

The Vector Zoo

Please note: The Arcade of Intentional Extinction will be closed for renovations between December 5th, 2126 and March 1st, 2127.

As the tram speeds along the tracks to where the Vector Zoo presides over the valley, the passengers catch glimpses of the City below. In the brightness of the day, both the luster from the city's highrises and the ostentation of its denizens bounce back, causing the riders to squint.

All miss the moment that the turf alongside the tracks turns into real grass.

When the rotunda of the Zoo's stately central building comes into view, the visitors make out an ample figure awaiting them at the end of the track. The pressurized tram doors gasp open, nearly brushing the buttons on his burgeoning waistcoat.

The man takes a few choreographed paces backward, allowing the guests to spill from the doors where they stretch their limbs, smooth out their protective garments, and instinctively distance themselves from one another.

"Esteemed guests," says the man. "My name is Barnaby Wilde. I am the supervisor here and today, I will be leading your special tour. While many of you may choose to remain in your Protective Suits, please be assured that the Vector Zoo is equipped with the most state-of-the-art sterilization technologies available today. We have real-time pathogen sensors and far UVC throughout the grounds, and the health of all of the animals within the building are monitored hourly."

The visitors whisper amongst themselves and nod, but none remove their hoods. They are fixated on a white pomeranian—*their first!*—which barks noiselessly from inside a clear bag that the supervisor clutches against his chest with one arm. Its collar reads 'ambassador.'

With a flourish of his gloved hand and the aplomb of an evangelical pastor, Wilde continues:

"As you are no doubt aware, the Vector Zoo commemorates humanity's valiant efforts to eradicate zoonotic and vector-borne diseases. While these diseases are no longer of any concern to *us*, you will encounter things inside that still afflict people *elsewhere*. Please be forewarned that while you will see things that are disfiguring or disturbing, you are not at risk. Still, if you find yourselves *affected*, find comfort in the fact that the presence of such creatures was, for many people throughout history, inducive of such reactions. Should you

need help in relating to these creatures, we recommend an attitude of curiosity rather than repulsion.”

At this, the guests fiddled with the settings on their Devices.

“As we walk through the zoo today, it is our goal that you come to understand the events and logic that led, in our city at least, to the Great Separation. It is, after all, a part of our history. And, it is a shame that this history is better known elsewhere, and mostly by those people who characterize it as ‘unfair’ or as ‘a great loss.’

Before we enter the Vector Zoo, I want to awaken your expectations. Today is a special day because it is the groundbreaking ceremony for our latest exhibit, the Last Mile Labyrinth, and you have qualified, through your Platinum donation, to get a preview. This eponymous exhibit, comprising a mile-long walk along a meticulously manicured promenade, is dedicated to the final stages of disease eradication. Should you not make it to the end, you needn’t worry, for that, too, is part of the experience. You need only marvel at its gilded gates to get a sense of its importance.

Because, as it had been so eloquently and *so hopefully* stated, ‘If it takes a village to raise a child, it takes thousands of villages, cities, governments, laboratory and social scientists, and donors, committed and working together, to traverse [the last mile required for disease eradication.](#)’

Of course, we now see that such ‘collective efforts’ are as fantastical as the ruby-encrusted rose bushes that line the path. Oh! And *do* look closely at these, for as Platinum Donors, you will find your names debossed upon the petals.

Now—from the expressions on all of your faces, I can see you are eager to learn more about what our Zoo has in store for you. Please follow me.”

With this, Wilde wheels around and strides toward the entryway. As the visitors follow him inside, the silhouettes of their Suits cast shadows on the stone like marooned astronauts against marble. From a panoramic viewpoint overlooking the buildings and statuary, Wilde continues his address.

“The first exhibit is the Hall of Vectors. Inside, you will see that most of the display is dedicated to the mosquito. An ideal vector, their slender and delicate bodies belie an insatiable thirst for blood, while their mobility and fecundity allowed them to spread pathogens over large geographic regions.

