“Now comes good sailing.”

Human Extinction: A Short History
First Edition

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Bio: Phil Torres is an author and scholar whose work focuses on existential risks to humanity and civilization. He has published widely in both scholarly journals and the popular media, written for the Future of Life Institute, given presentations at the Future of Humanity Institute, Princeton University, and Chalmers University of Technology, and been a visiting researcher at the Centre for the Study of Existential Risk at the University of Cambridge. His previous book, *Morality, Foresight, and Human Flourishing: An Introduction to Existential Risks*, included a foreword from Lord Martin Rees. For more, go to www.xriskology.com.

Cover painting by Dr. Byron Davies, who I met as a visiting student at Harvard University. The image was designed by Dr. Melinda Soares-Furtado.

Preface

This book was written over the course of several months, mostly during the early stages of the COVID-19 outbreak. But the idea for the project was born on exactly January 1, 2019, after the most tumultuous year of my adult life. Since then, I have been distracted by many different projects, but the lockdown—I am currently holed up with family in Virginia, in the US—gave me the opportunity to finally write this. The book is motivated by what the seventeenth-century philosopher Anthony Ashley Cooper, better known as the 3rd Earl of Shaftesbury, or simply Shaftesbury, referred to as a "universal Friendship" with humanity. That is, a love of the species—deeply flawed and devilish as it is. As he wrote in 1737, "to love the Public, to study universal Good, and to promote the Interest of the whole World, as far as lies within our power, is surely the Height of Goodness." By understanding how we came to recognize the vertiginous precarity of our existence within a morally indifferent universe, threatened by our own technological ingenuity, we can perhaps gain an appreciation of how lucky we have been to have made it this far. Of all the chapters in this, I hope, engaging story of human self-realization, the last is the most important. Yet this chapter makes sense only in the context of all the previous chapters, which outline our collective journey from a sense of existential security—or "Comfort," as Benjamin Franklin put it—to an alarming awareness that the human story could terminate tomorrow, forever. "We are creatures of the twilight," H.G. Wells wrote in 1902, but it is unclear whether the crepuscular rays in which we stand emanate from dawn or dusk. Perhaps, at best, this book can stimulate thoughts about human extinction that make it just a bit more likely that a bright, blue-skied day lies ahead.

Chapter 1: The Moods of Existence

Life begins as a quivering colloid, goes on painfully to build a brain, which automatically refines itself to the point of discovering and using the most efficient methods of destroying others, and by a boomerang effect, itself. Fate!—Louis Berman[1]

We sometimes speak of the dinosaurs as failures; there will be time enough for that judgement when we have lasted even one tenth as long.—Stephen Clark

Apocalyptic predictions require, to be taken seriously, higher standards of evidence than do assertions on other matters where the stakes are not as great.—Carl Sagan

"Oh yes, that could happen," Malcolm when asked if humanity could go extinct like the dinosaurs. "A meteor could strike Earth, climate change could destroy all plant life, causing animals and humans to starve to death, and if we catch too many fish, there will be too much algae filling up the ocean, and without water, we die." If some of these scenarios sound a bit strange, that may be because Malcolm is a seven-year-old boy from Sweden, responding to a question posed, at my behest, by a Swedish colleague of mine. What is so striking about this response from such a young person is that Malcolm did not find the question perplexing. He accepts that human extinction is possible. Yet for much of western history, almost no one would have agreed. Human extinction is a recent idea, and its story is full of twists and turns, colorful and eccentric figures, terrors and tribulations. This book is that story.

Never before in the short lifetime of civilization has the topic of our extinction been more discussed, or fretted over, than it is today. To borrow a term from Mike Hulme, a professor of human geography at the University of Cambridge, we live in an age of "extinctionism" in which prominent intellectuals, popular activist movements, and large portions of the general public are acutely aware of the imminent risks to our survival on this lonely planet in the Milky Way galaxy—"Spaceship Earth," as the futurist Buckminster Fuller liked to call it. For example, the late Stephen Hawking, one of the great cosmologists of the past century, wrote in 2016 that "we are at the most dangerous moment in the development of humanity." His colleague, the cosmologist Max Tegmark, stated in a 2018 interview that "it's probably going to be within our lifetimes … that we're either going to self-destruct or get our act together." Yet another cosmologist, the UK's Astronomer Royal, Lord Martin Rees, has given the great experiment of civilization a fifty-fifty chance of lasting through the twenty-first century—a mere coin toss. Such pessimistic declarations are not out of the ordinary for those who study the future of humanity. Indeed, most expert estimates of human extinction (not just civilizational collapse) before the twenty-second century tend to congregate around the *20 percent* mark. To put this in perspective, imagine boarding a plane and being told by the pilot that there is a 20 percent chance that the wings will fall off and everyone will die in a fiery explosion as the fuselage slams into a jagged mountain at the speed of Mach 1. No sane person would board the plane! Yet this is the situation of humanity right now—*we are on that plane*, mid-air, rocked by turbulence, with no runway in sight. Hence, as I have written elsewhere, a child born today may very well have a *much greater* chance of dying in a catastrophe that engulfs the entire planet than from natural causes in a nursing home. This is a stunning conclusion, and over the past two decades it has inspired a new field of academic inquiry called "Existential Risk Studies," which is completely unique in that human extinction is one of the central topics of investigation. More on this later.

The idea of human extinction has also been popularized by worldwide movements like Extinction Rebellion (XR) and School Strike for the Climate, the latter of which was founded by Greta Thunberg, whose courageous activism is reminiscent of the young Samantha Smith's calls for peace during the Cold War. (Sadly, Smith died at age 13 when the small plane she was in with her father crashed in Maine.) Both movements are motivated in part by the realistic worry that environmental destruction could jeopardize humanity's existence, if not shatter the fragile ho-

meostasis of the entire biosphere. For example, shortly after it was founded in 2018, the official XR Twitter account tweeted that "We are in a period of #ClimateBreakdown. It is our moral duty to fight for life," along with an image of two skulls and the caption "Climate Change = Human Extinction." Thunberg has frequently argued, sometimes before an audience of the most powerful political actors in the world, that climate change poses "an emergency … an existential crisis" that we should panic about the same way you would panic if your house were consumed by flames. Indeed, almost everywhere one looks these days there is some anxious soul waving a scientific report in the air and shouting "*The end may be near! Act now or perish!*" So pervasive is this attitude that a 2017 survey found that "four in ten Americans (39%) think the odds that global warming will cause humans to become extinct are 50% or higher." Another study queried people in the US, UK, Canada, and Australia, with similar results: "Overall," the authors wrote, "a majority (54%) rated the risk of our way of life ending within the next 100 years at 50% or greater, and a quarter (24%) rated the risk of humans being wiped out at 50% or greater." This study focused not just on climate change but the emergence of new diseases, economic depression, and conflict. Yet few experts believe that any of these could precipitate total extinction—with the exception of global pandemics, especially if human-made, or perhaps climate change if our carbon emissions trigger a "runaway greenhouse effect" similar to what happened on Venus. After all, we are an extremely adaptable species and there is plenty of real estate in the Canadian Arctic, Siberia, and Antarctica if climate change makes Earth's equatorial regions uninhabitable. Yet I have no doubt that as the public becomes more aware of the gargantuan risks associated with the new fields of synthetic biology, nanotechnology, and artificial intelligence (AI), people will grow *even less* optimistic about our future survival and ability to flourishing on, as environmentalists call it, "Planet A" (since there is no "Planet B").

Right now, the main approach to thinking about how we should respond to this situation involves what we can call the "engineering mindset." This sees the various potential causes of human extinction as posing technical problems that require technical solutions. Threats are to be measured, quantified, calculated, analyzed, categorized, averaged, summed, and ultimately addressed using the algorithms of decision theory—in particular, *expected value theory*. Consider that climate change has been driven by what some call *neoliberal market fundamentalism*, according to which economic markets work best without government regulation, and as the hackneyed saying goes, "it is easier to imagine an end to the world than an end to capitalism." This underlying cause of climate change isn't going to get fixed anytime soon. As the British Prime Minister Margaret Thatcher liked to say, "There is no alternative" (to market economies). Consequently, scientists have begun investigating ways of mitigating climate change that do not require civilization to stay within its "carbon budget," which refers to the dwindling amount of fossil fuels that we have left to burn up before we exceed the threshold of 1.5 degrees Celsius above preindustrial levels. If this threshold is crossed, the edifice of modern life may very well crumble to the ground. One of the technical solutions currently being explored is "stratospheric geoengineering," a proposal that my current scholarly research focuses on. This would involve peppering the upper atmosphere with chemicals that reflect incoming sunlight, thus reducing the total amount of radiation that reaches the ground—a kind of artificial "global dimming." With less sunlight reaching the ground, Earth's thermostat could return to "normal," where it has been set for the entire lifespan of civilization so far. Similar proposals for countering the dangers posed by synthetic biology, nanotechnology, and AI are being pursued by scientists in other fields. In a phrase, the roaring machine *itself* is not the problem, its rusty gears just need more (and more, and then more) lubricant.

But the engineering mindset constitutes a narrow, limited way of understanding the threat environment in which we now find ourselves, dazed and confused. We also need a *humanistic* perspective that focuses on the *attitudinal* factors contributing to our worsening plight. For example, we might ask what the ultimate *purpose* of the technological enterprise is. Since many of the most formidable risks facing humanity today arise from the "dual usability" of emerging technologies—where a "dual-use" technology is one that can be employed for both beneficial and

harmful ends—why not force the rumbling juggernaut of *technologization* to a screeching halt? If, as some scholars have argued, the "default outcome" of a machine superintelligence with slightly misaligned values is "doom," why not slap a strict moratorium on further research? Are our "Faustian genes," the part of our nature that pushes us towards recklessness, really so irrepressible? Is there no hope that Silicon Valley-types could move *slower* and *not* break things? And what alternative modes of living could enable humanity to live more harmoniously with the biosphere in sustainable "eco-technological" cities, with cars that are literally edible?[2] Should we replace the pernicious metric-of-progress known as the "GDP" (Gross Domestic Product) with the Bhutanese notion of "GNH" (Gross National Happiness)? Isn't the point of innovation and discovery to make our bodies healthier and our lives happier, rather than imprison us within the invisible walls of the deadline, quarterly report, and morning alarm? If humanity is at a greater risk of self-annihilation today than ever before in our history, can we really talk about "progress"? The old hunter-gatherer communities in which people lived for nearly 300,000 years never had to worry about destructive events that could wipe out an entire continent. Indeed, these communities were very likely the most egalitarian and leisurely that we ever created. This changed with the First Agricultural Revolution, or Neolithic Revolution, some 12,000 years ago, which replaced equality with oppression, increased the spread of zoonotic (animal-to-human) diseases, required far more labor-intensive work, and left our ancestors so malnourished that their average height dropped by inches. (Hence, the anthropologist Jared Diamond has described the Neolithic Revolution as "the worst mistake in the history of the human race.") Furthermore, the Industrial Revolution of the eighteenth century launched western civilization on a path that has proven to be profoundly destructive, leading to the current environmental crisis that could very well ruin everything. The list could go on, but the point is that looking at our plight from a perspective that emphasizes fundamental *values* rather than impersonal *numbers* is integral to finding a way out of this treacherous maze of our own making.

Even beyond the issue of problems and solutions, there are questions about what exactly is at stake when it comes to human extinction. In just the past decade, a growing number of philosophers have finally addressed this issue, with some putting forth ingeniously clever arguments for why our collective demise, *aside from* the ~8 billion people who would perish if extinction were to happen tomorrow, would constitute an unimaginably horrible tragedy. For example, the philosopher Samuel Scheffler has argued that people care deeply, far more than they realize, about the survival of the species. After all, many of the projects that we dedicate our lives to, from curing cancer and designing spacecraft to maintaining archives and building bridges, will benefit future generations much more than current ones. Caring about future people is baked into our projects today—we harbor a profound "love for humanity," even if this is not readily apparent. As Scheffler somewhat poetically put the idea, "we have an interest in their survival in part because they matter to us; they do not matter to us solely because we have an interest in their survival." Other philosophers have claimed that civilization is something of a team project involving people from all different generations, past, present, and future. Most often quoted here, as a point of departure, is the Anglo-Irish philosopher Edmund Burke, who likened society to "a partnership not only between those who are living, but between those who are living, those who are dead, and those who are to be born." We are "building something" over time, and so it behooves us to ensure that we are not the broken link in the chain. Still others have noted that we may be alone in the universe, and that some objects derive their value from being *unique* or *rare*. A letter sent home by a soldier in the trenches of World War I might not contain any great insights about the human condition; it may deal only with mundane matters about the family business. Yet a collector might spend considerable money acquiring it because of its special historical significance. Hence, if humanity is alone in the universe, if we are the only clumps of rearranged food and drink that are capable of looking up at the firmament in awe and asking the Leibnizian question "Why is there something rather than nothing?," it may be even more important that we continue to exist.

These philosophical ideas and arguments have greatly enriched the discussion about human extinction. They are a step in the right direction. But there is another angle that virtually no scholars have so far considered: how did we arrive at a place where people like Malcolm do not find human extinction impossible? That is to say: when did the *concept* of human extinction (in the modern scientific sense) first emerge? Why did it emerge when it did rather than at some other time? What factors explain its emergence? Did it take shape gradually or in leaps? These questions have been almost entirely neglected by historians and historically minded scholars (I include myself in the latter group). The *only* notable exception comes from my friend and colleague Dr. Thomas Moynihan, an intellectual historian based at the University of Oxford. In his 2019 PhD dissertation titled "Existential Risk and Human Extinction: An Intellectual History," he explores how an "anticipatory awareness" of risks to our survival arose between the 1720s and the 1830s, and identifies a number of factors that fertilized new insights about our "existential precarity," arguing that rigorous reflection on the possibility of extinction "is, then as now, of a piece with 'Enlightenment,' construed in its specifically Kantian guise, as the *global under-taking of self-responsibility*." This is an idea that I will elaborate on in later chapters. The gist is that as people began to realize that our collective existence is not, in fact, guaranteed by any Higher Power looking down on us with a loving and benevolent gaze, we became increasingly aware—frightfully aware—that whether or not we stumble into the eternal grave of extinction depends entirely upon the wisdom and foolishness of our own actions. It is thus *humanity's responsibility* to ensure that the succession of cohorts persists; the onus is on us. In what follows, I will draw from Moynihan's rich scholarship, although the present account differs in many quite substantive ways.

The primary contention of this short book is, as alluded to, that the idea of human extinction (the way evolutionary biologists use it) is of quite recent origin. More specifically, I will argue that it was not until the nineteenth century that a sizable portion of the educated class recognized this outcome as metaphysically *possible*, and not until the middle of the twentieth century that western culture, in particular, began to take it *seriously*.[3] In other words, the vacuum cleaner was invented long before many people began to actually worry that the human population could drop to zero and stay that way forever. This two-part thesis is based on a distinction between what I will call *conceptual intelligibility* and *conceptual prominence (or frequency)*. The first pertains to whether the concept is deemed by a certain group of people to be coherent. For example, the concept of *married bachelor* is incoherent because it is outright contradictory: you cannot be a bachelor if you are also married, or vice versa.[4] The second concerns the extent to which thoughts had by people at some time included the concept as a constituent. For example, the concept of *overpopulation on Mars* is intelligible to contemporary minds but not very frequent in our thoughts, whether entertained privately or expressed publicly in conversations, articles, and books, although perhaps this will change in a few decades given the big push by SpaceX and other companies to colonize the solar system. The obvious reason is that there are hardly ever any occasions on which thinking about Martian overpopulation would be considered appropriate, warranted, required, or fitting. Indeed, the only time I have ever come across this idea was when reading about debates over the dangers of advanced artificial intelligence. Specifically, in 2015 the AI guru Andrew Ng dismissed worries that a superintelligent machine could take over the world and exterminate humanity by arguing: "There could be a race of killer robots in the far future, but I don't work on not turning AI evil today for the same reason I don't worry about the problem of overpopulation on the planet Mars." In general, if a concept is unintelligible, it will be infrequent, at least among the general public. *Married bachelor* is something of an exception: it is familiar to anyone who has taken a philosophy course on the "analytic-synthetic distinction," but not so common at the local bar. "Yes, I'm a single, just ask my wife" is not a good pick-up line. But a concept being infrequent does not imply that it is unintelligible, as the peculiar example from Ng shows.

This being said, the central thesis of this book can be rephrased as follows: the idea of human extinction became intelligible, to many people in the west, about a century before scien-

tists and philosophers began to seriously worry about our extinction in the relative near future. And worries about our extinction in the relative near future were not common until the 1950s.

