5 Attacking the Fly from Within: Parasitization and Sterilization

In 2007, the journal *Science* carried an intriguing article. Ethiopia was developing a sophisticated weapon against *mhesvi*. The idea was to produce one million male flies per week, blast them with radiation for a few seconds to render them sterile, then set them free in *mhesvi*-infested areas at a ratio of 10:1 (sterile to wild). The releases would be made several times, the repeated mating without offspring resulting in the annihilation of the *mhesvi* population. This "birth control for insects" was lauded as "an elegant and environmentally friendly method" (Enserink 2007, 310).

The article noted the success of the sterile insect technique (SIT) in eradicating the screwworm in North America; saving apples in Chile, onions in the Netherlands, and melons in Japan from different kinds of *zvipukanana*; and, of course, eradicating *mhesvi* on Zanzibar island. Now Ethiopia! Soon, *mhesvi* would be history in over thirty-five African countries and, with it, *gopé* and *n'gana*.

The most biting critique came from none other than Glyn Vale, one of the leading figures in the Rhodesia tsetse control research project. The factory for engineering these insects alone cost $12 million, for a technique that might be effective against one of over twenty-three kinds of *mhesvi*—and even then, without assurance that reinfestation would not occur. "I hate to see a poor country waste so much money," Vale said. Edinburgh University's Ian Maudlin went even further: this was a giant waste of money by a poor African country succumbing to the seduction of the International Atomic Energy Agency (IAEA; Enserink 2007).

Glyn Vale would know: Attempts to destroy *mhesvi* from within had been made for almost the entire lifespan of the (Southern) Rhodesia project and found to be more expensive and less effective than other methods, like OCPs and traps specific to one type of *mhesvi*. This chapter considers the local history of attacking pests from within their bodies, focusing on two methods. The first, *parasitization*, involved strategically (re)deploying

mhesvi's parasites to kill it or render it inhospitable to microorganisms deadly to people or their *zvipfuyo*. The second, the *sterile insect technique*, involved using chemicals and gamma radiation to sterilize male *mhesvi*, then unleashing them to mate with the wild females, driving their race into extinction.

The argument made is that attacking *mhesvi* from within represents the applied value of the knowledge of *mhesvi*'s bionomics and internal mobilities, both internally (*nyongororo* moving within its body) and in situations of intimacy (nuptial flights). In the first instance, the weaponizable element was the *nyongororo*—specifically, the points of contact between this micromobile organism and (potentially) vulnerable parts and systems within the *chipukanana*'s body. In the second, the weaponizable element was the sexual act, meant to result in procreation, but now genetically engineered to accomplish the ultimate genocide—the extinction of the gene line. Both required a meticulous understanding of the micromobilities of *hutachiwana* (which *vachena* called "protozoa"), developmentally and physically, and of the sperm within the small body of *mhesvi*.

Parasitization: *Nyongororo* as Weapon

The earliest record of *nyongororo* (parasites) of *mhesvirupani* in Africa is Leiper's report from 1910 (Thomson 1947). Catches during the wet season in 1912 and 1913 revealed *mhesvirutondo* to have similar *nyongororo* within them. They had been recovered from the Mpika area of Northern Rhodesia (Lloyd 1912) and from *mhesvirupani* on Lake Victoria in Uganda (Carpenter 1912) and Katanga (Rodhain et al. 1913).

In 1923, entomologist J. K. Chorley became interested in researching the parasitization of *mhesvi* with just that in mind. His superior, Rupert Jack, said of the idea at the time: "The study of the natural parasites of the fly has yielded results of great interest and shows that a very high death rate occurs at certain seasons of the year from this cause."[1] He did not specify what the *nyongororo* were.

However, Dr. William Lamborn, a medical entomologist then working on *mhesvi*'s parasitization in Nyasaland (*vachena*'s name for a country *vatema* called "Malawi"), sent Chorley two consignments of flesh fly *zvikukwa* that had been parasitized with a *nyongororo* that *vachena* called *Syntomosphyrum glossinae*. He then established a *nyongororo* strain on locally bred flesh fly *zvikukwa*. The same *nyongororo* was also bred from *zvikukwa* that Chorley had collected on the Munyati. The successful breeding of the *nyongororo* was a first step toward "ascertaining whether we could induce

an artificial increase of parasitization with this species in the Tsetse fly's natural haunts." That is why "parasitised Flesh fly puparia were forwarded in regular succession" to Chorley on the Munyati River in 1923. As Jack noted, the experiment met with unforeseen challenges: "Unfortunately owing to various causes including the depredation of ants at his [Munyati River] camp and difficulty in breeding parasites in large numbers during the hot dry season, Mr. Chorley was unable to release great numbers of the insects in the tsetse haunts. This combined with the fact that a natural increase of the parasites occurred in the late dry season rendered conclusions impossible."[2]