Most of this exhibit is dedicated to malaria. This is by design. Humanity's long battle against malaria has [shaped the human genome](#) more than any other disease. First attributed to [malignant vapors and miasmas](#), a young French doctor named [Charles Laveran](#) linked it to a parasite in the 19th century. Shortly after, its association with mosquitoes became clear.

Malaria, as you will see for yourself, is a perfect example of why the Great Separation was necessary. You see, its eradication was simply too challenging.

Why, you ask?

Well, like many vector-borne and zoonotic diseases, [malaria's ability to shape-shift contributes](#) to its insidiousness. To truly eradicate malaria, a vaccine would have to target multiple stages of the parasite's life cycle, not only the hypnozoite stage before it reaches the liver, as the vaccines of the first quarter of the 21st century did. These were, in essence, a hepatitis B vaccine with a little malaria protein appended. Vaccine efficacy got better with time as this protein was refined, but never came close to approaching 100 percent.

You see, this is because efforts to expunge malaria were up against the parasite's extraordinary diversity! The parasite in Malawi is different than the parasite in Kenya, let alone the parasite in Myanmar. Some of these parasites, like *Plasmodium falciparum*, make people severely ill, whereas others, like *Plasmodium vivax*, [lurk dormant in the liver](#) for weeks or years evading detection. And do recall that, until the late 2040s, there were no diagnostic tests for these 'sleeping liver' stages. Imagine!

Even after we had the diagnostic tests to detect the presence of these parasites, their [genetic variation](#) was simply too great to devise a vaccine effective against them all. It would have taken an army of developers to come up with a multi-pronged vaccine with input from local epidemiologists on what to tweak.

This is why you need vaccines *and* cures¹. You need medicines that cure the disease and vaccines that prevent transmission. And, of course, they would need to offer a prophylaxis period going forward.

Now, I sense your skepticism upon hearing about these 'transmission-blocking vaccines.' People, though *clearly not yourselves* my venerated guests, are bad enough at taking a vaccine that protects *them*, let alone ones that are aimed at *community* health. It is no

¹ For a concise explanation of why this is the case, see [Jacob Trefethen's footnotes](#) to 10 technologies that won't exist in 5 years. In brief, "Circumstances differ across the world for the same disease, and more tools give health systems more options to work with. Nigeria would not be able to eradicate malaria with only the toolkit the U.S. had [in the 1940s](#)."

surprise then, that [vaccine refusal is one of the many significant obstacles](#) facing complete disease eradication.²

Now, you might be thinking ‘If you can’t go after the parasites why not go after their vectors?’ An astute question indeed.

Vectors, such as mosquitos, are adaptive just as we are. They evolve and relocate in response to the same pressures and forces that compel us to do so, such as climate change and urbanization. *Anopheles stephensi*, the primary mosquito vector in Southeast Asia, [showed up in Northern Africa in 2012](#). Not only did it spread rapidly, but contrary to its dawn and dusk-biting, light-avoidant conspecifics, it transformed into an urban-dwelling, daytime feeder. So even when we drain stagnant ponds and transform them into cities, and even when light pollution takes away the mosquitoes’ ideal feeding time, they follow us.”

Wilde echoes his own words, gesturing for the guests to follow. They do so, traipsing through an expansive central courtyard with exhibits rearing up around the perimeter. As they walk, they notice the birdsong, the melodies irregular, syncopated, and organic, not at all like the Birds in the city. In fact, when Wilde begins to speak again, the guests are relieved.

“As you will see time and time again in the Vector Zoo, it is not only vectors that are adaptive but also the parasites and microbes they carry. As the 21st-century author David Quammen reminded us:

‘A parasitic microbe, thus jostled, evicted, deprived of its habitual host, has two options—to find a new kind of host . . . or to go extinct.’

Ladies and gentlemen, what do you think they have evolved to do? Leap to a new host of course! Just as mosquitoes adapt to cities, viruses and bacteria adapt to new organisms. Interspecies leaps are common. About [60 percent of all human infectious diseases](#) currently known either routinely cross, or previously crossed, between other animals and ourselves.