In support of this thesis, I have organized the book according to two basic principles, one thematic and the other chronological. Within each chapter, I will consider the relevant developments in a roughy chronological order: this led to that, that led to this, and so on. However, the chapters themselves are based around different themes, which I will term "existential moods." To be clear, my use of the word "existential" has no direct connection to the twentieth-century philosophical movement of *existentialism*, according to which, in slogan form, "existence precedes being." Rather, I am using the term in relation to the existence of humanity, a growing family of ~8 billion people in a shrinking global village. However, there are some points of contact between my use of the term, which is standard within contemporary Existential Risk Studies, and existentialism. For example, the French philosopher and Nobel laureate Albert Camus wrote in his 1955 book *The Myth of Sisyphus* that "there is only one really serious philosophical problem and that is suicide. Deciding whether or not life is worth living is to answer the fundamental question in philosophy. All other questions follow from that." One could reconfigure this to apply on the grander scale of the species itself: Should we go extinct? Should humanity kill itself? Since everything we value—art, science, philosophy, music, poetry, novels, comedy, theater, sports, TV sitcoms, action movies, drinks with friends, long walks on the beach, exploring new places, and so on—depends upon our continued existence in the universe, there is really no more fundamental question for the lot of apes with large foreheads—us, you and me—to ponder. All other questions follow from how we answer. Whereas existentialists like Jean Paul Sartre, Simone de Beauvoir, Albert Camus, and Maurice Merleau-Ponty focused on the individual parts, so to speak, existential risk scholars (like myself) focus on the collective whole.[5]

While each chapter below focuses on a different existential mood, they nonetheless form a roughly linear order through time, with each building upon all the previous ones. Hence, they are *cumulative*.[6] But I have not yet said what an existential mood is. I will define it as a broad and widely accepted understanding of our collective predicament in this infinitely strange universe, full of swirling galaxies, squirming organisms, and quivering atoms. Each one arises from and is given shape by how people—in particular, "intellectuals," who will be my main focus, although public opinion will enter the picture on occasion—answer some of the deepest questions that any big-picture thinker could ask: Is human extinction *possible*? If it is possible, could it *actually* happen? If it could actually happen, how *probable* is it? Could *we* be the cause of our own annihilation? Is the *universe* our friend or a homicidal maniac out to kill us? What are the *ethical implications* of our collective demise? Would it matter if humanity were to disappear and, if so, why exactly? Together, these form the basis of, I believe, the most important conversation that our species has ever had with itself: as just mentioned, all of our hopes and dreams are predicated on the continued existence of our particular branch—nay, twig—of the evolutionary tree. The futurist Wendell Bell made this point eloquently in a 1993 paper: "If we give up on the future," he wrote, "we give up on ourselves."

Given the two organizational principles mentioned, I will argue that there have been five distinct existential moods throughout western history (although I will discuss non-western history when relevant). These are:

> (1) *Reassurance that, even if the world ends, everything is going to be okay*, which dominated futurological ruminations until the 1850s.
> (2) *Existential vulnerability in a dying universe*, which took shape in the 1850s.
> (3) *The imminent and multifarious threats of self-annihilation*, which emerged after 1945 but was not fully developed until 1954.
> (4) *The universe is out to get us*, which unfolded between 1980 and the early 1990s.
> And …

(5) *Human extinction would be profoundly worse than previous realized*, which coalesced in the 1980s but did not yield a research program until the early 2000s.

In what follows, I will outline the development of these moods, identifying along the way various *triggering factors* and *enabling conditions* that catalyzed the psychologically painful shifts from one to the other. I will show that the transitions from (1) to (2), (2) to (3), and (3) to (4) all occurred quite rapidly, and that each resulted from the discovery of a new (cluster of) scientifically credible *means of extermination*, or what I somewhat jaggedly call "kill mechanisms." By virtue of being scientifically credible, these kill mechanisms were not idiosyncratic speculations proclaimed by lone voices shouting out in the darkness of our ignorance, but ways that humanity could perish that the scientific community in general came to accept as real. The one exception is the transition from (4) to (5). This was catalyzed by a *conceptual* rather than *empirical* revolution in thinking about the ultimate *meaning or significance* of human extinction. Prior to this shift, intellectuals focused almost entirely on the badness of *going extinct*. Afterwards, many came to see the condition of *being extinct* as the worst part of dying out. It is the "opportunity cost," as economists—those practitioners of the "dismal science"—would say, of non-existence that renders extinction so undesirable. One can draw an analogy here with the death of single individuals. First, consider that, according to the ancient Greek philosopher Epicurus, death does not harm those who die. Why? Because when you are alive, you are not dead, and just as soon as you are dead, you no longer exist to suffer the absence of your presence. However, other philosophers have pointed out that when one dies—especially young—one misses out on all the marvelous things that could have been had one lived. That is, death deprives us of "countless possibilities," to quote the philosopher Thomas Nagel, for happiness, romance, laughter, creativity, knowledge, wisdom, and self-actualization. As the British polemicist Christopher Hitchens said about death during a 2011 debate, "It will happen to all of that at some point you'll be tapped on the shoulder and told, not just that the party is over, but slightly worse: *the party's going on but you have to leave*." This anti-Epicurean view has been called the *mortem thesis*, and something similar could apply to humanity as a whole: perhaps the human species is like a young genius who drops dead in the middle of recording what would have been one of the greatest pop-music albums of all time. The tragedy here is not just that this genius became an "ex-human," as Monty Python might have put it, but that her life could have realized great value if only she had remained alive.

So, scientific discoveries and conceptual revolutions triggered shifts in existential mood. Just as important are the enabling conditions that needed to obtain for the discovery of new kill mechanisms to have actually transformed our sense of existential security in the cosmos. It is not enough to see a lion charging at you in the middle of the African savanna. If you happened to grow up in a strange community where you were never taught that lions are ferocious beasts, and if you were to suddenly find yourself in the menacing path of a hungry big cat with sharp teeth and razor-sharp claws, then it might not occur to you that you should turn around and run for dear life. (Perhaps your amygdala, which processes fear, would automatically register the danger, but let's bracket this detail.) One must not only *see* the risk, but also *recognize* it as risky. Hence, a key component of each existential mood is what I will call an *existential hermeneutics*. The word "hermeneutics" is most closely associated with the German theologian Friedrich Schleiermacher and, later, Hans-Georg Gadamer. In the scholarly world, it is defined as "the philosophical discipline concerned with analyzing the conditions for understanding." But in a more colloquial sense, it simply refers to an *interpretative framework*. Using this meaning, an existential hermeneutics is a particular way of understanding the world around us—it is how one answers a question like, "Is that lion charging toward me a friend or foe? Does it want a treat or am I its dinner?" Examining the heavens above, the Earth below, and human affairs sandwiched in-between through different interpretive lenses will lead to radically different conclusions about our existential predicament. Without the right hermeneutical framework, we could draw conclusions about our fate that are not merely inaccurate, but dangerously so.

As will become clear in the following chapters, recognizing that human extinction is *possible* and could happen on timescales relevant to *you and me* requires a broadly *secular hermeneutics*. This is because, from a religious perspective, human extinction is impossible for at least two reasons. The first is what philosophers would call *ontological*: human beings possess immortal souls that, once created by God, exist for all eternity. In contrast, human extinction as scientists define it rejects the existence of an afterlife, except in the particular materialistic sense expressed by Scheffler: that there may be other people who survive one's death, meaning that if there are no such people, there is no afterlife. Extinction is the last gasp of air, the final sentence of a species' autobiography. It occurs when the very last member of a species—an "endling" or "terminarch"—stops kicking and returns to the earth—"ashes to ashes, dust to dust," as the *Book of Common Prayer*, first published in 1549, puts it. The second is what theologians would call *eschatological*: human beings with our immortal souls are the main character in a prewritten cosmic drama between Good and Evil. According to the eschatological narratives of the Abrahamic faiths—Judaism, Christianity, and Islam—humanity does not simply vanish into the oblivion when the end finally comes. Rather, the end inaugurates a new beginning: eternal happiness in heaven for the elect or believers and eternal suffering in hell for the reprobates or infidels. It follows from these two tenets that the more influence religion has on one's thoughts about our collective fate, the less plausible human extinction will appear.[7] The belief that human extinction could happen and adherence to religious worldviews are *inversely correlated*. Thus, the retreat of religion in the west opened up new conceptual spaces for thinking about our existential predicament in the universe. In other words, *secularization* has been a crucial enabling condition for fashioning novel hermeneutical lenses, which have allowed us to survey our threat environment with less blurry vision. Without the decline of Church authority over the past few centuries, I doubt that the first existential mood specified above would have yielded to the second. We could very well have gotten stuck in Plato's cave looking at shadows.

Finally, before setting off on the adventure that awaits, I should address the question of this book's *raison d'etre*. Of what value is this project? Why does it matter? There are several good answers. One is that understanding the history of this idea—*human extinction*—can enable us to predict its future. And predicting its future can generate insights about the conditions that must obtain for it to flourish. *And* the idea flourishing matters because, first, we are closer to becoming mere remnants of the fossil record, like the dodo and dinosaurs, than ever before in the past 3,000 centuries. This is not a dress rehearsal; this is not a game. We stand with wobbly legs at the edge of a cliff. Second, it seems plausible that to effectively keep ourselves from tumbling over this cliff, we must at minimum *acknowledge* that human extinction is a future possibility. Hence, if the idea were to become unintelligible, incoherent, or unimportant to a sufficiently large number of people in the coming years, then humanity could end up becoming more vulnerable to annihilation than would otherwise be the case. This is the number one reason for studying the origins and evolution of this idea: gaining an understanding of the triggering factors and enabling conditions catalyzed the shifts in existential mood over the past two centuries could have a nontrivial effect on our chances of surviving the current century.

A less urgent reason is that this diachronic tale of existential maturation offers a partial answer to why so little intellectual work to date has focused on any of the four primary goals of Existential Risk Studies: Which risks could kill us? What are their causes? How can we prevent them? And what are the ethical implications of dying out? As the Oxford polymath Anders Sandberg wrote in 2008, referring to the "Doomsday Clock" that a group of anxious physicists created shortly after World War II,

> in the 61 years since the Doomsday Clock's creation, the risk of human extinction has received relatively scant scientific attention, with a bibliography filling perhaps one page. Maybe this is because human extinction seems to most of us impossible, inevitable, or, in either case, beyond our control. Still, it's surprising

> that a topic of primary significance to humanity has provoked so little serious research.

Five years later, Sandberg's Oxford colleague, Nick Bostrom, echoed this puzzlement. "It is striking," he wrote, "how little academic attention these issues have received compared to other topics that are less important." Perhaps research on human extinction is "inhibited by the multidisciplinary nature of the problem [and] deeper epistemological issues." It could also be that contemplating our annihilation, which in most cases would produce a Mount Everest of profound suffering,[8] is too psychologically distressing for most people. Indeed, I would say that depression, anxiety, and other psychopathologies are very real *occupational hazards* for scholars who spend their days (and nights) contemplating how humanity the human story could come to a catastrophic end, whether in a bang or a whimper. However, the answer offered in this book concerns my central thesis that *human extinction* is a quite new addition to our shared library of concepts. But this is not a fully satisfying answer, I must admit, since there are far more recent concepts—like that of *social media*—that have received considerable scholarly attention by a wide range of researchers: ethicists, psychologists, sociologists, media studies scholars, and so on. Nonetheless, the fact that human extinction was more or less unthinkable for protracted stretches of (western) history *does* explain why there is no extensive scientific or philosophical tradition based around the idea. It accounts for why Plato never published one of his Socratic dialogues about it, nor did the Enlightenment philosopher Immanuel Kant write any ponderous tome titled *Critique of Pure Annihilation*. By the same token, it is unsurprising that there are no researchers studying the behavioral characteristics of married bachelors (they do not exist), and no university departments dedicated to solving the problem of overpopulation on Mars (there is no such problem). Ideas must be sufficiently intelligible and prominent to grab the attention of even the most curious human minds.

Let's now turn to the rough periodization sketched above. I will proceed as follows: chapter 2 examines a hodgepodge of ideas and speculations prior to the 1850s that gestured at our modern notion of human extinction and how this could come about. As we will see, there were some precocious thinkers—mostly poets and science fiction writers with atheistic tendencies—who seriously contemplated a world without humanity, but such individuals were very much the outliers. Chapter 3 explores how the emerging field of thermodynamics introduced the first scientifically credible kill mechanism capable of destroying humanity. Suddenly, scientists and philosophers were confronted with the prospect, apparently inescapable, of the eventual annihilation of the entire biosphere, including the bipedal apes with large foreheads known as "humankind." Chapter 4 discusses the identification of various anthropogenic kill mechanisms associated with radioactive fallout, pollution, ozone depletion, climate change, nanotechnology, artificial intelligence, and firestorms caused by nuclear explosions. These constitute the first credible ways that humanity could destroy itself, not just in the far future, but in the near-term. Chapter 5 examines the rise of a theory called "neo-catastrophism" in the Earth sciences. Prior to this transition, the only widely accepted *natural* threat to human survival came from entropy; afterwards, the scientific community came to recognize that asteroids, comets, and supervolcanoes pose very real dangers to human life on Earth. Chapter 6 then explores the most recent transition, which as mentioned above involved a Gestalt shift in our understanding of the moral importance and urgency of avoiding extinction. The final chapter surveys the territory covered and offers some brief remarks about the future of the idea of human extinction. There are also three "supplements" that discuss the nature of human extinction, the historical roots of our contemporary notion of humanity (for example, each of us possess a fundamental, unalienable *dignity* that grounds our modern conception of *human rights*), and some alternative perspectives on why human extinction might actually be *desirable* (for example, because procreation is morally wrong). For the most comprehensive view of the topic, I encourage readers to explore these stand-alone sections, too.

This book tells a traumatic story. We are all aware of our own morality—that we will someday join the estimated 60 to 100 billion human beings who have so far made the harrowing journey from the cradle to the grave. As the old gravestone epigraph goes:

Remember friend as you walk by
As you are now so once was I
As I am now you will surely be
Prepare thyself to follow me.

There are other species, too, that may have an inkling about their ultimate fate as sinking bones in forgotten soil. Creatures like elephants, dolphins, chimpanzees, and magpies appear to mourn the dead, which suggests a basic grasp, or proto-grasp, of the dichotomy between life and death, and the loss that transitioning from one to the other entails. But humanity is the only species capable of mourning—anticipatorily, of course—its own extinction. We are the only creature endowed with the cognitive capacities needed to comprehend our mortality *as a species*. This constitutes yet another way that humanity is unique within the Animal Kingdom, in addition to its opposable thumbs, use of fire, symbolic language, and relatively huge brains, which are quite literally the most complex objects in the known universe. Yet the process of recognizing our morality in this sense brought with it quite a bit of anguish. And the story is not yet over. Perhaps by understanding how we got to where we are today, we can shape how the story unfolds moving forward.

Chapter 2: A Tapestry of Apocalyptic Tales

I give them eternal life, and they shall never perish; no one will snatch them out of my hand.—John 10:28-30

Mythology is not a lie, mythology is poetry, it is metaphorical. It has been well said that mythology is the penultimate truth—penultimate because the ultimate cannot be put into words. It is beyond words. Beyond images, beyond that bounding rim of the Buddhist Wheel of Becoming. Mythology pitches the mind beyond that rim, to what can be known but not told.—Joseph Campbell

There are many sacred texts and mythologies that come *close* to imagining a world without humanity, and hence to envisioning human extinction. The most conspicuous in the western tradition, with its roots in Athens and Jerusalem, is the first book of the Tanakh (or Hebrew Bible), Genesis. The sixth to ninth chapters tell the story of Yahweh's wrath towards humanity, "for all people on earth had corrupted their ways." So Yahweh decided to "put an end to all people, for the earth is filled with violence because of them" by bringing a worldwide flood that will "destroy all life under the heavens, every creature that has the breath of life in it." (It is not clear how a flood would kill all marine organisms.) But Yahweh spares Noah, a 600-year-old who Genesis describes as "a righteous man, blameless among the people of his time, [and who] walked faithfully with God." Consequently, Noah built an ark in which a few individuals of every kind of creature took refuge. After the Great Deluge (as the painter Gustave Doré called it), the *only* humans who remained were "Noah and his sons, Shem, Ham and Japheth, together with his wife and the wives of his three sons." Yahweh commands them to "be fruitful and increase in number; multiply on the earth and increase upon it," and establishes a covenant, signaled by the rainbow, that "never again will there be a flood to destroy the earth." Although the human population dwindles to a small handful of individuals, it is doubtful that humanity could have actually "gone extinct," given that, as the Noachian story itself affirms, we are immortals created "in the likeness of God." Other passages in the Bible also clearly state that God has a grand redemptive plan for humanity: the crucifixion and resurrection of Jesus to "wash away our sins." Since this plan cannot unfold without humanity, we were never really at risk of disappearing—or so this line of reasoning goes.

The old tradition of Norse mythology tells a similar close-call story, but set in the misty future rather than the dusty past. It prophesies that our current world will end with a series of grand battles, a worldwide flood, and fires that engulf the planet. As one of the main poems about this cataclysm describes what will unfold:

> The sun starts to blacken,
> land sinks into sea,
> the radiant stars
> recoil from the sky.
> Fume rages against fire,
> fosterer of life,
> the heat soars high
> against the heaven itself.

This is known as *Ragnarök*, and it entails the death of several Norse gods, including Thor, the thunder-and-lightning deity who wields a hammer and protects Earth. Indeed, the Old Norse word "*Ragnarök*" means "Final Fate of the Gods." But the battles, floods, and fires will also destroy the entire human population except for two individuals: a man named Lif (meaning "life") and a woman named "Lifthrasir" (meaning "lover of life"). As with Noah and his kin, these lonely survivors will then repopulate the planet, which will emerge anew, green and fertile.