Jack decided to continue breeding and studying the *nyongororo* at Salisbury laboratory to understand more about its life history and factors affecting its breeding, "so as to be in a better position to test its capabilities in the field during the coming year." Meanwhile, attempts were under way to breed another *mhesvi* parasite *vachena* called *Mutilla glossinae* in flesh fly *zvikukwa* (pupa) at Salisbury "with a view to artificial increase." The entomological section was also investigating the *nyongororo* of flesh- and dung-breeding flies *vachena* called *Sarcophagidae* and *Musidae* at Salisbury to determine whether their *nyongororo* might also breed in *zvikukwa*.[3] Between 1915 and 1935, researchers in Northern Rhodesia found and took interest in yet another parasite found in a *chikukwa* the investigators called *Anastatus viridiceps*. The *chikukwa* was associated with *mhesvirutondo* (Waterston 1915, 1916, 1917; Lloyd 1912; Ferrière 1935).

More findings followed in the post–World War II period. In 1946, while researchers were dissecting 1,500 *mhesvirutondo*, three "*Mermis*"-type worms, each 79 mm long were found, all of them during the wet season in Tanganyika. The worms were bigger this time and occupied "so much of the abdominal cavity as seriously to incommode the tsetse." Thus, in one specimen there were samples of two different bloods, each with recognizable corpuscles, as if the *mhesvi* had been unable to take up enough blood at one time to satisfy its needs and had been forced to take two meals within an unusually short time. In 1955, what *vachena* classified as the *Hymenopteran* family *Eupelmidae* was found in *mhesvi* in Southern Rhodesia and Nyasaland (Buxton 1955; Heaversedge 1968). Then, on February 27, 1969, a *Hymenopterous nyongororo* emerged from *mhesvirupani zvikukwa* taken near Izom in Northern Nigeria. Under examination at the Commonwealth Institute of Entomology in London, the *nyongororo* was confirmed to be *Anastatus sp.*, the first time these *vachena* had found this *nyongororo* parasitizing *mhesvi* (Baldry 1969).

In 1971, a male *mhesvirutondo* of *vachena* classes as *G. brevipalpis* was discovered infected with two *zviguraura* (larvae) of the *Mermithidae* family. All these *nyongororo* infections occurred during the wet season. As Moloo (1972, 159) concluded, "the infective juveniles hatch during this season and penetrate into newly emerged *Glossina* through thin places in the body wall. … Since the incidence of infection is exceedingly low, the transmission to *Glossina* is almost certainly accidental."

Sterilizing the Male Tsetse

The second method of attacking *mhesvi* from within was to render its males sterile, thus preventing new insects from being conceived. Two methods were experimented with extensively, as discussed ahead.

Chemosterilants

Sterilize-and-release traps caught *mhesvi* that also could be retained as samples. The problem was that such traps were far more expensive and complex to assemble than catch-and-retain traps and required well-trained *vatema* to set and check them. Overall, these baits were generally affordable and effective when deployed in large numbers, but more expensive when deployed in smaller numbers. Cost-efficiency depended on the number of baits needed per area to produce optimal rates of decline in *mhesvi* populations.[4]

In a paper in 1966, R. J. Phelps is clear that "the sterile-male technique is a practical application" of H. J. Müller's 1946 Nobel Prize–winning work on the mutagenic effect of X-rays to induce mutations that would result in a sterile male. "In this context," Phelps says, "it does not mean a castrated male, but one which is normal in all respects except that damage has been done to the genetic material. Spermatozoa are produced by such males, and they are able to fertilize the female. However, no progeny are produced due to failure of proper chromosome pairing in the early embryonic divisions" (Phelps 1966, 29). Phelps had read North American research on releasing sterilized male screwworm flies, with field testing conducted in the West Indies (Baumhover et al. 1955) and, after its success, deployed in Florida and Texas at scale. It was due to these results that J. K. Chorley asked the British Colonial Office's Tsetse and Trypanosomiasis Committee to commission a study on the possibility of extending the technique to *mhesvi*. The resultant report was affirmative, with one study emphasizing dosage strength and the age of *zvikukwa* as critical determinants of success (Potts 1958). Another stressed the ratio of sterile males to females, urging that the technique

could only work if the female *mhesvi* population was first reduced through the application of chemical pesticides (Simpson 1958). The third study suggested the use of attractants to draw flies into areas where they could be treated (Knipling 1963). There was one problem: The chemicals for sterilization were "dangerous to handle" (Phelps 1966, 31) and the technique could only be conducted when safer chemicals were on the market.

