

[crickets]

[cymbal plays]

[chime]

[music plays]

[NARRATOR:] Brazil, late 2014.

[baby cries] Doctors noticed a disturbing trend. An increasing number of babies were born with abnormally small heads, a condition known as microcephaly.

[baby cries] The spike in microcephaly was linked to a virus called Zika that is spread by mosquitoes.

[TURCHI:] I just never dreamt as an epidemiologist of infectious disease that I would see a congenital transmission by a virus that would do such a great damage and would be transmitted by mosquitos.

[mosquito buzzes]

[NARRATOR:] Throughout the Americas, mosquito bites are tied to many viral outbreaks. In the months before Zika spread in Brazil, Chikungunya, a tropical virus that causes terrible joint pain, invaded the Western hemisphere, infecting almost a million people. And West Nile virus sickened more than 2,000 victims in the U.S., with symptoms ranging from fever to paralysis.

[music plays] To stop these outbreaks, scientists have turned their attention to fighting the mosquitoes that carry these diseases. And one of the weapons they are using is genetic engineering.

[music plays]

[NARRATOR:] In South America the Zika virus is spread by a mosquito called *Aedes aegypti*. Other diseases including dengue, Chikungunya, and yellow fever are also spread by this persistent insect.

[FRIEDEN:] *Aedes aegypti*, is the cockroach of mosquitos. It lives indoors and outdoors. It bites day time and night time. It develops a resistance to insecticides easily. The eggs can overwinter for a year. To control it, we have to kill the adult mosquitos, the larval mosquitos, both inside and outside.

[NARRATOR:] Health officials have used sprays and screens to protect people from diseases spread by mosquitoes. But since 2002, scientists at a biotech company called Oxitec have been investigating a more direct approach: A line of genetically modified *Aedes aegypti* mosquitos, called OX513A.

[PINTO:] The goal of this procedure here at Oxitec is to use our mosquito, OX513A, to reduce the population numbers of the *Aedes aegypti* mosquito in the wild.

[NARRATOR:] When released, these mosquitoes reproduce with wild mosquitoes and cause their offspring to die. Although there are concerns about this technology, authorities have allowed limited releases to study its efficacy and safety. So how were these genetically modified mosquitoes produced? The process involved engineering mosquitoes with two new genes.

[PINTO:] What you do first is create or synthesize the DNA you want to insert. So in our case we use the two genes that we inserted, the lethality gene and the fluorescent marker.

[NARRATOR:] The genes were inserted in the genomes of mosquito eggs. The lethality gene makes the developing mosquitoes dependent on the antibiotic tetracycline, which is fed to them in the lab, but is not available in the wild. The fluorescent marker gene produces a protein that glows red when exposed to light of a certain wavelength. It tells scientists which mosquitoes have the lethality gene. After the first genetically modified mosquitoes grew into adults, scientists bred them in the lab. These mosquitoes passed on the genetic modification to each new generation, giving rise to a colony of genetically modified mosquitoes, all dependent on tetracycline.

[PINTO:] So this is our female room. You can walk in. In these big cages, what we have is our egg producing colony. And in total about 12,000 females per cage and they are here to produce the egg. So our genetic modification has been done in 2002. This change was inserted in the genome of every single of these mosquitoes which are here in this room. They lay their eggs on these pieces of paper, all the black little dots are eggs that have been laid.

[NARRATOR:] When scientists plan to release genetically modified mosquitoes into the wild, they collect eggs from this colony. They place the eggs in water where they hatch into larvae and then grow into pupae. At this stage technicians separate the males from the females by size.

[PINTO:] These are the separated females and that's the male pot.

[NARRATOR:] The male pupae are significantly smaller than the females. Feeding them tetracycline, the antidote to the lethality gene, keeps the mosquitos alive as they grow into adults.

[PINTO:] So we give an antidote in the lab to the mosquito, so that they don't die and then we go release our male into the field.

[NARRATOR:] Male mosquitoes don't bite people so they will not spread disease. But they live long enough to mate with female mosquitos.

[PINTO:] Then life becomes exciting for them. They get to do what they are best at doing, which is searching females and copulating with those females and our males will deliver the lethality gene to their children. And in the wild the babies do not come in contact with the antidote and there they die.

[music plays]

[TRIVELLATO:] Well, here in this van you can fit almost 800,000 of male mosquitos. As we go driving through the area, every time the app beeps we just open one of these pots in here and the mosquitos will fly around and do their job.

[NARRATOR:] Once released, the genetically modified male mosquitos mate with wild females, and pass their genetic modification to all their offspring. The male carries two copies of the genetic modification, so all the offspring inherit a copy of the lethality gene. The wild offspring will not feed on tetracycline, the antidote to the gene, and they will die before reaching maturity. Scientists monitor how the technique is working by capturing larvae, and determining what percentage have the tell-tale red fluorescence. Studies have shown that, with repeated distribution, the wild mosquito population of a village or neighborhood can be cut by 95%. If the technique continues to prove effective and safe to humans and wildlife, it could be applied to other species of mosquitoes and help stem the spread of many dangerous diseases.

[baby cries]

[music plays]