This basic motif of decline leading to renewal, perhaps in cycles that continue indefinitely, is found in the eschatological schemes of many world religions. For example, Hinduism, possibly the oldest *organized* religion, describes the universe as cycling through stages of birth, growth, decay, death, and rebirth. According to the Puranas, a Sanskrit epic that was composed between the last few centuries prior to the Common Era (CE) and the twenty century CE, Brahma is "a living cosmos who lasts, in just one day-and-night, for a thousand cycles of four deteriorating ages." Each of these cycles lasts an incredible 4.32 billion years for us humans, and "at the end of 36,000 full years of these day-nights, Brahma rests or ceases, only to experience rebirth for another vast lifetime." Yet within each lifetime, the human world oscillates between dissolution and recreation thousands and thousands of times.[9] In contrast, Buddhism posits four periods, or "incalculable eons," that compose a single full cycle, or "great eon." During the first, the universe is destroyed; the second involves the universe stagnating in this state of destruction; the third marks the gradual renovation of the universe; and the fourth involves the universe remaining in this apotheosis. Each incalculable eon lasts so long that, to borrow an analogy found in the canonical sūtra literature, one could destroy a giant, solid-rock mountain by rubbing it with a smooth piece of cloth once every one hundred years before it ends.[10] Yet during these transitions from a golden age to moral degeneration, human beings survive. It is during the nadir of the cycle, when people have lost their moral compass, that some individuals return to traditional morality, which initiates the third stage of renewal.

However, there have been mythological systems that gesture at a world completely bereft of human beings. One example comes from the Aztecs of Mesoamerica—The People of the Sun—who believed that the world had been created, destroyed, and recreated multiple times. The very first world was occupied by giants who, at the command of the god Tezcatlipoca, were all eaten by jaguars. The second was inhabited by normal-sized people, but society deteriorated over time. Consequently, one of the gods turned everyone into monkeys, after which another blew them off the planet by a massive hurricane. The third world experienced a great drought. Its inhabitants desperately pleaded for rain, but this only angered the sun god who responded by pouring down fire until ash was all that remained. The fourth world ended when the goddess Chalchiuhtlicue cried blood for fifty-two straight years, drowning the human population in her tears. And finally, the fifth world, which they inhabited, is marked by an ongoing battle between Huitzilopochtli, the solar deity and god of war, and Coyolxauhqui, the goddess of the moon. This is why the Aztecs sacrificed tens if not hundreds of thousands of people, typically by slicing out the person's heart through the diaphragm: these aided Huitzilopochtli in the conflict. The Aztecs believed that if this practice were to cease, the sun would stop shining, a massive earthquake would rattle Earth, and humanity would perish. Of note is that this mythology did not specify a possible Sixth Sun, which suggests that the end of the current epoch would be the end of all epochs.

Another intriguing example comes from the mythology of ancient Egypt, a civilization of Northern Africa known for its mind-boggling construction of the great pyramids. Both the *Coffin Texts* and the subsequent *Book of the Dead*—so named because it was placed alongside decedents in their burial chambers or coffins—suggest that the self-created deity Atum will someday transform the world back into a primeval state like the one from which it sprang, thereby causing the death of all living things. As the *Book of the Dead* states, "this earth will return to the primeval water (Nun), to endless (flood) as in its first state. I shall remain with Osiris after I have transformed myself into another snake which men do not know and the gods do not see." Hence, the only remaining beings will be Atum and the god of renewal, Osiris. The survival of Osiris, though, seems to leave open the possibility that a new world will emerge, thus fusing the end with a new worldly beginning.

Among the ancient Greeks, one finds some intriguing cyclical narratives that specify periods during which no humans exist. Consider the pre-Socratic philosopher and poet Xenophanes of Colophon, an early fossil collector who, according to the British philosopher Karl Popper, offered "the first philosophical articulations of skepticism toward traditional religion." Part of

Xenophanes's philosophical system was that the world alternates between two extremes: wetness (or water) and dryness (or Earth). Over time, the ocean will submerge the land, turning it into mud and causing everyone alive to perish. But when the cycle reverses and dryness comes to dominate, the human race reappears. Thus, for Xenophanes, the non-existence of humanity does not constitute a permanent configuration of the universe. Roughly a century later, the pre-Socratic philosopher Empedocles, a great orator who believed in reincarnation and encouraged his contemporaries to practice vegetarianism, proposed a similarly dynamic narrative. However, he identified the two extremes as corresponding to "Love" and "Strife," which personify the cosmic forces of attraction/combination and repulsion/separation. These are engaged in an eternal fight for domination, with one defeating the other followed by the other defeating the first. Empedocles argued that when Love dominates, everything is fused into an undifferentiated mass and no life is possible; when Strife dominates, everything is pulled apart and, once again, no life is possible. It is the *transition* between Love and Strife, Strife and Love, that enables wriggling clumps of animate matter, like human beings, to appear. Hence, there are four stages to each cycle, two of which are "a-cosmic" and, as a result, cannot sustain life. The other two can and do.

These eschatologies point to an idea that has dominated western history for ages, called the "Principle of Plenitude."[11] This states that "no legitimate possibility remains unrealized"—or, put differently, "in the long run everything possible happens."[12] This idea may strike contemporary minds as bizarre, yet it held sway up to the end of the eighteenth century. An example comes from the French *philosophe* and editor of the hugely ambitious *Encyclopédie*, Denis Diderot, who claimed in 1769 that humanity will someday encounter the same fate of the sea-cow, an aquatic mammal (the most famous of which is the manatee) that was reported to have died out the previous year due to overhunting.[13] Yet Diderot did not believe that this would be the end of our story. One of the first to consider the basic logic of "natural selection," Diderot vigorously claimed that evolution would start over. It would begin with "I don't know what" and "then at the end of several hundreds of millions of years of I-don't-know-whats, the biped animal who carries the name man" would reappear.[14] Hence, the Principle of Plenitude posed a major intellectual barrier to imagining human non-existence as a *permanent* rather than merely *temporary* state. Perhaps we could disappear for a time, but if we did, we would surely reappear on the planetary stage, in the theater of life, at some later time.

Another Enlightenment philosopher, Immanuel Kant—the first real professional philosopher in the west, and someone who supposedly wrote at a *seventeen-and-a-half-grade* level—was also influenced by the Principle of Plenitude, although he drifted away from the idea in his later work. This is intriguing because he became increasingly preoccupied in the course of his career with the long-term future of humanity, and on numerous occasions gestured at the possibility of a world without us. For example, he wrote in his famous essay *Toward Perpetual Peace* (1795) that "a war of extermination, in which the destruction of both parties and of all justice can result, would permit perpetual peace only in the vast burial ground of the human race." It is difficult to know whether Kant was referring here to the complete annihilation of humanity or some post-apocalyptic world in which life continues but in degraded conditions. A similar ambiguity is found in his 1797 suggestion that a series of "great revolutions of nature" could cause orangutans and chimpanzees to acquire bipedal locomotion, opposable thumbs, natural language, and cumulative culture, thus enabling them to "dispute the claims of human beings to mastery over the earth."[15] One year later, he wrote that "wickedness cannot be incessant in the human race, for at a certain stage of disintegration it would destroy itself." He continued:

> The human race has always been in progress toward the better and will continue to be so henceforth … provided at least that there does not, by some chance, occur a second epoch of natural revolution which will push aside the human race to clear the stage for other creatures, like that which … submerged the plant and animal kingdoms before human beings ever existed.

On still another occasion, Kant more directly imagined a universe bereft of human beings, writing that "without man all of creation would be a mere wasteland, gratuitous and without a final purpose." I once asked a Kantian scholar what Kant would have said about human extinction and received this unequivocal response: "I think Kant's answer would have been direct, loud, and emphatic. He would have said (in German, of course): *hell, no!*" After all, Kant was clear in his influential work on ethics that rational beings like us are the only intrinsically valuable—or "valuable in itself"—entities in the universe, which is why the universe would be aimless without us.

Yet all of these statements, intriguing as they are, were generated by creative minds and scribbled onto paper before the scientific community as a whole came to accept that species—any species—*can go extinct*. Given that, as the science journalist Elizabeth Kolbert notes in *The Sixth Extinction*, the concept of *species extinctions* is probably the first scientific idea that children learn from books or school, many people find it surprising to discover that prior to 1800, scientists almost unanimously rejected the possibility of extinction. People had of course known about fossils for millennia—as noted, Xenophanes was a fossil collector, and there is even some evidence that "fossils were prized possessions of Neanderthals over 30,000 years ago," since they "have been found among the artifacts of these heavy-browed cave dwellers."[16] Some early iconoclasts even argued that these "curiously shaped rocks" in the ground belonged to species that had completely disappeared.[17] For example, the eighteenth-century English natural philosopher Robert Hooke, who some historians now call "the English Leonardo da Vinci," claimed in 1705 that some fossilized creatures had been, in his words, "wholly destroyed and annihilated." They are "ancient medals of nature."[18] Similarly, Voltaire—a French writer during the Enlightenment and fierce critique of organized religion—"publicly endorsed prehistoric extinctions," and around the same time, European colonization began to bring back stories of creatures like the great auk in Newfoundland and the aforementioned sea-cow of the Aleutian Islands disappearing.[19]

Yet the possibility of species disappearing was widely dismissed, if only because people at the time saw it as incompatible with Christian doctrine. The reasoning went like this: if species have gone extinct, then God's creation is imperfect; but since God's creation is perfect, no species have gone extinct. Intimately connected to this idea was the Great Chain of Being (or *scala naturae*), which originated with the ancient Greek Aristotle, whose pre-scientific theories had an outsized influence on the western tradition until the sixteenth-century Scientific Revolution. The Great Chain of Being was a conceptual system that organized all living creatures into a tightly woven hierarchy with humanity at the top (above which are the angels and, at the apex, God). As the English poet Alexander Pope, one of the most celebrated literary artists of the early eighteenth century, poetized in a 1751 *Essay on Man*:

> Vast chain of being! which from God began,
> Natures aethereal, human, angel, man,
> Beast, bird, fish, insect, what no eye can see,
> No glass can reach; from Infinite to thee,
> From thee to nothing.—On superior pow'rs
> Were we to press, inferior might on ours;
> Or in the full creation leave a void,
> *Where, one step broken, the great scale's destroy'd*;
> From Nature's chain whatever link you strike,
> Tenth or ten thousandth, breaks the chain alike (italics added).

Consequently, the notion that fossils belong to extinct species was excluded, *a priori*, from the space of possible hypotheses. In the seventeenth century, many Christian naturalists attempted to explain them away as mere "sportings of nature" (meaning that they were expressions of nature's creativity) or objects that had fallen from the sky.[20] The Welsh polymath Edward Lhwyd suggested that they had "originated from seeds that somehow grew within the rocks and thus mimicked living structures." And the English naturalist and ordained minister John Ray (although he later

came to accept Lhwyd's view) initially argued that fossils are the ancient remnants of creatures still alive in unknown (to the west) regions of the globe.[21] In fact, Thomas Jefferson, one of the US Founding Father, espoused a similar view: unobserved creatures in fossiliferous rocks must have migrated to other parts of God's green Earth. As he wrote in 1787, referring to the Great Chain of Being, "such is the economy of nature, that no instance can be produced of her having permitted any one race of her animals to become extinct; of her having formed any link in her great work so weak as to be broken." Thus, he was known to invoke "Indian legends to suggest that unknown beasts lived in the unexplored interior of America," and when Meriwether Lewis and William Clark took their famous expedition across the Continental Divide to the Pacific coast, he instructed them to collect evidence of American mastodons (*Mammut americanum*), whose remains had been unearthed in North America.[22]

The paradigm shifted dramatically, and abruptly, with the publication of a groundbreaking study in 1800 by the French anatomist Georges Cuvier, based on work four years earlier. Considered one of the greatest minds of his generation, Cuvier more or less founded the field of *vertebrate paleontology*—which Jefferson, who corresponded with Cuvier, brought to the US through a presentation to the American Philosophical Society, based in Philadelphia. Legend has it that Cuvier understood the internal structure of organisms so well that if one were to present him with a single bone, he could reconstruct the whole animal to which it belonged. In his 1800 paper, he showed beyond a reasonable doubt that the elephantine bones found in North America and Siberia—some of which were provided by Jefferson himself—belong to two species that had gone extinct: the mammoth and (what Cuvier himself named in 1817) the mastodon. This, along with Cuvier's expansion of the taxonomic system put forth by Carl Linnaeus in 1735, dealt a fatal blow to the *scala naturae*, although "it would be many decades before the majority of naturalists threw off the last vestiges of the chain of being."[23] It also posed a major challenge to the Principle of Plenitude: not only could species disappear, Cuvier argued, but they could disappear forever. God's creation was not so perfect after all. However, believing that species could go extinct does not immediately lead to the idea that *humanity* can go extinct: if humanity is not a species *in the sense that other creatures are*, then we may not be susceptible to the same vagaries of annihilation. In fact, as discussed in the next chapter, it was not until Charles Darwin's *magnum opus*, published in 1859, that the ontological gap separating humanity from the rest of the Animal Kingdom was closed.

Yet some eighteenth-century thinkers did flirt with the idea that humanity itself could disappear if the global population were to dwindle for some reason until no one was left standing. For example, the philosopher and jurist Montesquieu published an epistolary novel in 1721 that consist of letters authored primarily by two fictional Persians named Usbek and Rica while they were exploring different European countries. (Montesquieu wanted to show Europeans what their cultures might look like from the eyes of a foreigner.) In one letter to Usbek, the character most aligned with Montesquieu's own views, from his friend Rhedi, the latter reports that

> after doing calculations as exact as is possible …, I have concluded that the earth supports barely a fiftieth of the population that it had in Caesar's day. What is astonishing is that the population continues to diminish daily, and if this trend persists, within ten centuries the earth will be nothing but an uninhabited desert. … We see here, my dear Usbek, the most terrible catastrophe the world has ever experienced; but people have barely noticed it, because it has occurred so gradually, and over the course of a great many centuries; this points to an internal defect, a secret, hidden poison, a decline afflicting the human race.

The focus on *populations* rather than *individuals* on display here was a novel development of the time, and led to the formation of the field of *demography*. If populations are natural entities *in their own right* that respond to environmental factors and grow/shrink according to law-like regularities, they can be studied scientifically no less than chemical reactions and the movements of

planets (a word that literally means "wanderers").[24] This is the basic idea in Rhedi's letter: "if this tend persists," then there "will be nothing but an uninhabited desert." In fact, the Scottish historian and philosopher David Hume published a 1754 essay on "populousness" that was in part a response to Montesquieu. In it, Hume "pronounces that man, just like all other species, will eventually undergo unrecoverable decline."[25] Perhaps most notable during this period was the demographic theories of Thomas Malthus, an economist and Anglican cleric who predicted societal collapse based on the supposed principle that food grows linearly while human populations expand geometrically. As he wrote in 1798, "the power of population [expanding at a geometric rate] is so superior to the power in the earth to produce subsistence for man [at an arithmetic rate], that premature death must in some shape or other visit the human race." Yet despite these words, Malthus did not appear to infer from this that humanity would go extinct. Rather, he suggested that the differences in food production and population growth yield cycles of expansion and collapse. Or as he put it, a "perpetual oscillation between happiness and misery." In a critical response to Malthus twenty-two years later—in 1820—the political philosopher William Godwin penned a book titled *Of Population* in which he dismissed Malthus's central claim that human populations grow geometrically. If anything, population sizes may *decrease* over time due to a variety of causes, some of which Malthus failed to recognize (such as war). In Godwin's words, which may cause modern readers to stumble,

> it is at least problematical, whether there is a tendency in the human species to increase, and that, for any thing that appears from the enumerations and documents hitherto collected, it may be one of the first duties incumbent on the true statesman and friend of human kind, to prevent that diminution in the numbers of his fellow-men, which has been thought, by some of the profoundest enquirers, ultimately to threaten the extinction of our species.

The point is that thinking about population *themselves* as entities opened up the conceptual door to imagining them as "a new unit of potential perishing."[26] If populations are discrete things in the world, and discrete things in the world can be destroyed, then the human population can be destroyed, too—or so this troubling line of reasoning went.

While the field of demography was taking off and scientists were reluctantly abandoning the Great Chain of Being and Principle of Plenitude, the nineteenth century also witnessed a flurry of poems, novels, and artwork centered around the "Last Man" theme. Like the apocalyptic prophecies of *Ragnarök*, this new genre of the Romantic era (1800 to 1890) imagined future scenarios in which the human population contracts to one or a few lonely persons roaming a largely vacant planet. In some cases, the decline of humanity clearly does not result in our extinction, if only because the catastrophe is part of God's masterplan for humanity. For example, the first speculative fiction novel about the last man was Jean-Baptiste Cousin de Grainville's novel *Le Dernier Homme*, or *The Last Man*. This was published posthumously in 1805, after de Grainville, who suffered from a desperate case of loneliness, committed suicide by leaping into the Canal de la Somme at two in the morning. The story follows the peripatetic journey of Omegarus, the protagonist, who boards an airship to Brazil in search of the only remaining fertile woman on Earth, Syderia. Omegarus finds Syderia and they return to Europe, but the first man, Adam, from the biblical story of creation, persuades Omegarus to leave Syderia (who is with child) so that the biblical apocalypse can begin, as God wills. Omegarus obeys Adam and, upon wandering the European wilderness, observes the slow and sorrowful termination of our world:

> The sun no longer had the power to outshine the faint light of the stars. Seen together, the sun and the night stars were a frightening spectacle. … The moment had come when the destiny of the Earth, of Heaven, and of Hell would be settled forever. The last scene in the history of the world was beginning. … The shades of the dead, fugitive and wandering, hastened to the final scene. … All Heaven

> waited on this great event with impatience; and there came an instant, universal cry of joy. The reign of time had ended, and a vista of eternity opened up.