The result was a collaborative project between the United States Department of Agriculture (USDA) and the Agricultural Research Council of Rhodesia and Nyasaland (ARC), financed by the United States Agency for International Development (USAID). USDA would supply the personnel and sterilizing agents (mostly chemicals); ARC would mass-produce *zvikukwa* and *mhesvi*. The agreement signed in 1963 by H. C. Periera of ARC and J. H. Starkey, an administrator with USDA's Agricultural Research Service, committed the United States to supply $84,000 for the collaborative research. In exchange, it stipulated that "any invention resulting from this cooperative work and made jointly by an employee or employees of the United States Department of Agriculture and the Cooperator, or an employee or employees of the Cooperator, shall be fully disclosed, either by publication or by patenting in the United States, and any such patent shall either be dedicated to the free use of the people of the territory of the United States or be assigned to the United States of America."[5]

The Participating Agency Service Agreement (PASA 3–8) took effect on June 14, 1963. Then, from June 22 to July 5, Dr. Paul Oman (assistant to the director of USDA's Entomological Research Division) and Dr. David A. Dame (ARC's principal investigator, based on the collaborative agreement) visited Salisbury to review plans for executing the research in phases with local representatives of USAID and ARC. They also checked facilities, personnel, equipment, and other logistical matters before flying to Lagos for consultations with USAID and the Commission for Technical Cooperation in Africa (CTCA). The trip was intended to situate the Rhodesia research within the larger continental control of *mhesvi* and *gopé*/*n'gana*.[6] From September 25 to 28, Dr. Carroll N. Smith, lead investigator of the "Investigations on Insects Affecting Man" project at Gainesville, Florida, attended the CTCA's Meeting of Experts on Trypanosomiasis in Lagos, along with Dame. The meeting's purpose was to revise the International Scientific Committee for Trypanosomiasis Research (ISCTR) to create "a council to aid and organize trypanosomiasis research in Africa."[7]

By this time, R. J. Phelps's sterile male–release technique was showing that sex and reproduction could be turned into not just a point of intervention, but a means of effective *mhesvi* self-destruction, at the moment

that *mhesvi* was engaged in its most intimate act. Laboratory-bred sterile males would be released in large numbers to mate with the females. By 1966, however, the challenge was that "the tsetse [was] refractory to laboratory maintenance; the most important symptom of this [was] the failure of laboratory-maintained flies to produce viable offspring at regular intervals," possibly due to neuroendocrine failure (Bursell 1967, 34).

The sterile male technique required the breeding of *mhesvi* in quantity—by stabilizing food supply, keeping them in mosquito-gauze cages with a tethered food supply inside, and using controlled environment rooms in cages large enough to contain an ox. Lab-kept *mhesvi* colonies were a recent phenomenon (Phelps 1966, 32). Dame and Schmidt (1970) found that mass sterilization depended on mass rearing of *mhesvi* in the absence of living host animals. Feeding *mhesvi* on different animals through natural and synthetic membranes revealed that the insect's mouthparts were adapted for piercing; it could not be induced to ingest from liquid surfaces (Langley 1972).

The record is again thin for the war period; by 1982, however, the BTTC was conducting field trials on several sterilization devices to replace retaining cages used in the catch-and-retain traps. These were designed to detain *mhesvi* in a chamber for half an hour so that more could enter. At that point, the chamber's position changed in a way that simultaneously swung the entrance shut and sprayed the flies with metepa aerosol. Once the *zvipukanana* were sufficiently sterilized, the chamber moved into another position again, opening the door and allowing them to escape. The chamber was one component of a three-chamber cylinder that rotated automatically at intervals, set at collect, spray, and release positions. Automation was electrically controlled using eight flashlight batteries that lasted for several months. A University of Zimbabwe (formerly University College of Rhodesia and Nyasaland) Zoology Department study had shown a wild *mhesvi* population exposed to odor-baited traps fitted with sterilizing devices to contain females with degenerated ovaries, while their male companions had "a high degree of sterility without a reduced longevity."[8] By then, research had shown that *mhesvi* could be permanently sterilized using chemicals. The sterilants were applied using injection, by dipping the *zvikukwa*, via wind tunnel spray treatment, and by contact with treated surfaces (Phelps 1966, 31; Dame and Ford 1966, 1968; Dame and Mackenzie 1968).