The Vector Zoo is rife with spillover! AIDs from Chimpanzees, leprosy from 9 banded armadillos, SARS-CoV-2, Rabies, Hendra, Lyssavirus, from bats—and so much more. And of course, similarity between one kind of host animal and another is a significant indicator that a pathogen is likely able to cross over. Or, as the Roman poet Quintus Ennius foretold

² When to *stop* vaccinating a population against disease is another factor that makes disease eradication challenging. Both false positives (eradication fails and vaccination levels drop after the eradication goal is abandoned) and the fact [many live vaccines also exert non-specific effects that prevent other infections](#) make it risky to stop vaccination programs.

two millennia before Quammen—*Simia quam similis turpissima bestia nobis*.

Oh, most wretched monkey, how similar you are to us.³ And this brings us, of course, to the Monkey Mansion.”

As the guests turn a corner, this mansion appears across the field. Even from a distance, they can make out an elaborate frieze over the door, a carving that depicts the Three Wise Apes from the Japanese pictorial maxim. Two of these stare back at them, while the third, who “sees no evil,” cannot bear to meet their gaze. Wilde continues:

“Our similarity is plain in our features and the way we clutch our young, but also in our genes, which you can browse at your leisure. We have taken the liberty of overlaying our own genome next to theirs, and you can see for yourself that even when DNA insertions and deletions are taken into account, humans and chimpanzees still share [96 percent sequence identity](#). The grisly consequences of such close genetic kinship are worth dwelling on.

See, we are hardwired to [prefer certain animals over others](#). Those with big eyes and infantile features increase our attention, willingness to care, positive affect, and protective behavior. Yet by [worshipping monkeys](#) and [bringing similar animals](#) into our homes, we subject ourselves to their pathogens and scourges. You see, they really do belong *here*.”

The supervisor gently caresses the bagged pomeranian, which as he walks, bounces in time with his stride.

“On the other hand, though, it follows that genetically distant and dissimilar creatures do not elicit our affection. You can observe this for yourself in the Arcade of Intentional Extinction.

He gestures towards the Arcade, located beside the Hall of Vectors:

“Inside, my friends, you will see ticks, copepods, nematodes, and worms magnified and projected onto the wall. At this resolution, they are both terrifying and beautiful, with mandibles like grinding machines, and compound eyes like the skin of oranges.

Striking as they are though, you’ll discover how much easier it is to call for the destruction of such alien forms of life. Try this yourself in our gene-drive simulator! Just click on any invertebrate that displeases you and experiment with [genetic engineering techniques to sterilize them](#). For some, a disclaimer may come up about their importance as pollinators or

³ Turpissima could also be translated to depraved, wicked, base, vile, or corrupt.

keystone creatures, but you can disregard this if it slows you down.

After all, it is because of regulations and ethical trepidation that it took decades from the discovery of gene drives to their implementation. But eventually, the [public outcry](#) over the moral and financial consequences of mosquito and other vector-borne diseases pressured public health organizations to roll them out.

Still, as you probably know from your own choices, financial incentives are the most powerful of all. So it was that the first gene drives were initiated by the Uruguayan beef industry, and targeted the *Cochliomyia hominivorax*, ‘the man devourer,’ or New World Screwworm. These are a botfly that lay their eggs in open wounds and use their screw-shaped body to drill into the flesh of animals. These screwworms were laying waste to Uruguayan cattle, costing the livestock industry [\\$40 million to \\$154 million a year](#).

My guess, dear patrons, is that it will not pain you to hear how these flesh-eating maggots were eradicated, and instead, you may wonder why there were not more similar successes.

This will be answered in a part of the Vector Zoo that props up all of the rest. It is truly glorious! Do you see it over there? In the grandest building of all, we have the Temple of Political Will.”

The guests follow the histrionic flourish of Wilde’s finger to the roof soaring above some topiary cut into the shape of flags. As they approach, the fluttering leaves appear to wave.