However, the "reign of time" reaching its terminus yields a marvelously new point of departure: the Kingdom of Heaven. Another story depicting the end of the world that stops short of declaring humanity gone for good was also titled "The Last Man," published in 1826 by an anonymous author in *Blackwood's Edinburgh Magazine*. It culminates with the tremulous shrieks of the main character:

> Alas! Alas! I soon and easily gained the top of the rising bank, and fixed my eyes on the wide landscape of a desolate and unpeopled world. … Desolation! Desolation! I knew that it was to be dreaded as a fearful and a terrible thing, and I had felt the horrors of a lone and helpless spirit—but never, never had I conceived the full misery that is contained in that one awful word, until I stood on the brow of that hill, and looked on the wide and wasted world that lay stretched in one vast desert before me.

Yet, in a plot twist that modern readers would find quite banal, the story ends with the main character awakening from a dream. He then observes, in his words, "my man John, with my shaving-jug in the one hand, and my well-cleaned boots in the other—his mouth open and his eyes rolling hideously at thus witnessing the frolics of his staid and quiet master." As the award-winning science fiction writer David Brin once told me in an interview about the topic, "most science fiction about human extinction is actually about *almost* human extinction."

Other Last Man tales, though, do suggest that the "last man" is also the final quivery particle of humanity: when he dies, so does the species. For example, consider Mary Shelley's book *The Last Man*, also published in 1826. Although it received poor reviews at the time—in part because the "last man" theme had become quite hackneyed—it is generally considered to be the first true work of post-apocalyptic fiction. Furthermore, it does not end with a new beginning: the last man, Lionel Verney, spends weeks wandering from town to town looking for any trace of life, but finds nothing. As he scribbles on writing materials found in an author's study, "the sun had bathed in gold the western atmosphere, and in the east the clouds caught the radiance, and budded into transient loveliness. It set on a world that contained me alone for its inhabitant." Lionel then plans a trip around the Mediterranean out of "restless despair and [a] fierce desire of change," hoping in part that he will "find what I seek—a companion; or if this may not be—to endless time, decrepid and grey headed—youth already in the grave with those I love—the lone wanderer will still unfurl his sail." Hence, one is left with the eerie sense that Lionel lives the rest of his days in complete isolation, a state of emotional torment that likely reflected Shelley's personal situation after the death of her husband Percy Shelley in 1822 and friend Lord Byron in 1824.[27]

The fact that Mary Shelley did not intertwine her narrative with the apocalyptic hope of Christian eschatology may have been due to her irreligious upbringing. Her father, the aforementioned William Godwin, was trained as a minister but he became an atheist, and her husband was expelled from the University of Oxford for failing to answer questions about a pamphlet that he penned called "The Necessity of Atheism." Furthermore, Shelley's colleague in the so-called "Satanic School" of poetry, Lord Byron, was a bisexual libertine who reportedly once said that he does "not see … very much the need of a Saviour." In fact, his well-known 1816 poem *Darkness* was among the very first to explicitly depict a world that is "Seasonless, herbless, treeless, *manless*, lifeless—A lump of death—a chaos of hard clay" (italics added). This was composed the same year that Mary Shelley began writing *Frankenstein*, while Byron and the Shelleys were holed-up together near Lake Geneva during the so-called "Year Without a Summer," caused by the super-colossal eruption of Mount Tambora in Indonesia the previous year. Although Byron was unaware of the Tambora event, he was familiar with Cuvier's work, and a "recurrent theme" in his writings is the threat to human survival posed by *comets*. He even once suggested "that

there had been many impact catastrophes in which previous inhabitants of the Earth had been wiped out." In *Conversations of Lord Byron* (1824), fellow English poet Thomas Medwin recounted an occasion in which Byron, while presiding in Pisa around 1822, argued that "we are at present in the infancy of science. Do you imagine that, in former stages of this planet, wiser creatures than ourselves did not exist?" He thus worried that without a way to destroy incoming comets, humanity is "perhaps only temporarily in the ascendent."[28] As Byron wondered aloud, according to Medwin,

> who knows whether, when a comet shall approach this globe to destroy it, as it often has been and will be destroyed, men will not tear rocks from their foundations by means of steam, and hurl mountains, as the giants are said to have done, against the flaming mass.

This is probably the earliest reference in the west to a *planetary defense system*, or system whose purpose is to protect Earth from rocky assassins dashing through our solar neighborhood. Today, [Planetary Defense Coordination Office] […]

Byron's conjectures about cometary collisions points to an important fact about this initial period: even if one found the idea, or proto-idea, of human extinction *intelligible*, it was entirely unclear what sort of cosmic phenomena from above or below could *precipitate* our disappearance. In de Grainville's novel, the human population declines because of infertility, while in Shelley's *The Last Man* the cause is a plague. Others agreed with Byron that a comet, which ancient Chinese oracle bones indicate have been known about for millennia, could violently smash into Earth. As the British physicist Duncan Steel observes, "the possibility of catastrophic impact by comets resurfaced from time to time before the modern era." For example, the British astronomer Edmond Halley, who identified the periodicity of what is now called "Halley's Comet," suggested in 1694 that the Caspian Sea, along with other large Earth structures, may have formed as a result of cometary impacts. Halley also "proffered modernity's first image of a 'mass extinction event,'" according to Moynihan, by "speculating that cometary impacts had previously wiped out entire 'worlds' of unknown phyla."[29] Still other creative minds proposed cometary kill mechanisms that did not involve the conversation of kinetic into heat through a collision. In the 1839 short story "The Conversation of Eiros and Charmion" by Edgar Allan Poe—the first person to outline a "big bang" theory of the cosmos (in his poem "Eureka")—humanity perishes in an "irresistible, all-devouring, omni-prevalent, immediate" conflagration. This is caused by a comet passing by our planet and extracting nitrogen from the atmosphere. The remaining oxygen, which is highly combustible, then catches fire, obliterating all human life. (Note that Halley's comet passed by Earth a few years earlier, in 1835. So the timing of Poe's story was not coincidental.)

But these were all a bunch of idiosyncratic speculations rather than scientifically credible hypotheses. At least two considerations counted against the comet-impact idea. First, many scientists calculated that the probability of a cometary strike is very low, so we should not be worried about this happening. For example, the French astronomer Jérôme Lalande crunched the numbers and concluded that there is a 1/76,000 chance that Earth's path through the solar system will intersect with a comet's.[30] Another astronomer in France, François Arago, calculated that "the chances of a collision with the Earth, for any particular comet, were no more than 1 in 281 million."[31] As Thomas Jefferson supposed declared in 1807 after being told about the "Weston meteorite" that exploded into fragments over the small town of Weston, in Connecticut, "I would more easily believe that two Yankee professors would lie than that stones would fall from heaven." Second, natural philosophers in the seventeenth and eighteenth centuries tended to believe quite firmly that God would never *allow* a calamitous collision to wreak havoc on our planet, the playground of creation. Isaac Newton, the brilliant physicist and inveterate loner who tinkered with prisms, established the three laws of motion and universal gravitation, and invented the infinitesimal calculus, held this view, arguing that since God loves his children, passing comets were much more likely to be beneficial than harmful—for instance, by replenishing Earth with

water.[32] Decades later, Benjamin Franklin put the idea as follows in his 1757 *Poor Richard's Almanac*:

> Should a Comet in its Course strike the Earth, it might instantly beat it to Pieces, or carry it off out of the Planetary System. The great Conflagration may also, by Means of a Comet, be easily brought about. All the Disputes between the Powers of Europe would be settled in a Moment; the World, to such a Fire, being no more than a Wasp's Nest thrown into an Oven. But our Comfort is, the same great Power that made the Universe, governs it by his Providence. And such terrible Catastrophes will not happen till 'tis best they should.

This pacifying view held sway into the nineteenth century, too. For example, the British minister Thomas Dick, who was known for arguing that science and Christianity can co-exist in peace, published an 1840 book titled *The Sidereal Heavens and Other Subjects Connected with Astronomy*. In it, he wrote that an impact with comets is inconceivable without the "sovereign permission" of our Heavenly Father. Everything that happens, happens for a reason, so if there is no good reason for Earth and a shimmering celestial body to collide, we can count on this never happening.

The point is that while intellectuals concocted plenty of imaginative ideas about possible kill mechanisms, the scientific community could not agree about whether any of them were actually capable of bringing about our extinction. A particularly fascinating discussion of doomsday scenarios comes from an 1816 article titled "Of the End of the World" in *The New Monthly Magazine*, a British periodical in which Mary Shelley once published. Written by an anonymous "H," it seems to be an attempt to convince readers that "the end of the world" is a topic worth taking seriously—that natural (or naturalistic) phenomena really could destroy humanity. As the author concludes the article, "I have thus given the *end of the world* with variations, so that amateurs may take their choice; but I hope I have said quite enough to stop the mouths of all who may be disposed to make light of so serious a subject." Some of the causes of world destruction, though, are quite fantastical, not unlike Malcom's musings in chapter 1. For example, the author claims that "our poor Earth is drying up, … There will, therefore, come a day when not a drop of water will be left on the globe." This will fuel a large conflagration that causes "burning minerals" to release water vapor, resulting in "tremendous torrents of rain." Yet "H" adds that, while "the generation now living … shall all be burned," a new species of intelligent beings will eventually return to "build cities, compose operas, and invent cosmogonies"—a claim quite possibly made untie spell Plenitude Principle. "Here, then," the author declares at one point, "is a very rational *end of the world!*"[33]

But these scenarios were really nothing more than hand-waving, despite "H's" insistence to the contrary. And crucially, without a plausible way that extinction *could* occur, there was no good reason to think that it *would* occur. Even more, the lack of a secular existential hermeneutics would have prevented people from recognizing phenomena like comets as dangerous even if the calculations made by Lalande and Arago implied that a collision was highly probable. A global catastrophe would of course cause a lot of human misery, but the other side of the apocalypse is utopia. Indeed, Poe's story above describes the ensuing worldwide fire as "the entire fulfillment, in all their minute and terrible details, of the fiery and horror-inspiring denunciations of the prophecies of the Holy Book," and the dialogue occurs between two "departed spirits," Eiros and Charmion, in the afterlife. The same goes for *Le Dernier Homme*. For many at the time, human extinction in the sense used today by evolutionary biologists was quite simply unimaginable. The dominant Christian worldview of the period made no room for serious speculations about a future in which humanity is no more.

To underline this point, consider an observation made by the French historian Lucien Febvre in his 1942 *The Problem of Unbelief in the Sixteenth Century*. "A full-blown atheism," he writes, "in the sense that we use the word today was impossible." The reason is that "the concep-

tual difficulties in the way of a complete denial of God's existence … were so great as to be insurmountable."[34] Given the monopoly of religious eschatology on the marketplace of ideas at the time, imagining our permanent non-existence in the universe encountered the very same conceptual difficulties, thus rendering human extinction quite literally *unthinkable*. Another way to put the point is like this: most people during the period would have seen "human extinction" as an oxymoron, not unlike "married bachelor." This is because the concept of *humanity* contains within it the idea—the conviction—that we are ensouled bodies and embodies souls who will persist *through* and *beyond* the cataclysmic paroxysms of the End Times, whenever it occurs ("But concerning that day and hour no one knows, not even the angels of heaven, nor the Son, but the Father only," the Bible states). Since each individual human is naturally immortal, so too is the human species, and hence extinction is metaphysically impossible.

The resulting existential mood was thus infused with a spirit of *general reassurance*—or to borrow Franklin's term, "Comfort"—that the collective whole could perish neither entirely nor forever. Indeed, for many centuries people did not even believe that *non-human* creatures could vanish forever. The idea of human extinction was thus almost never seriously considered, except by those irreligious rarities like Byron, Godwin, and Shelley.

However, digging through the literature of the time may lead one, at first glance, to arrive at a different conclusion. There are in fact plenty of references to "human extinction" printed in the pages of dusty old books, now taking up space in server farms as digitized facsimiles. For example, William Pitt the Younger, who was Prime Minister of Great Britain and the United Kingdom during the French Revolution (1789 - 1799) and Napoleonic Wars (1803 - 1815), wrote the following:

> The progress of inventive cruelty kept pace with the gory necessities of the hour. The old means of *human extinction* were too slow for the system which contemplated the extinction of party by the extinction of communities. The gibbet and the wheel were soon superseded by the rapid services of the guillotine (italics added).

This was published in 1835, and is part of a critique of the French Revolution, which deteriorated into the Reign of Terror (giving us our modern English word "terrorism"). Pitt is thus discussing how slower forms of execution were supplanted by the guillotine, and thus "human extinction" refers to the death of individuals rather than the species.[35] Similar analyses apply to instances of "human annihilation." In many cases, those using this term were referring to the theological doctrine of *annihilationism*, a view espoused by the Seventh-day Adventists, according to which the souls of unsaved people will be destroyed at the end of time rather than cast into the Lake of Fire. Hence, typographical appearances can be deceiving: most talk of human extinction was not really about *human extinction*, in the sense common today. One also finds statements and phrases that give the *impression* that an author was discussing our disappearance, but upon closer examination these too mislead. For example, Joseph de Maistre, a major contributor to the Counter-Enlightenment (arising in the late eighteenth century), published *Considerations on France* in 1797, which includes a chapter titled "On the Violent Destruction of the Human Species." But this is not about humanity going extinct; rather, it examines the potentially *beneficial* effects of war, suffering, and strife throughout history. As Maistre writes in a passage that could very well have been excerpted from one of Hitler's speeches:

> Yet there is room to doubt whether this violent destruction [of human beings] is, in general, such a great evil as is believed; at least, it is one of those evils that enters into an order of things where everything is violent and against nature, and that produces compensations. … In a word, we can say that blood is the manure of the plant we call genius.

So, the "violent destruction" that Maistre discusses is not of the human species itself, but members of the species: "mankind may be considered as a tree which an invisible hand is continually pruning and which often profits from the operation." The only notable hint of human extinction comes in the following sentence, in which Maistre notes that "in truth the tree may perish if the trunk is cut or if the tree is overpruned," yet he adds that "who knows the limits of the human tree?" This last sentence actually captures, quite nicely, the predominant view of the time: who knows the limit of the human tree? Why would we think there is one?

These observations bring us to the end of this initial period, when the existential mood was generally mellow, despite occasional hints at the secular destruction of humanity. Let's now examine the nature and causes of the first major qualitative shift in existential mood that unfolded in the 1850s.

Chapter 3: 'Til Entropy Death Do Us Part

So far as scientific evidence goes, the universe has crawled by slow stages to a somewhat pitiful result on this Earth, and is going to crawl by still more pitiful stages to a condition of universal death.—Bertrand Russell

"Excuse me, Professor, but when did you say that the universe would come to an end?" "In about four billion years," replied the speaker. "Thank God," remarked the old lady, "I thought that you said four million."—unknown

1st law: You cannot win. 2nd law: You cannot even break even.—An old physics joke about the two laws of thermodynamics.

One of the great disagreements throughout history has been whether cosmic time is cyclical or linear. Whereas Eastern religions have tended to embrace the former, the Abrahamic faiths adopt the latter. According to the British historian Norman Cohn, the ancient Persians quite literally *invented* the linear conception of time—that is, of history having both a definite beginning (creation) and definite end (the apocalypse). "The ultimate origin of the notion that time will have an end," Cohn writes, "does indeed lie in the visionary experiences of the Iranian prophet Zoroaster." This was likely passed to the Jewish people during the Babylonian exile of the sixth century BCE, and from there leapt like a virus to Christianity and Islam—which is why their eschatological narratives are so strikingly similar. For example, the Zoroastrian narrative includes a virgin-born messiah, bodily resurrection of the dead, Final Judgment of humanity, and grand battle between Good and Evil (Armageddon).[36]

Scientists also debated the issue, although there was no strong evidence for one view over the other. But this changed dramatically in the early 1850s, when physicists like Rudolf Clausius and Lord Kelvin (a.k.a. William Thomson) formulated the *second law of thermodynamics* (or "Second Law," as I will call it). This states that "isolated" systems, or systems that cannot exchange matter or energy—whatever that is exactly (we do not actually know)—with their environs, will spontaneously drift toward a state in which the matter and energy that they contain become uniformly distributed throughout. Or as the American historian Henry Adams—whose grandfather and great-grandfather were both US Presidents—metaphorized, "the ash-heap becomes ever bigger." One implication of this is that time is an arrow rather than a circle, that cosmic history has the properties of being both *linear* and *directional*: it began in an orderly state and is inexorably marching toward a state of chaos and thermodynamic equilibrium.[37] Since life requires thermodynamic *disequilibrium*—we are little bundles of organized matter and energy that maintain order by increasing the disorder of our surroundings—the Second Law thus entails that our cosmic abode is becoming increasingly inhospitable, and will continue to do so until the metabolic processes that make life possible can no longer occur. Nothing will survive, not even a forlorn squeak that our civilization once existed on a wobbling blue-green planet in a galactic corner of the Milky Way. Many leading physicists at the time immediately recognized this dismal implication: our trusty sun will eventually burn out, Earth will become a frozen wasteland, and the biosphere will collapse. As Clausius wrote in 1887, using the term "entropy" that he coined in 1865,

> it is often said that the world goes in a circle … such that the same states are always reproduced. Therefore the world could exist forever. The second law contradicts this idea most resolutely. ... The entropy tends to a maximum. The more closely that maximum is approached, the less cause for change exists. And when the maximum is reached, no further changes can occur; the world is then in a dead stagnant state.