Gamma Irradiation

Parallel to the chemosterilants project, the International Atomic Energy Agency (IAEA) commissioned a study on using gamma irradiation (exposure

to radiation) to sterilize *mhesvi*. Experiments were also conducted on young *zvikukwa* under laboratory and small-cage conditions. By 1965, two preliminary studies had concluded that gamma irradiation and chemosterilants could reduce the reproductive capacity of *mhesvirutondo* (Potts 1958; Chadwick et al. 1964).

ARC deployed *vatema* as *mafrayi* on the Kariba islands to locate and collect *zvikukwa*, which were then flown to Salisbury (Phelps 1964). Inside the lab, they were floated in methylated spirit to remove dead and parasitized *zvikukwa* and maintained at 25°C, plus or –2°C, and around 70 percent relative humidity. The *zvikukwa* were stored in 8 × 8 × 11 in. wooden cages with transparent plastic walling and mutton cloth at one end, and male and female flies were separated each morning into similarly sized cages, but with fine wire mesh walls, a cotton mesh top, a mutton cloth sleeve, and a wire mesh floor. A guinea pig was placed in the middle for one hour to provide a blood meal for the *mhesvi*. The gamma irradiation used the Eldorado G Cobalt 60 Teletherapy Unit at Salisbury Central Hospital, as follows: "The pupae were held in fine cotton mesh bags and exposed for varying periods on a 15-sq. cm surface at a distance of 55 cm beneath the source. The adult flies were enclosed in a 4 × 12 × 12 cm wooden-framed box covered with fine cotton mesh. The Cobalt room was maintained at about 26°C, a fan was used to assist aeration during the irradiation, and the material for treatment was conveyed in a Kaylite box to and from the laboratory" (Dean and Wortham 1969, 506). The effectiveness of radiation on reproduction was deduced from the number of *zvikukwa* the treated and untreated *mhesvi* produced. Mortality increased with dosage. The experiments revealed that irradiation did not affect the male's ability to inseminate females; in fact, sperm from irradiated males was "mobile and apparently behaved normally" (518).

In 1972, studies were conducted in the use of nitrogen and chilling to produce radiation-induced sterility in *mhesvirutondo*. Several studies found gamma irradiation "safer, more convenient and reliable than chemosterilants" (Curtis 1968, 1969, 1970, 1972; Curtis and Jordan 1970; Curtis and Langley 1972, 360; Curtis, Curtis, and Hamann 1973; Dean and Clements 1969; Dean, Clements, and Paget 1969; Dean, Dame, and Birkenmeyer 1969; Dean and Wortham 1969; Potts 1958; Itard 1968, 1970). In their field experiment at the Salisbury lab in 1968, Dean, Phelps, and Williamson gamma-irradiated *zvikukwa* of unknown age with 8,000–15,000 rad. They recorded a 95 percent reduction in reproduction in male flies one week old that mated with untreated females. Applying 4,000–9,000 rad to males emerging from *zvikukwa* three or four weeks after treatment, they achieved complete sterilization. In adult males treated with 8,000–16,000

rad, they recorded 95 percent complete sterility for the forty-five-day trial period (Dean, Phelps, and Williamson 1968). *Mhesvi* was extremely resilient to sterilants; it required far higher doses than any other problem insects (Curtis 1970; LaChance, Schmidt, and Bushland 1967). By using a nitrogen atmosphere (irradiation without oxygen), sterility could be achieved with less induced biological (somatic and genetic) damage to *mhesvi*, thus enabling it to feed, chase, and mate (Langley and Maly 1971; Baldwin and Chant 1971). It also was known at this point that radiation treatment in the air later in *mhesvi*'s life cycle yielded less reliably sterile insects. In the field, sterilized adults failed to reduce the population; *zvikukwa*, by contrast, succeeded, owing to "delayed flight muscle development" in lab-confined adults (Dame and Schmidt 1970; Dame and Ford 1968; Langley 1970). Hence, Curtis and Langley (1972) studied sterilization in the late stage of a *chikukwa*.

