with Storytelling" in this special report.[45] Anthropologist Maryam Yahya notes that conspiratorial idioms "crystalliz[e] valid commentary on broader political experience in colonial and post-colonial settings," even when specific claims may be unsubstantiated.[46] Questions about foreign influence may be seen as questions about the larger web of relationships fostered by research collaborations and development aid.

In the case of the GCMU, questions about the role of the US military led to an examination of the lopsided power structure of the program. In fact, this relationship involves a feedback loop, as the lack of involvement of Indian scientists in project design and site selection led some of them to suspect foul play. For the purposes of this paper, one may assume that the US military had no involvement with the project; it is still important to appreciate the context that gave rise to such claims.

Critics of Target Malaria in Burkina Faso have similarly suggested that the research "conceal[s] industrial and military objectives," as part of a broader critique of the political economy under which such research is undertaken.[47] They place genetic control research in a lineage of experimentation on colonial subjects.[48] These concerns have gained some traction in Burkina Faso; a 2018 march in the capital attracted around 1,000 participants to lobby against Target Malaria and Monsanto.

More pointedly, critics have used claims of foreign interference to interrogate the conditions under which host nations enter into research projects. Rajagopalan maintains that collaborations between high and low-income countries are inherently risky for the latter due to structural inequalities, including less access to technology and scientific capacity to independently evaluate and monitor projects, and incentives for scientific elites within host countries to maintain positive relationships with scientific networks in wealthier nations with more resources for training and funding.[49]

Similarly, Ali Tapsoba of the NGO Terre à Vie in Burkina Faso points out that scientific research and public health work in the country relies heavily on international funding, including significant amounts from the Gates Foundation. "It's a form of pressure," he argues; "the Burkinabé state cannot refuse [the Gates Foundation] anything."[50] The groups advocating against gene drives have also been active in lobbying against genetically modified crops, and Burkina Faso's ill-fated decision to adopt Monsanto's GM cotton in 2008 is relevant in this respect. The adoption of GM cotton has been attributed in part to the desire to curry political favor with the US; the US ambassador advocated for the government to adopt an agreement that limited Monsanto's liability.[51] In arguing against gene drives, the African Centre for Biodiversity draws attention to the role that actors such as Gates foundation and other US based charities funding gene drive research have played in through their investments in setting up regulatory structures for genetic modification on the African continent.

This context underscores the challenges of reaching agreement for research projects when political and economic power is unequally distributed. Humanitarian projects, whether locally driven or foreign, are political in the sense of supporting particular forms of social organization, and regulatory regimes are shaped by political cultures.[52] These factors strengthen the case for robust public deliberation to ensure that projects reflect local values. They also suggest the importance of deliberative forums that are independent of organizations supporting the research. And they imply that deliberative forums may need to be able to reflexively account for the sociopolitical conditions that have given rise to their existence.

These observations do not imply that postcolonial nations lack agency in the development of sociotechnical projects or regulatory regimes, and are certainly not meant to create a dichotomy between "local" cultures and global science. Even apart from the difficulties in determining relevant units of geographical or political scale when involving communities, the "local" is dynamically constructed in relation to the global. For some, local or national sovereignty may be found through engaging transnational networks, while others see neo-imperialism in those same networks. Rather than assuming that local cultures and global scientific research need to brought into alignment, attention should be paid to the way that value-laden regulatory regimes are constructed through the interaction of actors and institutions.

4. Concerns may be aired outside deliberative forums, in different venues or at different scales.

Discontent with the GCMU bypassed community engagement channels, percolating into the press and from there into Parliament. Possibly, community members had concerns that they did not express to researchers, or expressed only to the press; possibly, concerns came from outside the communities. This raises the importance of looking beyond just "community engagement" both in terms of how grievances are aired and who has concerns. The press may be one means of bringing other voices forward. At least some scientists working on the project expressed dissatisfaction with how things were run when given the opportunity to air their views anonymously.

Today, projects that have devoted substantial attention to public engagement such as Target Malaria seek agreement from the village where mosquitoes are released; outside of this village, groups are "informed and consulted."[53] Yet, the GCMU was problematized at a national level, questioned through the lens of national sovereignty. This underscores the importance of conducting deliberation at multiple scales, and of acknowledging that parties outside of the release area may feel that they have a stake in the matter.

Much more could be said about how research projects become matters of concern at different scales, in relation to the distinctive sociotechnical imaginaries of different political communities, and about how perceptions of national interest related to science and technology are contested within nations. Concerns about foreign influence in scientific collaborations may draw attention to structural inequalities that are important to account for, but may also be wielded to stoke nationalism for political gain. The claims are politically powerful because of the history of colonialism and violation of self-determination in postcolonial countries.[54] Despite or perhaps because of this political charge, "community engagement" has become a buzzword surrounding contemporary genetic control projects, but geopolitics and history—including prior scientific experimentation, military interests in the technology, and the legacy of colonialism—is less often discussed in this context. Understanding the history of genetic control research is a step towards avoiding past errors.

Notes

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