“Inside, you won’t find any vectors or reservoir hosts, but a stately room dedicated to the social and political dimension of eradicating disease.

In one wing, you can find a row of toilets, matches, and other destructive implements with stacks of cash beside them. Here, you can experiment with disposing of money in whatever way you see fit. You see, all of them are surely a better investment than tamping down small regional outbreaks.

Because, as you will learn, once the incidence of a disease is low enough to escape public awareness—political will and funding dry up. This you can feel viscerally in the 100°F Funding Desert Annex. Inside, sun-baked dirt and scorching sand cover the floor, while ceiling fans blow military supplemental spending appropriations across the room on sheets of paper. I mean, why go after a few cases of polio when you could buy a hypersonic weapon instead?

Once, as it was concisely put to me by a public health historian in my acquaintance, ‘Going

from a million deaths down to a thousand deaths is easy. Going from a thousand deaths down to 10 deaths is hard. Going from 10 deaths down to zero deaths is unbelievably expensive.'

But the Temple of Political Will shows you both sides. After all, what about when the investment *is* worth it? Consider the economics of the eradication of rinderpest or smallpox! [The eradication of smallpox took \\$300 million](#) over ten years. The partial eradication of bovine tuberculosis in a single country took 40 years and \$100 million. Yet, as you will see, both programs paid for themselves within three years of completion. Experts suspect that eradicating some extant diseases, such as polio, would be [similarly cost-saving compared to permanent control](#).

Surely I do not have to tell *you* how money talks.

Many of you know someone or were someone, who sponsored the disease bounty hunters responsible for eradicating the last vestiges of Guinea Worm. Many of you know firsthand how critical private philanthropy and federal investments were in the disease surveillance programs which included [cash rewards for verifiable reports of local cases of the diseases](#).

This brings us, finally, to the Last Mile Labyrinth."

The group reaches the end of the row of topiary and stops. Below them, cut into the hillside, terracing reveals an immaculate maze. Red light from the roses bounces onto the path and seeded clouds from above cast ship-like shadows across the labyrinth.

Wilde is breathing hard, but his voice is startlingly clear.

"This, I am happy to tell you, is the Tour De Force of the Vector Zoo and the reason for the Great Separation. Pace yourselves today, for as you leave the Temple of Political Will and approach the Last Mile Labyrinth, it will appear to get further away. But, this is just an architectural trick. In fact, this mirage and the frustration it brings out in you is an important part of the Vector Zoo because, before you see what is at the end of the Last Mile, you have much to contend with.

Rieux, the doctor in [Camus' novel The Plague](#), muses that 'A pestilence does not have human dimensions, so people tell themselves that it is unreal, that it is a bad dream which will end.' But he is deceiving himself, for the human dimension of zoonosis is ancient and irrefutable. After enlisting animals into our projects, our cities, and our homes, what chance did we stand? The human dimension resides in our breaking of the boundary between their world and ours: we imprison them in proximity to our filth and subsequently punish them for

sickening us. The human dimensions of pestilence lie within our lust for meat and for each other, in our hunger for contact, close contact. It resides in the vacillations of our political will and in economic justifications. In brief, in both the body and the body politic.

You see, the Last Mile Labyrinth has a secret. It is not like other labyrinths. It bifurcates. Down one path, is a world of pan-vaccines, investment in [zoonotic risk technologies](#), gene drives, the abolition of factory farming, better climate and ecological modeling, disease bounty hunters, surveillance, and early detection. This path is meandering. *Long*. It will force us to collaborate and listen to expert opinions. It will demand that we do everything that is challenging for us.

The other path is the one you are much more familiar with, for it takes you back to the hermetically sealed tram, to the City, and your sterile private apartments. It is the path, of course, that brought us to the Great Separation. Down this path, *thank God*, we can avoid the messiness of human-animal engagement and even other people.

For as the Vector Zoo will surely make clear, those who say the Great Separation is ‘a step too far’ must be deluded. It is the Last Mile that is too far! But please, if you don’t believe me, see for yourself! Let those walk it who think they can truly reach the end.”

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