It is difficult to *overstate* the Second Law's impact on the intellectual climate of the latter nineteenth century. From one scientific field to another, to philosophy, to literature, the notion of a secular end to the universe, in accordance with the universal laws of nature, left many dismayed. The Austrian physicist Joseph Loschmidt, for example, colorfully limned this law of nature in 1876 as a "terroristic nimbus … which lets it appear as a destructive principle of all life in the universe." The same year, an American geologist named Alexander Winchell published *Sketches of Creation*, in which he—perhaps gesturing at the literary theme discussed above—discusses

> the awful catastrophe which must ensue when the last man shall gaze upon the frozen Earth, when the planets, one after another, shall tumble, as charred ruins, into the sun, when the suns themselves shall be piled together into a cold and lifeless mass, as exhausted warriors upon a battle-field, and stagnation and death settle upon the spent powers of nature.[38]

Shortly afterwards, in 1881, the psychologist Henry Maudsley offered a similar narrative of humanity's ultimate fate on Earth. The sun will gradually cool down until it has been completely "extinguished." Consequently,

> species after species of animals and plants will first degenerate and then become extinct, as the worsening conditions of life render it impossible for them to continue the struggle for existence; a few scattered families of degraded human beings living perhaps in snowhuts near the equator, very much as Esquimaux live now near the pole, will represent the last wave of the receding tide of human existence before its final extinction; until at last a frozen earth incapable of cultivation is left without energy to produce a living particle of any sort and so death itself is dead.

Years later, the German historian Oswald Spengler opined in his hugely successful 1918 book *The Decline of the West* that "entropy firmly belongs to the multifarious symbols of decline," and the sociologist Herbert Spencer, known for advocating the insidious theory of "social Darwinism," found himself "staggered" when he finally realized the Second Law's terminal consequences.[39] Perhaps no one summed up the resulting gloominess better than the hugely influential British philosopher and Nobel laureate Bertrand Russell. In a 1903 paper titled "Entropy and the Heat Death," Russell lamented that because of the Second Law,

> all the labors of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins.

The Second Law also captured the imagination of science fiction writers like Camille Flammarion and H.G. Wells. Flammarion himself did not believe that entropy would result in a lifeless *universe*—that is, he did not accept what the German physicist Hermann von Helmholtz called in 1854 the cosmic "heat death"—because he believed that the universe is infinite, so there will always be new worlds popping up here and there across cosmic time. (One can see the Principle of Plenitude at work in Flammarion's thought.) But Flammarion did firmly accept, based on "the science of mathematics," that the solar system's energy will someday be depleted, resulting in "absolute death" for all earthly lifeforms. He helped to popularize this idea in his 1894 *La fin du monde*, or *Omega: The Last Days of the World*, which begins with a fascinating exploration of scientific and religious responses to a comet that could destroy humanity. The mechanism of death is a flood of "carbonic-oxide," now called "carbon dioxide," that will rain down upon the planet. As one character declares: "But, gentlemen, the injurious properties of carbonic-oxide are

not the only ones to be feared; the mere tendency of this gas to absorb oxygen would bring about fatal results. To suppress, nay, even only to diminish oxygen, would suffice for the extinction of the human species." However, the second half of the novel ends with an eschatological account of how changing thermal conditions on Earth bring about our annihilation. As Flammarion describes this dreary end:

> Yes! all this progress, all this knowledge, all this happiness and glory, must one day be swallowed up in oblivion, and the voice of history itself be forever silenced. Life had a beginning: it must have an end. The sun of human hopes had risen, had ascended victoriously to its meridian, it was now to set and to disappear in endless night. To what end then all this glory, all this struggling, all these conquests, all these vanities, if light and life must come to an end? … Everything is doomed to decay, and death must remain the final sovereign of the world.

One year later, Wells published his celebrated novel *The Time Machine*. As we will see, Wells was a uniquely prescient futurist who founded the field of "Future Studies" in 1901 (discussed in chapter 6) and played an outsized role in inspiring novel thoughts about the existential precarity of *Homo sapiens* throughout the twentieth century, up to the present. In *The Time Machine*, Wells outlines the adventures of an anonymous character who builds a "time machine," a term that Wells himself coined. The final pages of the book describe the time traveler venturing more than 30 million years into the future to find "abominable desolation [hanging] over the world" due to the gradual dimming of the sun. "All the sounds of man," he says, "the bleating of sheep, the cries of birds, the hum of insects, the stir that makes the background of our lives—all that was over." As with *La fin du monde*, humanity falls victim to entropy's unforgiving dictatorship in the universe.

Hence, the early 1850s introduced, for the first time in human history, a kill mechanism that the scientific community as a whole accepted as real and believed would eventually lead to "eternal rest," as Helmholtz wrote. This was not idiosyncratic speculation but scientific fact. As Sir Arthur Eddington once put it, the Second Law "holds … the supreme position among the laws of Nature." This was not the first scientific idea to imply a frigid end to life on the planet. During the previous century, the French naturalist Comte de Buffon hypothesized that Earth is a fragment of the sun that had cooled off over the course of some 74,000 years.[40] He thus likened our planet to a "dying ember of the sun" that, as such, would become increasingly inhospitable due to "its gradual refrigeration, a reign of perpetual winter." (This was, in fact, one of the scenarios mentioned in 1816 by the anonymous "H" in the previous chapter.) Buffon was extremely influential during his time—"Truly," one scientist wrote, "Buffon was the father of all thought in natural history in the second half of the 18th century"[41]—yet his theory of Earth's origin and future did not hold sway. This was in part because many people believed that Earth could not be older than about 7,000 years. For example, according to a famous calculation by James Ussher, the ecclesiastical head of the Church of Ireland, God created the world on October 23, 4004 BCE. The idea that Earth might be more than eleven times as old was quite revolutionary for the period.

The point is that the Second Law made *credible* predictions about the future conditions of life on Earth, which made all the difference to the new existential mood. What was this new mood? A first-pass answer is this: an eschatological malaise that might best be termed *cosmic nihilism*: in the end, all will be lost, so says the fundamental laws of physics. As Russell eloquently stated in the paper quoted above, referring to the cheerless eschatology of thermodynamics:

> All these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of *unyielding despair*, can the soul's habitation henceforth be safely built (italics added).

Yet this interpretation of the Second Law's implications could not have arisen if not for another crucial development during the nineteenth century: the retreat of religion. The seeds of this shift are found in the Enlightenment of the previous century, which Jean le Rond d'Alembert, co-editor of the *Encyclopédie* with Diderot, described as "the century of philosophy *par excellence*." This was a period of great intellectual growth. Its motto was, in the immortal words of Kant, "*Dare to know!*" and "Have the courage to use your own understanding." Yet there were few outright atheists during the Enlightenment. Kant himself has traditionally been described as a Christian philosopher, although recent biographical scholarship disputes this,[42] and many leading thinkers adopted a *deistic* worldview according to which God created the universe but has not intervened since setting it in motion. This "clockwork universe" model arose from the work of Isaac Newton, which some historians identify as having initiated the Enlightenment. Deists of the period also tended to reject faith and revelation in favor of reason and evidence, and were consequently skeptical of certain aspects of the Bible. Thus, Thomas Jefferson created his own edition of the Good Book by excising every reference to Jesus's miracles and most references to supernatural phenomena. However, there were some explicit disbelievers during the eighteenth century Enlightenment, most notably Diderot. As the theologian Michael Buckley observes, "in many ways, Diderot is the first of the atheists, not simply in chronological reckoning but as an initial and premier advocate and influence."

Yet the philosophical shift away from faith and revelation toward reason and evidence did not lead to widespread apostasy, or atheism, among intellectuals until the nineteenth century. Most contemporary historians of the period concur that three factors in particular catalyzed this change: the emergence of historical and textual criticism, moral challenges to traditional Christian doctrine, and scientific breakthroughs like Darwinian theory.[43] The first pertains to new insights about the reliability of the biblical texts. It had been known since the work of John Mill in the early eighteenth century that the oldest extant copies of the New Testament contained a huge number of discrepancies. Mill himself counted more than 30,000 variants among 100 ancient texts, which was shocking to people at the time. But new insights the following century from "textual criticism" foregrounded and underlined the problematic implications of these textual variants. Considerations from "historical criticism" also cast doubt on biblical claims. For example, the Census of Quirinius, which brought Mary and Joseph to Bethlehem, occurred in 6 CE. This we know. But we also know from the first-century Jewish historian that Herod the Great, who ordered the Massacre of the Innocents in a futile attempt to murder the baby Jesus, died around 4 BCE. So the story could not have unfolded the way infallible scripture says. Both of the creation stories in Genesis and the crucifixion narrative engender similar chronological errors.

Second, evolving moral sensibilities led people to question the traditional conception of God as all-good and all-powerful. At first the primary issue discussed by scholars was how a perfectly loving God could sentence people to an eternity in hell for mere disbelief. How does the punishment fit the crime? Surely there must be some degree of *proportionality* between the two. This was later joined by what is now called the "Problem from Evil," which asks: how could any perfectly loving deity capable of any logically possible action allow so much—not to say *any*—evil in the world? Much of this evil is gratuitous, what theologians classify as "natural evil," meaning that there is no person, or "moral agent," responsible for the resulting harms to conscious beings. Examples of natural evils include hurricanes, tornadoes, earthquakes, outbreaks of infectious disease, falling trees, tumbling rocks, landslides, avalanches, crumbling cliffs, and cancer. (Think of the countless children who have died horrible deaths from leukemia and brain tumors.) Since the world is full of (natural) evil, and since the existence of evil is incompatible with a truly compassionate Creator, this Creator, if he/she/it exists, must not be truly compassionate. Hence the standard understanding of God's qualities must be wrong: maybe God is morally indifferent, or maybe he/she/it is downright evil.

The most formidable *scientific* challenge to Christianity in the nineteenth century came from Darwin's theory of evolution by natural selection. Darwin delineated this idea in his 1859 masterpiece *On the Origin of Species*, which amassed a Mount Everest of evidence for the claim

that species are not fixed types—the so-called "typological view" of species—but are constantly changing in response to their environment. He further argued that evolutionary change over time is shaped by the invisible hand of natural selection, which explains the *appearance* of "design" found in nature. Although few initially accepted the mechanism of natural selection (partly because Darwin did not have a good account of inheritance, a problem that persisted until Gregor Mendel's work was rediscovered in 1900 and subsequently integrated into evolutionary theory), Darwin did succeed in convincing large portions of the scientific community that evolution is a biographical fact about Earth-originating life. Some Christians at the time did not see the *Origin* as undercutting religion. For example, the Christian Socialist priest Charles Kingsley wrote (to Darwin) that he found Darwin's theory "just as noble a conception of Deity, to believe that He created primal forms capable of self-development ... as to believe that He required a fresh act of intervention to supply the *lacunas* which He Himself had made." But others quickly grasped the devastating implications of species mutability: since we arose gradualistically from earlier humanoid species—the Australopithecines, followed by *Homo habilis*, *Homo erectus*, and *Homo neanderthalensis*, according to modern anthropology—we are different in *degree* rather than *kind* from other creatures. Consequently, there is no unbridgeable *ontological gap* between human beings and the rest of nature.

While Darwin notes at the end of the *Origin* that there was "no good reason why the views given in this volume should shock the religious feelings of any one," he intentionally avoided the particular topic of human evolution. As he wrote in 1857—two years before the *Origin* was published—to the co-discoverer of natural selection, Alfred Russell Wallace, "I think I shall avoid the whole subject, as so surrounded with prejudices." Slightly more than a decade later, Darwin finally did confront the evolution of humanity head-on in *The Descent of Man* (1871). This explicitly affirmed that, indeed, humanity is "like every other species."[44] In Darwin's words,

> it is notorious that man is constructed on the same general type or model with other mammals. All the bones in his skeleton can be compared with corresponding bones in a monkey, bat, or seal. So it is with his muscles, nerves, blood-vessels and internal viscera. The brain, the most important of all the organs, follows the same law. … There is no fundamental difference between man and the higher mammals in their mental faculties.

Since Christian doctrine, or specifically what theologians call "Christian anthropology," is predicated on the idea that we exist *within* but *apart from* the natural order—we have immortal souls dwelling within us and were created in the image of God—these assertions imply that Christianity is false. The resulting injury to established religious dogma opened up new conceptual space for non-religious existential hermeneutics. This is important because without a secular perspective on the scientific developments of the nineteenth century, the Second Law would not have led intellectuals to link entropy with "unyielding despair," as Russell wrote. Indeed, Lord Kelvin himself was a devout Christian who both understood and *rejected* the long-term annihilatory entailments of the Second Law. As he wrote in an influential 1862 paper, "there is a universal tendency … which produces gradual augmentation and diffusion of heat, cessation of motion, and exhaustion of potential energy through the material universe." This means that "a state of universal rest and death, if the universe were finite and left to obey existing laws." Yet Kelvin vehemently added that it is "impossible to conceive either the beginning or the continuance of life, without an overruling creative power," which implies that "no conclusions of dynamical science regarding the future condition of the earth can be held to give dispiriting views as to the destiny of the race of intelligent beings by which it is at present inhabited." This contrasts of course with Russell's response, which was enabled by his fierce opposition to the Christian faith. (In a 1947 article, Russell says that he prefers the term "atheism" when talking to the general public, but "agnosticism" when speaking to other philosophers.) Darwin himself, although quite religious in his youth, to the point of embarrassment (on Darwin's own account), grew increasingly agnostic during his

later years. He thus came to espouse the same cosmic nihilism that animated Russell. For example, Darwin wrote in 1887 that

> with respect to immortality, nothing shows me how strong and almost instinctive a belief it is, as the consideration of the view now held by most physicists, namely, that the sun with all the planets will in time grow too cold for life, unless indeed some great body dashes into the sun and thus gives it fresh life. [This is one hypothesis, before radioactivity was discovered, of where the sun's energy comes from.] Believing as I do that man in the distant future will be a far more perfect creature than he now is, it is an intolerable thought that he and all other sentient beings are doomed to complete annihilation after such long-continued slow progress.

Darwin then observed that "to those who fully admit the immortality of the human soul, the destruction of our world [due to the Second Law] will not appear so dreadful." In other words, since God gave us immortal souls, we cannot go extinct in the sense that other creatures like the dodo and dinosaurs have.

Interestingly, I do not believe that Darwin ever once considered the possibility of human extinction caused by natural selection. This is peculiar, since Darwin believed both that *Homo sapiens* is no different than any other species *and* that "of the species now living, *very few* will transmit progeny of any kind to a far distant futurity."[45] (Today we know that 99.9 percent of all once-extant species are now extinct.) Darwin also affirmed that groups of people—or "races"—can "encroach on and replace each other, so that some finally become extinct," to which he adds, channeling the pervasive racism of the colonialist Victorian Era, that "at the present day civilized nations are everywhere supplanting barbarous nations."[46] On my count, the word "extinct" appears 118 times in the *Origin* and "extinction" 65 times, and indeed he pondered in 1839—twenty years before the *Origin*—that "certainly, no fact in the long history of the world is so startling as the wide and repeated extermination of its inhabitants." But apparently we are different, or so Darwin's silence implied. A similar point could be made about Wallace, who held that (in his words) "a vast number" of species have gone extinct and "races" of people can die out, yet he never entertained any thoughts about the possibility of human extinction, or at least not in writing, to my knowledge.

The point is that natural selection *could have* introduced a second scientifically credible kill mechanism in the 1850s. But it was likely blocked from recognition by several ideological assumptions: first, even though a growing number of intellectuals had shed the skin of religious belief, there was still the lingering conviction that humanity is the pinnacle of life. And it was difficult to imagine the pinnacle of life succumbing to the same evolutionary forces that were responsible for the extinction of mere beasts. Second, many were still influenced by the view, ossified by the Great Chain of Being, that there are "lower" and "higher" species. Hence, even though species are, on the Darwinian view, changeable rather than immutable, the general trend of evolution is upwards—from the lower to the higher. This *teleological* view, which historians call *progressionism*, is evident in Darwin's words above, and it implies that, given the first assumption, our future is one in which we may disappear but only by being replaced by "far more perfect creatures." Note that modern biology rejects teleology: there are no lower or higher forms, it claims, just species more or less well-adapted to their selective environments.

In sum, the decline of Church authority in the 1800s enabled a radical new existential hermeneutics to arise. As the science historian Spencer Weart notes, "it was in the early nineteenth century that ideas about the end of the world first began to separate from their original mythical and religious contexts, joining up instead with science." With this new Gestalt in place, the door was open to (re)interpreting all sorts of phenomena as posing secular threats to our collective survival. For example, Wells—who identified as an atheist—became worried that certain

natural hazards, like infectious disease agents, could jeopardize our earthly existence. Hence, he speculated in an 1894 article titled "The Extinction of Man" that

> the plagues of the Middle Ages, for instance, seem to have been begotten of a strange bacillus engendered under conditions that sanitary science, in spite of its panacea of drainage, still admits are imperfectly understood, and for all we know even now we may be quite unwittingly evolving some new and more terrible plague—a plague that will not take ten or twenty or thirty per cent, as plagues have done in the past, but the entire hundred.[47]

Wells was also one of the first to consider the possibility that humanity disappears because of "regressive" *devolution* rather than "progressive" *evolution*. For example, before venturing more than 30 million years into the desolate future, the anonymous traveler of *The Time Machine* arrives at 802,701 AD where he discovers that the human lineage has bifurcated into two distinct species: the *Eloi*, a beautiful but intellectually stunted species that lives above ground, and the *Morlocks*, a brutish subterranean species that provides goods to the Eloi, who they devour for sustenance on moonless nights. (Consequently, the Eloi are terrified of the new moon.) The traveler conjectures that this evolutionary split may have resulted from class divisions in society: the Eloi were the "Capitalists" and the Morlocks were the "Labourers." As Wells writes: "So, in the end, above ground you must have the Haves, pursuing pleasure and comfort and beauty, and below ground the Have-nots, the Workers getting continually adapted to the conditions of their labour." Yet over time the power dynamics flipped such that the Eloi became the livestock of the more intellectually vigorous Morlocks. Hence, over hundreds of thousands of years evolutionary forces had replaced humanity with two "lesser" species, one childlike and the other subhuman.