Meanwhile, the Tsetse Research Laboratory at the University of Bristol School of Veterinary Science was experimenting with introducing "chromosome translocations" into *mhesvi* to depress fertility through semisterile "heterozygotes." However, this strategy also depended on mass production of the translocations in the form of fertile "heterozygotes." The mutations were obtained from the *mhesvi* that *vachena* called *G. austeni* through radiation and careful selection for semisterility, with the offspring of these mutant individuals inbred to produce "homozygotes." The translocation homozygotes were mated with "close relatives" and produced numerous "translocation homozygotes" and "heterozygotes," one inexplicable wild type, and "some fully fertile matings which are expected to be founders of pure translocation homozygote families" (Curtis 1971, 425).

Hybrid *Mhesvi*

A third method was to produce a hybrid *mhesvi*. In 1972, Curtis reinvestigated hybrids of *mhesvirutondo* using contemporary rearing techniques. He returned to Vanderplank's earlier work, which sought to determine the effects of releasing alien types into *mhesvi* populations (Vanderplank 1947). This deployment of *mhesvi* as a weapon of mass destruction against fellow *mhesvi* without recourse to chemicals or gamma irradiation had a distinct advantage, not least because it avoided "the reduced viability or other abnormalities often associated with sterilizing doses of radiation … or with translocation homozygosity." As Curtis saw it, "the use of genetic incompatibility will only be effective where behavioural barriers to cross mating are weak or absent" (Curtis 1972, 250). The idea, therefore, was to simply cross one type of *mhesvi* with another and produce a sterile critical mass

to release into the environment. Again, the problem boiled down to producing this critical mass. Rhodesia did not have that capacity yet.

Conclusion: Rhodesia's Tsetse Research in the Global Context

Our grandchildren may never see a cockroach, a Japanese beetle or a corn earworm. The pests may all be wiped out by new scientific weapons, deadly to insects, safe for humans.

Man is plotting to abolish some of his ancient insect enemies from the face of the earth. Insect experts, called entomologists, are fighting a research war on six fronts. Only one front uses pesticides that have come under so much fire recently. These are the fronts:

1. *Sterilization*—mass application of chemicals or radioactive materials can make insects incapable of having offspring.
2. *Traps*—insect traps will be baited with food or female "perfume" to lure thousands of unsuspecting insects, some that would be killed and others that would be chemically treated, then released to carry sterility and disease.
3. *Predators*—hordes of creatures, harmless to man, are being sought by scientists and released in infected areas to prey on and destroy harmful pests.
4. *Disease*—plagues will wipe out huge "cities" of harmful insects as diseases are mass produced and sprayed over large areas.
5. *Starvation*—insect food supplies will be cut off by planting crops that are immune to insects, taste bad to them, or grow at the wrong time of year for them to eat.
6. *Poisons*—new chemical poisons will be used in different ways. ("War against Insects" 1964, 74)

This *Science News* article was published in 1964. At the time, the USDA's Agricultural Research Center in Beltsville, Maryland, had performed experiments on the deployment of birth control for beetles, flies, caterpillars, *hutunga*, boll weevils, cockroaches, and screwworm flies—also called blowflies. The eggs of the latter, when deposited through a bite into the flesh of *vanhu* or *mhuka*, "hatched into maggots which burrow[ed] into the flesh" ("War against Insects" 1964, 74). Houseflies were being lured to feed on sugar solutions packed with chemosterilants, later hatching sterile eggs. Scientists were "meddling with the love life of the cockroach," manipulating the "perfume" the female emitted to lure the male. The perfume chemical was now identified, extracted, and produced synthetically for use as trap bait, with chemical pesticides performing the roach's last rite of passage. Light was being used to attract moths and other flying *zvipukanana* to their death or impotence—also at the hand of chemical pesticides. "Diseases for insects only" were being manufactured. Airplanes flew low, spraying

"*Bacillus thuringiensis*," a special chemical disease to kill gypsy moths, cabbage moths, and other moths. They also sprayed a hormone designed to prevent caterpillars from sexual maturity and oviposition. Several viruses were being developed to kill sawflies on forest trees, cabbage loopers on cabbage leaves, and other pests. Infected caterpillars were ground to obtain the virus, the resulting mash then mixed with a solution and sprayed over the land. *Zvipukanana*'s habitat and plants were being modified to expose and starve them—by way of more Hessian fly-resistant wheat, corn resistant to maize borers, earworms, and other worms, and destruction of tobacco stalks to deny the tobacco hornworm its winter housing. The "*Bacillus*," the hormones, the viruses, the environmental destabilization—all these were described to the public as "harmless to man and other animals" ("War against Insects" 1964, 75; "Insect Chemical Warfare" 1962; Fleschner 1959).