Like Wells, the British philosopher Olaf Stapledon explored the future of human evolution but on much grander timescales—over billions of years. An "agnostic mystic," his sprawling 1930 book *Last and First Men* traces the rise and fall of *eighteen* different species of humans, beginning with *Homo sapiens*, the "First Men." Global civilization eventually collapses due to "the sudden failure of the supplies of coal," which precipitates an economic disaster and "unprecedented psychological crisis." However, 100,000 years later a new civilization of First Men emerges, the "Patagonian Civilization," so-named because "complex climatic changes had rendered the southern part of South America a fit nursery for civilization." But this self-destructs after a "petty dispute" breaks out in one of the mines excavated for extracting metals and minerals that were no longer available near Earth's surface. Some of the rioters underground inadvertently initiate a cataclysmic explosion that propagates around the world, leaving the planet an uninhabitable wasteland except for "the Arctic and a few favoured corners of the sub-Arctic." The only human survivors are those stationed on an exploration ship in the Arctic ocean. These marooned explorers (twenty-eight men and only seven women) procreate and over the course of some ten million years post-catastrophe speciate into two new groups: one subhuman, ruled over by a more intelligent species of monkeys, and the other the Second Men. The First Men then go extinct.

Of note in this narrative is that the Second Men decide at some point in their journey that "it was time for man to take control of himself and remake himself upon a nobler pattern" via *artificial* evolution. Consequently, "two great works were set afoot, research into the ideal of human nature, and research into practical means of remaking human nature." A similar project was carried out by the Fourth Men. They recognized that the only way to surmount their inadequacies was through "the production of new individuals more harmonious than themselves"—a superior new race that would replace them in the theater of existence. This points to yet another novel idea enabled by the new hermeneutics: we could, as Darwin held, be replaced by more advanced beings through natural processes, or we could "degenerate" into various "lesser" species, as Wells depicts. *Or* we could usurp the role of natural selection to create a new species of "superhumans." This idea was, in fact, taken up by scientists like Stapledon's friend and admirer Sir Julian Huxley, an influential evolutionary biologist and atheist whose grandfather, T.H. Huxley, a vociferous

defender of Darwin's work, coined the term "agnosticism." Huxley himself added the word "transhumanism" to the English lexicon, which he defined as the view that "the human species can, if it wishes, transcend itself—not just sporadically, an individual here in one way, an individual there in another way—but in its entirety, as humanity." As he wrote in a 1927 book titled *Religion Without Revelation*,

> civilised man is beginning to realise that he can, if he so wishes, in large measure model the world in accordance with his desires. … [But] there is [an] extension of the same outlook to his own nature. … the study of heredity and population-growth, and the knowledge of eugenics and of birth-control are pointing the way to wholly new aims—to a conscious control by man of his own nature and racial destiny.

The word "eugenics" in this passage is important. As if the tangle of connections between people and neologisms wasn't thick enough already, it was Darwin's half-cousin Sir Francis Galton who introduced this term. Eugenics, which literally means "good birth," aims to improve the "human stock" by encouraging people with desirable qualities to reproduce while discouraging those with undesirable qualities from doing so. The most salient and horrifying case of eugenics in action was given to us by the Nazis, who force-sterilized more than 400,000 people and attempted to exterminate entire ethnic groups, most notably the Jewish people during the Holocaust, which the Jewish-French philosopher Emmanuel Levinas poignantly described as "the end of theodicy" given the immense gratuitous suffering that it caused men, women, and children. Yet in the early twentieth century, eugenics was widely endorsed by people on all sides of the political spectrum, as well as many religious believers. For example, white Protestant Americans worried that the higher birth rate among Catholic immigrants from Italy and Ireland, who were for a time considered "non-white," would overwhelm their communities. In fact, the Nazis drew explicit inspiration from the forced sterilization program that California implemented in 1909, which continued until 1963; anti-miscegenation laws, which criminalized interracial marriages, were not overturned in the US—the "melting pot"—until 1967. The rise of secularism opened the door to an alternative goal of eugenics: since species are plastic rather than immutable, and since *Homo sapiens* is a species like any other, we could use science and technology to create an entirely new species of superhumans, or what contemporary transhumanists call "posthumans." In this way, humanity would erase itself by drawing something better. This is an issue that we will return to in chapter 6, since transhumanism has played a central role in the most recent transition of existential moods.

The new existential hermeneutics also enabled worries that large-scale conflicts could bring about our collective demise, or at least the collapse of civilization. (Human extinction would of course entail civilizational collapse, although civilizational collapse need not entail human extinction.) This was especially the case after World War I (1914 - 1918), which was the first major war propelled by the *mechanization* of mass violence—think of the term "machine gun," which combines the hopeful ideas of progress, human ingenuity, and industrialization with the terrifying prospect of bloody homicide. Thus, an article published in the *Minnesota Alumni Weekly* one year after the war ended warns: "We cannot go farther on the road we have been taking; we have learned that. It would lead to ultimate human extinction. Because progress has furnished the key to destruction." Many intellectuals of the time couched this in terms of a *race* between wisdom and technology—that is, between our "know-how" and "know-why" or "know-what-for," as psychologist Erich Fromm later put it. For example, the (future) UK Prime Minister Winston Churchill—who boasted of having read every one of Wells's novels *twice*—penned a quite bleak article in 1924 titled "Shall We Commit Suicide?" He worried that the development of our moral character may be trailing behind our capacity to inflict catastrophic harm by means of the new death machines. In his words:

> Mankind has never been in this position before. Without having improved appreciably in virtue or enjoying wiser guidance; it has got into its hands for the first time the tools by which it can unfailingly accomplish its own extermination. … Death stands at attention, obedient, expectant, ready to serve, ready to share away the people *en masse*; ready, if called on, to pulverize, without hope of repair what is left of civilization.

The same year, British-Indian polymath—and eugenicist—J.B.S. Haldane made a similar point in arguing that "the future will be no primrose path. It will have its own problems. Some will be the secular problems of the past, giant flowers of evil blossoming at last to their own destruction. Others will be wholly new." Haldane then cautions that civilization's story could unravel unless we become a wiser species: "Whether in the end man will survive his ascensions of power we cannot tell. [The future] is only hopeful if mankind can adjust its morality to its powers." Hence, there emerged a general belief among some of the most prominent intellectuals and political leaders that hope is *conditional* upon humanity undergoing growth-spurt into our ethical adulthood. We are no longer children playing with matches but children playing with flamethrowers—quite literally. This comports with Moynihan's thesis that novel worries about human extinction, in the modern scientific sense, were tightly coupled to the Enlightenment notion of self-responsibility. On this view, there is no divine fatherly figure watching us from above, ready to protect us if we fail to protect ourselves. When God is in control, there is nothing to worry about; but when there is no God, or when God takes a deistic hands-off approach to human affairs, one cannot afford to take moral holidays.

We can now see how the existential mood of this period was qualitatively different from that of the previous period. The discovery of the Second Law in the 1850s and the secularization of intellectual culture throughout the century catalyzed new kinds of thoughts about the long-term fate of humanity in a hostile and morally indifferent universe. This fomented a deeply traumatic shift in the prevailing *Weltanschauung*: our species is mortal, just like the individual, and given enough time our annihilation is certain. The term "human extinction" is no longer oxymoronic. Many educated people struggled with this dispiriting realization. As Wells opened the article mentioned above about "the extinction of man": "It is part of the excessive egotism of the human animal that the bare idea of its extinction seems incredible to it"—an idea similar to the German philosopher Günther Anders's notion of "apocalyptic blindness," which arises from a "lack of imagination." The final paragraph then argues, with characteristic insight, that

> man's complacent assumption of the future is too confident. We think, because things have been easy for mankind as a whole for a generation or so, we are going on to perfect comfort and security in the future. We think that we shall always go to work at ten and leave off at four, and have dinner at seven for ever and ever. … Even now, for all we can tell, the coming terror may be crouching for its spring and the fall of humanity be at hand. In the case of every other predominant animal the world has ever seen, I repeat, *the hour of its complete ascendency has been the eve of its entire overthrow* (italics added).

In other words, our continued existence is not guaranteed—we are not existentially secure. The mood that fell out from these worries descended upon the west with a thump. Indeed, Russell was not the only major figure of the period to explicitly describe the resulting malaise of melancholia. The German neurologist who founded psychoanalysis, Sigmund Freud, also depicts the period's existential mood in his influential book *Civilization and Its Discontents* (1930). "Men have brought their powers of subduing the forces of nature to such a pitch," Freud writes, "that by using them they could now very easily exterminate one another to the last man."[48] Freud then claims that, referencing his contemporaries, knowledge of this hazardous predicament has elicited "a great part of their current unrest, their dejection, their mood of apprehension." (Freud himself,

we should note, was "an uncompromising atheist."[49]) This captures, with frightful clarity, the essence of this period's mood: unrest, dejection, apprehension, and unyielding despair. For the first time in western history, humanity came to recognize that it was *existentially vulnerable*.

Chapter 4: The Suicidal Species

The world is now too dangerous for anything less than utopia.—Buckminster Fuller

The threat of the apocalypse will be with us for a long time; the apocalypse may come.—Robert Oppenheimer

I know not with what weapons World War III will be fought, but World War IV will be fought with sticks and stones.—Albert Einstein

Speculations about how humanity could bring about its own demise date back millennia. We have always been anxious about tripping on our own shoelaces and falling off a doomsday cliff. The worldwide flood that wiped out the entire human population except for Noah and his family was brought on by humanity's corruption, and the Fifth Sun of Aztecan mythology will terminate, resulting in our annihilation, only if human sacrifices cease. In both cases, the fault was (or would be) our own. But the Industrial Revolution of the eighteenth and nineteenth century, along with the rise of secularism, stimulated a host of alternative thoughts about how we could stumble. Increasingly, these did not involve the wrath of supernatural deities but modern technologies and new scientific discoveries. Some future-oriented thinkers even went so far as to identify lone actors rather than large groups as the potential culprits. New apocalyptic scenarios were being concocted in the restless laboratory of the human mind.

For example, the very first account of technology *accidentally* destroying the world is found, according to the historian of physics Spencer Weart, in the 1862 novel *Five Weeks in a Balloon* by Jules Verne, who along with Wells has been lionized as the "Father of Science Fiction." As one of the book's characters, a Scotsman named Dick Kennedy, states, "By dint of inventing machinery, men will end in being eaten up by it! I have always fancied that the end of the earth will be when some enormous boiler, heated to three thousand millions of atmospheric pressure, shall explode and blow up our Globe!" Weart also claims that "the first extended treatment of an individual destroying the entire world" by himself was probably M.P. Shiel's *The Purple Cloud*, published in 1901. As discussed above, there were also newly emergent fears that another world war could bring about the total extinction of humanity. In fact, one survey found that before WWI, "two-thirds of fictional apocalypses had been due to natural causes" whereas "after 1914 two-thirds were caused by humans, and of these, three-quarters of the doomsdays came in world wars with scientific weapons."[50] As Haldane wrote in *DAEDALUS*, exactly one decade after the start of WWI, if there *were* to be a second world war, "human organization on a planetary scale may be rendered impossible. If so man-kind will probably have to wait for a couple of thousand years for another opportunity."[51] (Incidentally, Wells predicted that there would indeed be a second world war, and that it would commence in 1940. He was of course one year off.[52])

But there was no scientifically credible account of how individual humans or the collective whole could actually bring about our total destruction. No one was really worried about enormous boilers obliterating the planet, and concerns that another world war like the first could cause our extinction were a bit hyperbolic—not to mention Eurocentric, since there were large regions of the world that had been left untouched by that pointless conflict triggered by Gavrilo Princip (the most important person of the twentieth century that most people have never heard of). In fact, the mechanism of world destruction in *The Purple Cloud* is a miasma of poisonous gas belched out from the ground because the main character disobeys God by traveling to the North Pole.

This situation began to change in the early twentieth century. The story goes like this: for ages, alchemists had been trying to convert, or *transmute*, chemical elements into gold. Isaac Newton himself focused a considerable amount of energy on the issue, and some historians have even suggested that his occult studies may have had more personal value to him than his scientific labors. But transmutation was the stuff of legend, like the fountain of youth: crackpot claims

aside, no one had ever succeeded in turning one element into another, much less into gold, the most valuable precious metal. Then in 1902, the British physicists Frederick Soddy and Ernest Rutherford unlocked a secret about *radioactivity*, which had been discovered just a few years earlier, in 1896. When certain elements undergo radioactive decay, one type of atom transmutes into another type of atom. For example, uranium-238 decays into lead-206 over the course of billions of years, and thorium-228 decays into radium-224 in about two years. In fact, when Soddy and Rutherford realized this, Soddy exclaimed, "Rutherford, this is transmutation!" to which Rutherford shot back, "For Mike's sake, Soddy, don't call it transmutation. They'll have our heads off as alchemists!"

This groundbreaking discovery to a flurry of both utopian and apocalyptic speculations. For example, the two scientists hypothesized that a "planetary chain reaction," could obliterate the world by converting all of Earth's elements into new elements, such as helium. Consequently, as Weart notes, Soddy and Rutherford "provided the first superficially rational description of how a person might in fact destroy the world." Indeed, the French polymath Gustave Le Bon reported in 1903, with a heavy touch of sensationalism, that Rutherford had "playfully suggested to [him] the disquieting idea that, could a proper detonator be discovered, an explosive wave of atomic disintegration might be started through all matter which would transmute the whole mass of the globe into helium or similar gases." Other scientists picked up on this possibility, too. For example, the 1923 textbook *The Atom and the Bohr Theory of Its Structure*, which includes a foreword by Rutherford, considers "what would happen if it were possible to bring about artificially a transformation of elements propagating itself from atom to atom with the liberation of energy." How much energy? The answer comes from Albert Einstein's theory of special relativity, which asserts that mass is concentrated energy—that is, they are not two distinct categories of fundamental cosmic stuff, but *equivalent*. However, the amount of energy per unit of mass is *huge*, as expressed by Einstein's famous equation "$E = mc^2$." This means that the energy (E) equals the mass (m) multiplied by the *square of the speed of light*, which is 186,282 (miles per second). Thus, as the book puts it, "the quantities of energy which would be liberated in this way would be many, many times greater than those which we now know of in connection with chemical processes." It continues:

> There is then offered the possibility of explosions more extensive and more violent than any which the mind can now conceive. The idea has been suggested that the … catastrophes represented in the heavens by the sudden appearance of very bright stars [called "novae"] may be the result of such a release of sub-atomic energy, brought about perhaps by the "super-wisdom" of the unlucky inhabitants themselves. But this is, of course, mere fanciful conjecture.

Yet the following decade, the wife-and-husband team of Irene and Frédéric Joliot-Curie devised a way to artificially *induce* stable elements into becoming radioactive atoms. This was a startling discovery because, to quote Weart, it "looked like a step toward *contagious* radioactivity, the fateful chain reaction that Soddy and Rutherford and wondered about decades earlier" (italics added). It also resulted in the Joliot-Curies being awarded the 1934 Nobel Prize (note that Irene was the daughter of Marie and Pierre Curie, who themselves won the Nobel Prize in 1903 for their work on radioactivity). In his acceptance speech, Frédéric explicitly warned of the possibility of artificial transmutation bringing about a worldwide catastrophe, also referencing the occasional brilliant explosions observed in the nighttime sky through telescopes:

> If such transmutations do succeed in spreading in matter, the enormous liberation of usable energy can be imagined. But, unfortunately, if the contagion spreads to all the elements of our planet, the consequences of unloosing such a cataclysm can only be viewed with apprehension. Astronomers sometimes observe that a star of medium magnitude increases suddenly in size; a star invisible to the naked

> eye may become very brilliant and visible without any telescope—the appearance of a Nova. This sudden flaring up of the star is perhaps due to transmutations of an explosive character like those which our wandering imagination is perceiving now—a process that the investigators will no doubt attempt to realize while taking, we hope, the necessary precautions.

By the 1930s, the idea of a runaway atomic experiment, as discussed by the textbook and Frédéric, had become so widespread that even many children were aware of it.[53] On the utopian side, speculations were equally extreme. For example, Soddy calculated in 1904, just a single "pint bottle of uranium contained enough energy to drive an ocean liner from London to Sydney and back."[54] Four years later, he declared that "a race which could transmute matter would have little need to earn its bread by the sweat of its brow. Such a race could transform a desert continent, thaw the frozen poles, and make the whole world one smiling Garden of Eden."

Yet there was no practical means of liberating, in a controlled manner, the huge quantities of useable energy—"*atomic energy*," as it was called—bottled up within the nuclei of atoms to power ocean liners, turn deserts into lush forests, warm up the poles, and so on. Consequently, some scientists became increasingly skeptical as the decades passed about the jubilant promises once made about radioactivity. For instance, a 1933 *New York Times* article titled "Rutherford Cools Atom Energy Hope" quotes a famous assertion by Rutherford, made during a lecture in London, that "anyone who says that with the means at present at our disposal and with our present knowledge we can utilize atomic energy is talking moonshine." The reason is that, the article explains, "walls of electric energy surround the nucleus. To break down wall after wall and eventually reach the holy of holies in which almost incredible energy is concentrated, the physicist must lay siege to the atom. So he tries to batter it and blast it apart" by shooting Alpha particles (a type of helium) at the nuclei. The problem is that even in massive, immensely powerful particle accelerators, only "one particle in 10,000,000 strikes the nucleus." It appeared increasingly certain that there was no way of harnessing atomic energy after all—meaning no threat of some omnicidal "madman" converting Earth into helium but also no utopian world powered by an "inexhaustible" source of energy, as Soddy put it.

This changed when a young physicist from Budapest—who had, incidentally, nearly died in 1918 during the Spanish flu pandemic, a global catastrophe—named Leo Szilard happened to have attended Rutherford's lecture. The "moonshine" statement irritated him, and while waiting for the lights to change at a London street corner that same day, devised a way to unlock atomic energy via what is now called a "*nuclear chain reaction*." The idea involved a subatomic particle called a "neutron," which had been discovered just the previous year, in 1932. If a single neutron were to react with an atom such that the atom then releases two neutrons, then the process could become *self-propagating*. In the process, huge amounts of energy would be released. But how exactly could this be accomplished? Which chemical element might release neutrons when perturbed in the right way? The answer to the second question came from Frédéric Joliot-Curie and colleagues, who discovered that atoms of *uranium* would release enough neutrons under the right conditions to propagate a chain reaction. The answer to the first was found in 1938 with the discovery of *nuclear fission*. To be clear about all of these scientific ideas: radioactive decay occurs naturally with certain elements. And artificial radioactivity involves bombarding an atom with Alpha particles until it becomes a single new atom that is then radioactive. Fission is different. It occurs when a single atom transmutes into *two* elements—in the case of uranium, it becomes krypton and barium. In the process, it releases more neutrons, which react with other uranium atoms, converting them into krypton and barium as well. And so on.

Suddenly, releasing the huge stores of atomic energy contained in atomic nuclei became conceivable. Whereas natural radioactivity releases this energy over long stretches of time, a nuclear chain reaction involving the self-propagating fission of uranium atoms would do this in an *instant*. In fact, also on Szilard's mind that day in 1933 was a 1913 book by Wells, *The World Set Free*, which he had been reading. In it, Germany invades France, and the ensuing conflict in-

volves pilots dropping what Wells called, coining the term, "atomic bombs" that produce "a blazing continual explosion." These bombs used a fictional radioactive element called "Carolinum" to unleash unprecedented destructive violence. As Wells wrote, "once its degenerative process had been induced, [Carolinum] continued a furious radiation of energy, and nothing could arrest it." Wells's futurological ruminations once again proved to be fecund—and prescient. Although the mechanism by which these atomic bombs exploded was different, the idea played an important part in stimulating Szilard's extraordinary insight, which would soon change the world forever. Several years later, in 1942, Szilard and a colleague initiated the first nuclear chain reaction in uranium. At first, the experiment failed, but this was because, as Szilard's colleague soon realized, one of the machines was not plugged in. After fixing this rather comical error, they succeeded—which deeply worried Szilard. As Szilard later wrote about the incident: "We turned the switch and saw the flashes. We watched them for a little while and then we switched everything off and went home. … That night, there was very little doubt in my mind that the world was headed for grief."

With the advent of World War II, Szilard's fears about this new knowledge being weaponized came into sharp focus. If Nazi Germany were to build a nuclear weapon before the Allied Forces, the war—the first genuinely *global war*—would likely have ended with a victory for Hitler.[55] (Note that many in the US did not initially oppose Hitler's regime. After all, pro-eugenic and anti-semitic attitudes were widespread, at least among the white population. Hence, the US did not become involved until after Japan surprise-bombed Pearl Harbor.) These concerns prompted Szilard to write a confidential letter to President Franklin D. Roosevelt, signed by Einstein, in 1939. In fact, when Szilard initially explained to Einstein how the conflict could end if the Nazis reached the nuclear finish line first, Einstein replied with consternation: "I did not even think about that." With the support of Einstein, who at that point had become one of the most famous scientists in history, the letter catalyzed the formation of the Manhattan Project, a two-billion-dollar effort to build the first nuclear weapon ($23 billion in 2018 dollars) that involved 130,000 scientists, although only a handful knew about the project's ultimate, and ominous, aims. (Einstein himself was not granted clearance to contribute because he was deemed a security risk.)

The Manhattan Project was directed by the physicist Robert Oppenheimer, a brilliant child prodigy, workaholic, and chainsmoker who was known to consume between four and five packs of cigarettes a day. After years of arduous research, the first atomic bomb was detonated in the desert of Jornada del Muerto, which is sometimes translated from Spanish as "Journey of the Dead Man." Upon witnessing the spectacular explosion, which produced a terrifying ball of smoke and fire that rapidly ascended 40,000 feet into the early morning sky, at 5:29 am, Oppenheimer later recalled that "a few people laughed, a few people cried, most were silent." Oppenheimer himself claimed to have quietly recited a haunting passage from the *Bhagavad-Gita*, a Hindu scripture: "Now I am become Death, the destroyer of worlds." However, the first time Oppenheimer mentioned this was in 1948, and according to his brother, Frank, what he may have actually said immediately after detonation was: "It works." As it happens, months before the test was conducted, Oppenheimer opined to Szilard that "the atomic bomb is shit." Why? Because the atomic energy that it was anticipated to release would be so immense that it would not be practically "useful in war." Even more discomfiting, some Manhattan Project physicists had worried prior to the first atomic bomb explosion could initiate a self-sustaining nuclear chain reaction in the atmosphere and oceans, thus resulting in the total destruction of all human life, and perhaps the biosphere. This resulted in a 1942 report on the issue that has been described as the very "first quantitative risk assessment of human extinction." It found that this atmospheric/oceanic chain reaction would *probably* not occur, although it ended with a rather unnerving sentence: "The complexity of the argument and the absence of satisfactory experimental foundations makes further work on the subject highly desirable" (Teller and Konopinski 1946). Of course, if the report's conclusions had been wrong, there would be no one around to talk about its conclusions having been wrong.

The first atomic bomb used in combat was dropped on Hiroshima, Japan, just one month later: August 6, 1945. Newspapers reported the blast with lurid bursts of apocalyptic dread. For example, a typical headline of the time declared that Hiroshima had been annihilated by a "cosmic power … hell-fire … described by eyewitnesses as Doomsday itself!"[56] Photographs of the carnage were soon published by the *New York Times*, and after being apprised of the devastating loss of human life in this single act of catastrophic violence, Einstein lamented: "I could burn my fingers that I wrote that first letter [authored by Szilard] to President Roosevelt." Three days after the obliteration of Hiroshima, the US dropped a second bomb on Nagasaki, which forced the surrender of Imperial Japan on August 15. The *second world war* predicted by H.G. Wells and written about with trepidation by Haldane and others was over. Yet the catastrophic conclusion of this conflict also marked the beginning of two new portentous eras: the Atomic Age and a period of militarized peace called the Cold War.[57] The Atomic Age in particular, as the German philosopher Günther Anders observed, brought about a qualitative shift "in the history of barbarism where the human species in its entirety could be eliminated through catastrophic violence." Whereas the Holocaust showed that "all people are killable," Anders argued, the bombings of Hiroshima and Nagasaki established that "humanity as a whole is killable."[58] So momentous was this event that Anders proposed a new calendar periodization in which August 6, 1945, was "Day Zero" (just as Jesus' birth was supposed to coincide with the split between "BC" and "AD"). Hence, he declared in 1958 that "we live in the Year 13 of the Calamity. I was born in the Year 43 before. Father, who I buried in 1938, died in the Year 7 before."

The primary locus of nuclear fear at first was the immediate effects of a nuclear explosion: the intense heat, vaporization of objects in the vicinity, and fires. Of these, the blast was the most widely emphasized. For example, in a radio announcement delivered 16 hours after Hiroshima was razed to the ground, President Harry Truman boasted that the atomic bomb harnesses "the basic power of the universe. The force from which the sun draws its power has been loosed against those who brought war to the Far East," and that its explosive power was "more power than 20,000 tons of TNT. It had more than two thousand times the blast power of the British 'Grand Slam,' which is the largest bomb ever used in the history of warfare." What was intentionally *not* discussed by US officials was the threat posed by *radioactive fallout*. In Hiroshima and Nagasaki, this monstrosity took the form of a "sticky, dark, dangerously radioactive water" that began to descent from the sky 30 to 40 minutes after the bombs exploded. This "black rain … not only stained skin, clothing, and buildings, but also was ingested by breathing and by consumption of contaminated food or water." As a result, many people suffered from *radiation sickness*, which was also initially referred to as "atomic bomb illness" and "atomic plague." Yet the nature of this pathological condition initially baffled Japanese doctors, with some noting rumors of "a poison gas or deadly germ had been loosed in Hiroshima … Perhaps a gas bomb had been dropped."[59] Meanwhile, US officials feared that radiation produced by the atomic bombs would be linked to chemical and biological weapons, which both civilian and military groups strongly objected to—a PR nightmare in the making.

Yet some scientists had warned early on that an all-out nuclear exchange could litter Earth's surface with deadly amounts of radioactive particles, which release ionizing radiation when they decay that can cause cancer, birth defects, and other maladies. Worries about radiation actually predate the invention of nuclear weapons. For example, the Nobel laureate Herman Muller, known for his work on *mutagenesis*, had warned in the early 1930s that exposure to x-rays, such as at the dentist's office, could threaten the future of humanity by contaminating the "germ plasm" within our bodies. "We must remember," he wrote in 1933, "that the thread of germ plasm which now exists must suffice to furnish the seeds of the human race even for the most remote future. We are the present custodians of this all important material and it is up to us to guard it carefully and not contaminate it." Thus, a nuclear exchange could potentially bring about the "erosion" of this delicate genetic material, thereby turning future generations into grotesque mutants. But for the entire human species to be affected by radioactive fallout—for genetic mutations in our germline to threaten our continued survival on Earth—its effects would

need to be *global* in scope. And it was not clear after Hiroshima and Nagasaki that this was possible.

This changed rapidly after a thermonuclear test called "Castle Bravo" was conducted on Bikini Atoll, a coral reef surrounding a central lagoon in the Marshall Islands. The detonation occurred two years after the first thermonuclear weapon, or *H-bomb* (sometimes translated as "Hell bomb" rather than "hydrogen bomb"), was built and detonated by the US. Such weapons are far more powerful than atomic weapons; for example, the most powerful thermonuclear weapon ever detonated, the Tzar Bomba, was more than 10 times more powerful than *all* the conventional explosives used in WWII and 3,000 times more powerful than the bomb dropped on Hiroshima. It was in fact the development of thermonuclear weapons that led the venerable *Bulletin of the Atomic Scientists* to move the minute hand of their iconic Doomsday Clock, created in 1947 to inform the public about our collective proximity to annihilation, a mere two minutes before midnight, or doom. The minute hand remained at this setting until 1960, when the *Bulletin* pushed it back to the slightly less terrifying time of seven minutes before midnight.[60] (Note that two minutes was the closest the clock ever inched toward midnight until 2020, when it was set to only 100 seconds before doom.)

The Castle Bravo test occurred on March 1, 1954, and produced an explosion 2.5 times *greater* than what scientists had calculated. Radioactive soot was catapulted into the stratosphere, and the residents of a downwind island, Rongelap Atoll, had to be evacuated; many came down with radiation sickness. The detonation also rained down radiation on a Japanese fishing vessel, resulting in an international incident after the crew became ill and one person died. But even more alarming than this, the debacle confirmed suspicions that radioactive fallout could spread over large regions of Earth's surface. For example, scientists from Japan detected trace amounts of radioactivity thousands of miles across the Pacific ocean, and "in some cases the isotopes became concentrated as they worked their way up through food chains, so that a fish could be much more radioactive than the surrounding water." Scientists thus "began to warn the world of a new reality: a human act at one locality could physically affect the environment across vast distances."[61] Indeed, the thermonuclear tests conducted in the 1950s left an indelible mark in the geological record: a thin layer of artificial radionuclides that blanketed the entire planet due to fallout. This layer, in fact, is one of the leading contenders for dating the recently proposed geological epoch called the "Anthropocene." If aliens were to discover Earth in a million years, their geologists would find this layer underground and realize that we had discovered the secret to splitting the atom. They might also conclude that we disappeared because of it.

The Castle Bravo disaster threw both the public and the intellectual community into a frenzied state of apocalyptic anxiety. This is why I date the beginning of the present period to be 1954 rather than 1945.[62] With the spread of radioactive particles across vast stretches of Earth's trembling surface, scientists and public alike came to recognized as a scientifically credible kill mechanism, thus making possible, for the first time in history, human *self*-annihilation. As Bertrand Russell and Albert Einstein worried in their co-authored "manifesto," issued in 1955 shortly after Einstein's death,

> it is stated on very good authority that a bomb can now be manufactured which will be 2,500 times as powerful as that which destroyed Hiroshima. Such a bomb, if exploded near the ground or under water, sends radio-active particles into the upper air. They sink gradually and reach the surface of the earth in the form of a deadly dust or rain. It was this dust which infected the Japanese fishermen and their catch of fish. No one knows how widely such lethal radio-active particles might be diffused, but the best authorities are unanimous in saying that a war with H-bombs might possibly put an end to the human race. It is feared that if many H-bombs are used there will be universal death, sudden only for a minority, but for the majority a slow torture of disease and disintegration.

They add that these "best authorities" hold views about the issue not based "in any degree upon their politics or prejudices." Rather, "they depend only, so far as our researches have revealed, upon the extent of the particular expert's knowledge. We have found that the men who know most are the most gloomy."[63] The following year, President Dwight D. Eisenhower wrote a letter about the nuclear arms race between the US and Soviet Union. His tone was hopeful but unequivocally bleak:

> When we get to the point, as we one day will, that both sides know that in any outbreak of general hostilities, regardless of the element of surprise, destruction will be both reciprocal and complete, possibly we will have sense enough to meet at the conference table with the understanding that the era of armaments has ended and the human race must conform its actions to this truth or die.

Many other political figures made comparatively dire comments over the next few decades. For example, the US Secretary of State Henry Kissinger answered a question from a reporter in 1974 with the observation that "the accumulation of nuclear arms has to be constrained if mankind is not to destroy itself. This is a question that will be before humanity under all circumstances, and before American governments, as long as the accumulation of nuclear arms continues." And President Jimmy Carter, in 1981, wrote that

> in an all-out nuclear war, more destructive power than in all of World War II would be unleashed every second during the long afternoon it would take for all the missiles and bombs to fall. A World War II every second. … The survivors, if any, would live in despair amid the poisoned ruins or a civilization that had committed suicide.

Similar sentiments were expressed by government officials in the Eastern Bloc, too. For example, the Soviet Union printed a booklet in 1981 that contained the following cautionary remarks: "The Soviet Union holds that nuclear war would be a universal disaster, and that it would most probably mean the end of civilization. It may lead to the destruction of all mankind."[64]

While Russell had previously waxed poetic about the dismal long-term implications of the Second Law, he and many others were now fixated on the very real possibility of *near-term* extinction, or as Russell liked to call it, "universal death." In his 1960 book *Has Man a Future?*, Russell nervously pondered whether, in this new epoch of unprecedented destructive capabilities, humanity was writing the "prologue" or "epilogue" of its autobiography. Perhaps the final paragraph of our story will begin with the sentence, "And then humanity unlocked a secret about the universe that it was not responsible enough to know."

Over the years, people proposed a creative array of additional kill mechanisms associated with nuclear weapons. There were, as one might expect, plenty of unscientific claims about the potential effects of nuclear explosions. For example, people linked them to earthquakes and strange weather halfway around the globe. In 1957, the first secretary of the Communist Party of the Soviet Union, Nikita Khrushchev, reportedly stated that he had a bomb that could "melt the Arctic icecap and send oceans spilling all over the world."[65] A year earlier, Estes Kefauver, the Democratic vice presidential candidate in 1956, claimed that thermonuclear weapons could "right now blow the earth off its axis by 16 degrees."[66] There were also speculations "that a sufficiently large number of nuclear weapons wrapped in cobalt would, when detonated, render the Earth's surface uninhabitable for five years." This "cobalt bomb" was initially proposed by Szilard in 1950, and it soon yielded worries about the possibility of building a "doomsday device" or "doomsday machine." In fact, Edward Teller—the physicist who first raised concerns about a self-sustaining nuclear chain reaction initiated by an atomic bomb—was said to have had, in his Los Alamos office, a blackboard on which he listed various hypothetical nuclear weapons. The most potentially devastating identified the method of delivery for the bomb as simply

"Backyard." The reason was that, according to the Manhattan Project physicist Robert Serber, "since that particular design would probably kill everyone on Earth, there was no use carting it anywhere."