This was not confined to science in the United States or Europe or built lab science; Chinese citrus growers also had for centuries deployed colonies of predator huang jin yi (yellow fear ants, also called huang gan yi [yellow citrus ant]) in orchards to protect *kumquat* fruit trees against pestiferous *zvipukanana*, especially black ants. In 1708, the writer Pei Wan Chai said that people were purchasing these yellow (weaver) ants and putting them in trees to attack the black ants and kill them (Fleschner 1959, 539). Enterprising farmers also grew mulberry trees, upon which they raised silkworms—not to make silk, but to feed them to the yellow ants, which they then sold to orange growers for a stipulated amount per nest (Huang and Yang 1987, 665). In addition to Chai's text, other records of the use of some *zvipukanana* to control pestiferous ones are found in the Ching dynasty encyclopedia *Gu Jin Tu Shu Ji Cheng* (1726) and *Nan Fang Cao Mu Zhuang* (Plants and Trees of the Southern Regions, 304 AD; Huang and Yang 1987, 666).

In the twentieth century, scientific laboratories seriously considered the role of insects as engineers. By 1963, the US Air Force Office of Scientific Research had taken strong interest in *zvipukanana*, blind fish, octopuses, and mice to learn from them—just as we discussed *vedzimbahwe* doing (Lener 1963, 27). Other scientists took interest in what they called the *tenebrionid* beetle of the *Stenocara* genus found in the Namib desert in southern Africa, which tilts its body into the wind to gather water. Droplets then form above its wings and roll down the *chipukanana*'s surface straight to its mouth. Material engineers were examining this process to create films capable of providing drinking water in dryland areas. Meanwhile, at the Institute of Neuroinformatics in Zurich, Rodney Douglas was examining the eyes of *chipukanana* to design artificial retinas. At Caltech, a laboratory was building a robot with movement based on a fly's visual system, and

a computer mouse with an optical rather than a ball sensor, based on the way a fly's brain worked (Flannery 2002, 377).

The roles of *zvipukanana* as organic chemists were also recognized, especially as producers of pesticides. For instance, when attacked, the scorpion emitted a precisely aimed spray later found to contain 85 percent acetic acid, 10 percent water, and 5 percent octanoic acid. Among other pheromones (the chemical transmitters of information between members of a species) was what *vachena* called *bombykol*, a sex attractant of the female silk moth they called *Bombyx mori*. The "calling" female emitted the pheromone in small pulses at intervals. From 1968 to 1969, three glossinologists in Rhodesia investigated the possibility of *mhesvi* determining the presence of the opposite sex using smell sensors on the antenna or arista. They did so "by removing, with fine scissors, these appendages at their basal segment from flies," and then determining the success of mating "by dissection of the female flies and microscopic examination of the *spermathecae*" (Dean, Clements, and Paget 1969, 356).

In contrast, butterflies courted in broad daylight using vision, but males of certain kinds were found to have odorous organs *vachena* called *hairpencils* or *danaids*, which contained cetyl acetate, cis-vaccenyl acetate, and a heterocyclic ketone. When rubbed against the female's antennae during "hairpencilling," the pheromone (or *danaidone*) transmitted a sexual message that males could not refuse (Meinwald 1990, 30). However, as research on the *shayishayi* (monarch butterfly) also found, the pyrrolizidine alkaloid material for constituting the *danaidone* comes from the *shayishayi's* visit to a plant the researchers called *Heliotropium steudneri* (Meinwald 1990).

As an example of the weaponization or strategic deployment of nature, this chapter addressed the creation of *nyongororo*-resistant *mhesvi* through bioengineering of the insect so that, upon mating, no fertilization occurred. Rhodesia must not be treated in isolation, however: An experiment conducted on *hutunga* in Sao Tomé in 1946 sought to understand this insect carrier's natural resistance to *nyongororo*. The objective was to "build a better mosquito [that would] someday neutralize the deadly threat of malaria by making mosquitoes healthier, leaving the victims of Anopheles bites at risk of nothing worse than an itchy bump" (Levy 2007, 817). Research at Johns Hopkins University was seeking to manipulate the genome of *hutunga* (*Anopheles gambiae*) to produce malaria resistance by inserting an extra gene into the *Anopheles stephensi* that transmitted malaria in India. The question was whether lab *hutunga* would cope in the wild. Meanwhile, researchers at Caltech aimed to force transgenes into a wild insect population at rates much faster than those produced by normal

Mendelian inheritance. However, these bioengineers were attempting to cause a resistance to malaria that *hutunga* of Africa had long achieved naturally (818–819).

By the 1980s, the debate had shifted to the implications of releasing genetically engineered *zvipukanana* into the environment. Environmentalists and ecologists sued the US government to compel it to stop molecular biologists from releasing the recombinant DNA–carrying *zvipukanana*, which the investigators argued were "nothing more than well-known organisms with well-defined and predictable alterations" (Tangley 1985, 470). One proposal—from the National Institutes of Health's Recombinant DNA Advisory Committee in 1983—sought to release a genetically modified "*Pseudomonas syringae*" bacteria to make potato plants frost-resistant. A second—from the seed and pesticide giant Monsanto in 1984—sought to release on trial another *nyongororo* these *vachena* called the *Pseudomonas fluorescens* carrying a gene that produced a toxin lethal to *zvipukanana* that attacked the roots of maize plants. Ecologists rejected both because of possible ecosystemic effects on plants, *mhuka*, and energy and nutrient cycling. The biologists argued that because they were engineering single-gene changes, these organisms were basically the same as the original ones—but ecologist Frances Sharples of Oak Ridge National Laboratory disagreed. Past experiences had shown such single-gene changes to cause antibiotic resistance in bacteria and pesticide resistance in *zvipukanana*. "It's not the number of new genes but what their functions are that is ecologically important" (Tangley 1985, 472).

It wasn't only the smallest members of the animal kingdom that were turned into pesticides or even the animals for that matter. By 1940, bench scientists were also vigorously searching for ways of making plants function as pesticides. The objective was to improve microbial pathogens lethal to *zvipukanana*, cause defects in the pests, and transfer *chipukanana*-resistant genes to plants. There was one potential problem: the development of *zvipukanana* resistant to the *chipukanana*-resistant plants (Raffa 1989, 524). New phosphorous compounds equipped plants to "bite" *zvipukanana* that bit them—by carrying chemical pesticides through their sap streams so that their leaves, stems, flowers, and roots in effect became *mishonga* (poisons). Pyrethrum (produced in Kenya) extracted from dried, daisy-like flowers and nicotine from tobacco paralyzed beetles, flies, cockroaches, and other pestiferous *zvipukanana*. Plant extracts were used to stretch the efficacy of existing pesticides (hence the name *stretchers*). The goal of these systemic pesticides—developed in Germany during World War II—was to induce the plant's sap stream to kill pestiferous insects without harming harmless ones and by spraying leaves or the soil for root uptake (Morrow 1952, 330).

Meanwhile, in China, no effort was spared in the promotion and development of plant materials as pesticides, to reduce reliance on synthetic chemicals from the West. Building on a long history of herbal medicine, China embarked on a program of using indigenous plants with insecticidal properties in the 1950s, isolating, identifying, and chemically synthesizing them into pesticides. For example, cottonseed oil, juniper oil, mustard, and tobacco extracts were used to control wide varieties of agricultural pests, like rice borers and leafhoppers. The extensive industrial development and public use of herbal pesticides—indeed, herbal medicine in general—owed much to China's isolation from the Western world and the need to reduce dependence on imported magic. The question was how to develop and sustain a public health system under difficult conditions; this was the background to the "Eliminating the Four Pests" campaign against *mhesvi*, *hutunga*, rats, and fleas in the 1950s. Out of this campaign emerged a movement in communes, colleges, and research centers dedicated to indigenous pesticides (Yang and Tang 1988).

The Mobile Workshop

The Tsetse Fly and African Knowledge Production

By: Clapperton Chakanetsa Mavhunga

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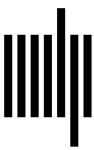

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