Incidentally, a futurist who had worked for the RAND Corporation named Herman Kahn insisted in his 1960 book *On Thermonuclear War* that the US should seriously consider setting up a doomsday machine to deter a preemptive strike by the Soviet Union. This proposal, which caused a furor, inspired the black comedy *Dr. Strangelove or: How I Learned to Stop Worrying and Love the Bomb*, released in 1964. The movie ends with a terrifying montage of nuclear explosions occurring around the world while the British singer Vera Lynn poignantly sings, "Keep smiling through. Just like you always do. 'Till the blue skies drive the dark clouds far away." According to public records, no state has ever built a cobalt bomb, although the Soviet Union did establish a system, known as "Dead Hand," that would automatically launch a barrage of (nuclear) intercontinental ballistic missiles at the US in case of a preemptive attack. There is some speculation that Russia never discontinued the program.

But there was another effect, initially unrecognized, of nuclear explosions that *could* have plausibly threatened human survival, too: ozone depletion. The hypothesis that nukes could deplete the ozone layer, a 3-millimeter-thick blanket in the stratosphere that protects all biological life from DNA-mutating ultraviolet light, gained prominence after it was discussed in a textbook titled *Ecoscience: Population, Resources, Environment* (1970), written by Paul and Anne Ehrlich in collaboration with the scientist John Holdren, who later advised the Obama administration on science and technology issues. This led the Arms Control and Disarmament Agency (ACDA) to publish a book in 1975 titled *Long-Term Worldwide Effects of Multiple Nuclear-Weapons Detonations*, which "confirmed the potential for stunning impoverishment of ozone in the stratosphere."[67] The discovery of another credible kill mechanism thus made the ACDA's director at the time to worry that there could be who-knows-how-many *additional* scenarios that scientists have no yet identified. As he put it in a speech delivered to the Chicago Council on Foreign Relations: "The more we know, the more we know how little we know. … Each of these discoveries tore a hole in the facile assumptions that screened the reality of nuclear war. Each brought a new glimpse into the cauldron of horrors. What unexpected discovery will be next?"

But the most significant new development involved the what the atmospheric scientist Richard Turco called the "nuclear winter" hypothesis. This was first outlined in a 1983 paper coauthored by a team of five scientists: Turco, Owen Toon, Thomas Ackerman, James Pollack and Carl Sagan, and hence is dubbed the "TTAPS" paper. The abstract begins with an affirmation of the dangers posed by radioactive fallout, which lost ground in discussions of nuclear conflict since the 1960s: "In a 5,000-megaton war, at northern mid-latitude sites remote from targets, radioactive fallout on time scales of days to weeks can lead to chronic mean doses of up to 50 rads [i.e., a unit of absorbed radiation dose] from external whole-body gamma-ray exposure, with a likely equal or greater internal dose from biologically active radionuclides." But the new and original idea was that "for many simulated exchanges of several thousand megatons, in which dust and smoke are generated and encircle the earth within 1 to 2 weeks, average light levels can be reduced to a few percent of ambient and land temperatures can reach -15° to -25°C." To fill in the details here, the idea is this: a nuclear war could initiate multiple urban *firestorms*, or conflagrations so intense that they generate their own gale-force winds. (This is actually what happened in Hiroshima, and it was the primary reason that so many people died.) The resulting bubble of heat could then transfer soot into the stratosphere, a layer of the atmosphere above the troposphere, which is where clouds and the droplets that become rain form. This matters because rain removes aerosols from the atmosphere, meaning that soot in the stratosphere can remain aloft, and spread around the globe, for long periods of time. If this were to happen, it would block out incoming sunlight, rendering the midday skies literally pitch-black and causing surface temperatures to plummet. Global agriculture would subsequently collapse and huge numbers of people would starve to death. Humanity could very well go extinct.

The same year, Carl Sagan used his status as a popular celebrity scientist—his 1980 *Cosmos* series on PBS was a smash hit that catapulted him to stardom—to alert the public of this possibility via two articles, one published in the magazine *Parade*, which had more than 10 million subscribers, and the other in *Foreign Affairs*. In the latter he wrote that

> there is little question that our global civilization would be destroyed. The human population would be reduced to prehistoric levels, or less. Life for any survivors would be extremely hard. And there seems to be a real possibility of the extinction of the human species.

Previous scientists had actually expressed similar worries. For example, the biologist Tom Stonier, in his 1964 book *Nuclear Disaster*, calculated the quantity of soil (rather than soot) that a nuclear explosion could inject into the stratosphere, and examined historical data of cooling periods following volcanic eruptions, which can inject ash into the stratosphere, as occurred during the aforementioned Tambora eruption of 1815. Stonier concluded that "although radioactive fallout could inflict a great ecological catastrophe, it could not change the climate. Other debris injected into the atmosphere from explosions, however, did have the potential to do this."[68] The book mentioned above by Ehrlich and co-authors also "pointed to explosive dust injections and smoke from huge fires as potential engines of regional and global climate change." And Stephen Schneider, a climatologist at Stanford University, conjectured after this that "ozone depletion and dust injections into the stratosphere might cause Earth's surface to cool from a fraction of a degree to a few degrees Celsius."[69] This may not sound like much, but the temperature differences between the glacial and interglacial periods of the Pleistocene were never any greater than about 4 degrees C.

However, these warnings were, as the historian of physics Lawrence Badash puts it, little more than "hand-waving" at the time. In contrast, the TTAPS paper utilized cutting-edge research on the climatic effects of volcanic eruptions, dust storms on Mars, haze in the Arctic, and new ideas about how the dinosaurs went extinct 66 million years ago (discussed in the next chapter), some of which was facilitated by advancements in digital computer simulations, to make a scientifically robust case that a nuclear winter really could occur. Consequently, the idea of "mutually assured destruction" (MAD) that described the interstate dynamics of the Cold War up to then—basically, "if you destroy me, I will destroy you in response, so there is no point in destroying me"; some have thus argued that *nuclear weapons* should have received the Nobel Peace Prize—was replaced with the idea of "self-assured destruction" (SAD)—basically, "if you try to destroy me in one fell swoop and I *don't* retaliate, you will likely destroy yourself." Anti-proliferation activists had claimed many times that a nuclear war was unwinnable, but now the best science of the time backed this up.

Ehrlich himself was, despite his strong opposition to nuclear proliferation, skeptical that a nuclear war could cause our extinction. But in 1983, after the TTAPS paper was published, he organized a conference to examine the "long-term biological consequences of nuclear war." This changed his mind. Consequently, he wrote with others (one of whom was Sagan) in a book that was born from the conference that

> it was the consensus of our group that, under those conditions, we could not exclude the possibility that the scattered survivors simply would not be able to rebuild their populations, that they would, over a period of decades or even centuries, fade away. In other words, we could not exclude the possibility of a full-scale nuclear war entraining the extinction of *Homo sapiens*.

Suddenly, radioactive fallout no longer appeared to be the most serious threat. It was replaced by the nuclear winter scenario, in which emaciated people around the world succumb to hunger on a freezing planet in perpetual nighttime. In fact, a Google Ngram search of "human extinction" re-

veals a huge spike in the frequency of this term during the 1980s, peaking between 1984 and 1985. For scientists and the public alike, a secular apocalypse brought on by an unfortunate combination of scientific genius and the fatuity of politics never looked so real, or close.

But our existential situation was worse than this. In a 1962 book titled *The Silent Spring*, Rachel Carson, a brilliant scientist who died at the relatively young age of 54 after battling breast cancer, argued that synthetic chemicals, such as DDT and other insecticides developed from the 1940s onwards, were poisoning humanity and destroying the biosphere. Although there had been environmentalists for some time—names like Henry David Thoreau, who lived in a small cabin around Walden Pond in Massachusetts, and John Muir, whose writings helped establish Yosemite National Park, may come to mind—this book more or less single-handedly initiated the *modern* environmentalist movement, which continues today through global movements like Extinction Rebellion and School Strike for the Climate. As a review from the *New York Times* described Carson's book: "Miss Carson's cry of warning is timely. If our species cannot police itself against overpopulation, nuclear weapons, and pollution, it may become extinct." In fact, Carson was explicit about this possibility, writing that

> along with the possibility of the extinction of mankind by nuclear war, the central problem of our age has ... become the contamination of man's total environment with such substances of incredible potential for harm—substances that accumulate in the tissues of plants and animals and even penetrate the germ cells to shatter or alter the very material of heredity upon which the shape of the future depends.

Although Carson did not discuss anthropogenic climate change, her book was released around the time that scientists voiced the first concerns that carbon dioxide (CO2), a byproduct of burning fossil fuels, could alter the global climate. For example, in 1965, while President Lyndon Johnson was in office, climate scientists warned the US government that "the climate changes that may be produced by the increased CO2 content could be deleterious from the point of view of human beings." This was based on research going back to the 1600s, when the thermometer was invented, which enabled daily temperature fluctuations to be recorded; some of these records "were published in the earliest scientific journals." A few centuries later, in 1859—the year Darwin published the *Origin*—the influential Irish physicist John Tyndall demonstrated that complex molecules can absorb thermal radiation (heat), noting that "changes in the amount of any of the radiatively active constituents of the atmosphere such as water … or CO2 could have produced 'all the mutations of climate which the researches of geologists reveal.'" In other words, the glacial periods of the Pleistocene may have resulted from changes in atmospheric chemistry, a point also made by the Swedish chemist Avant Arrhenius, who proposed in 1896 that "a 40 percent increase or decrease in the atmospheric abundance of the trace gas CO2 might trigger the glacial advances and retreats."[70] A rise in the surface temperature of Earth has been observed since the 1830s, but it was the introduction of gasoline-powered automobiles in the early twentieth century that precipitated a spike in CO2 emissions. Humanity thus began to alter the chemical content of the atmosphere at a rate that, on geological timescales, was extremely sudden. Scientists took note and, having understood the basics of the greenhouse effect since the nineteenth century, began to worry. Unfortunately, although there is overwhelming agreement among scientists around the world that we are in the midst of a climate emergency, there are still climate-deniers today who claim that the anxious screams of climate scientists are part of a worldwide hoax designed to increase personal wealth by making it easier to get research grants.

Other scientists began to focus on the environmental consequences of human overpopulation. As the strategy consultant and policy analyst Rupert Darwall wrote in 2013, "with a decade" of Carson's book, "the notion that mankind's pillaging of the planet was leading to an environmental catastrophe—risking man's extinction —had taken hold." And according to the existential risk scholar Simon Beard, within three decades after WWII, "the combination of the demographic

Baby Boom and the post-war Economic Miracle lead to a huge increase in the size of humanity's impact on the planet with some pollutants increasing by 900 percent."[71] The loudest alarm bells came from the 1968 book *The Population Bomb*, by Ehrlich and his wife, Anne, and a book four years later titled *The Limits to Growth*, published by the Club of Rome. The first, which at times reads like a thriller, famously prognosticated mass starvation in the 1970s and 1980s. The second "examined the five basic factors that determine, and therefore, ultimately limit, growth on Earth —population, agricultural production, natural resources, industrial production, and pollution." It concludes that

> if the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity.

Note that, at the time, there were around 3.5 billion people on the planet. Today, as of this writing, there are 7.8 billion—more than double the number *just a few decades ago*. Indeed, *The Limits to Growth* emphasized that understanding the most likely future outcomes requires a grasp of exponential (or geometric) trends, which the human mind is not well-suited for. (A former professor of mine, Christopher Cherniak, used to say, "Humans are the opposite of computers: we are qualitative geniuses but quantitative imbeciles," meaning that we excel at things like recognizing faces, yet fail to grasp the *enormous* difference between, say, 10^{10} and 10^{11}.) The authors thus retell an old Persian legend about a courtier who presents a chessboard to his king, asking in return for one grain of rice for the first square, two grains for the second, four for the third, and so on. The king, not understanding the explosive nature of exponentials, agrees, and by the fortieth square, the king has to order a *million million* grains of rice from his storerooms, thus depleting his entire supply. "Exponential increase is deceptive," the authors conclude, "because it generates immense numbers very quickly." The point is that the exponential growth of the human population, which may lead to exponential increases in environmental degradation and require exponential increases in food production, could be, as the Erhlichs warn, a ticking time bomb.

Both books drew from earlier warnings based on the same basic reasoning. Although the idea of a "Malthusian catastrophe" fell out of favor for a time, it was revived after WWII in "neo-Malthusian" fashion by environmental conservationists like Fairfield Osborne, who published an exploration of the topic in 1948 titled *Our Plundered Planet*, and William Vogt, who published a book the same year called *Road to Survival*. Indeed, the science journalist Charles Mann argues the Vogt—an American ecologist and ornithologist who saw capitalism as a root cause of environmental ruination—founded what has been dubbed "apocalyptic environmentalism," which refers to "the belief that unless humankind drastically reduces consumption and limits population, it will ravage global ecosystems."[72] These early pioneering works left the door ajar for the husband-and-wife Ehrlich team (whose book was published the same year that Vogt died) and the Club of Rome, whose dire prognostications were not unreasonable given the rapid growth of the global human population at the time.

What prevented a Malthusian catastrophe was the so-called "Green Revolution," which took off right around the time these books were published. Indeed, the Nobel laureate and "Father of the Green Revolution," Norman Borlaug—who, as it happens, met Vogt once; they argued and never spoke again—has been described as saving more than 1 billion people from starving to death. Yet the inadvertent side-effects of using chemical fertilizers and agro-chemicals has caused even worse environmental outcomes, such as the loss of biodiversity and massive "dead zones" throughout the world's oceans in which almost no wriggling marine life can survive. Just consider that, according to the 2018 Living Planet Report, the global population of wild vertebrates—mammals, birds, reptiles, fish, amphibians, and so on—declined by a staggering *60 percent* between 1970 and 2014. It was, in fact, the narrowing of *agricultural* biodiversity that led to the

establishment of various "seed vaults" around the world that store and protect seeds to ensure the preservation of genetic diversity in case of a global crisis. The most famous of these vaults is the Svalbard Global Seed Vault, also dubbed the "Doomsday Vault," on the snowy Norwegian island of Spitsbergen, which was built in 2008 as a "failsafe" in case of disaster. Yet in a frighteningly ominous "sign of the times," as Christians would say, the vault flooded in 2017 due to melting permafrost caused by climate change. The point is that while the particular warnings of *The Population Bomb* and similar publications did not come true, the basic fears of environmental catastrophe that they embodied have indeed been tragically realized.

So, while scientists were busy investigating the scope of radioactive fallout, the effects of nuclear explosions on the ozone, and (later) the consequences of massive firestorms, other scientists were focused on synthetic chemicals, climate change, and overpopulation. There was, in fact, a connection between these two categories of risk, at least at the beginning: both initially arose from fears of *contamination*.[73] This is a prominent cultural motif that stretches back into our deep ancestral past—people have always been anxious about their minds, bodies, or environs being exposed to some pollutant, whether physical or spiritual in nature. For example, when Adam and Eve ate the forbidden fruit from the "tree of knowledge of good and evil," they became contaminated with sin. The Zoroastrians have traditionally placed the bodies of the dead in "Towers of Silence," also known as "Dakhma," where they are picked apart by vultures. This is done to prevent death—specifically a demon thought to enter the body at the transitional moment—from contaminating the earth. And so on. Hence, Carson was tapping into this powerful idea when she wrote that

> the most alarming of all man's assaults upon the environment is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials. This pollution is for the most part irrecoverable; the chain of evil it initiates not only in the world that must support life but in living tissues is for the most part irreversible. In this now universal contamination of the environment, chemicals are the sinister and little-recognized partners of radiation in changing the very nature of the world—the very nature of its life. Strontium 90, released through nuclear explosions into the air, comes to earth in rain or drifts down as fallout, lodges in soil, enters into the grass or corn or wheat grown there, and in time takes up its abode in the bones of a human being, there to remain until his death.

She then adds, shifting the focus from radioactive fallout to insecticides, that

> chemicals sprayed on croplands or forests or gardens [similarly] lie long in soil, entering into living organisms, passing from one to another in a chain of poisoning and death. Or they pass mysteriously by underground streams until they emerge and, through the alchemy of air and sunlight, combine into new forms that kill vegetation, sicken cattle, and work unknown harm on those who drink from once pure wells.

Humanity was, therefore, primed to react strongly, and emotionally, to such claims. Indeed, the Castle Bravo test played a critical role in getting the US and Soviet Union to sign the Partial Test Ban Treaty in 1963, which prohibited above-ground nuclear tests. Prior to 1954, only about 20 percent of the American public supported a test ban, but by 1957 the number had risen to 63 percent, thus pressuring both governments to stop polluting Earth with radiation. And Carson's book resulted in the US Toxic Substances Control Act of 1976, which either banned or severely restricted all the chemicals—six in total—that were singled-out by Carson in her book. Hence, as the American journalist Bill Moyers rightly claimed in 2007, "it's impossible to do justice today to Rachel Carson's impact." Yet another connection was expressed even earlier by Vogt: the continued degradation of environmental systems—the loss of Earth's "carrying capacity"—will make

war almost inevitable. Or as he put it, "there is little probability that mankind can long escape the searing downpour of war's death from the skies." When this finally happens, "it is probable that at least three-quarters of the human race will be wiped out."

These were the two most prominent threats to humanity recognized during this period, but they were not the only ones. Scientists and philosophers also began to take seriously the potential dangers posed by artificial intelligence, nanotechnology, bioterrorism, biological warfare, and high-powered particle accelerators. The period of "anthropogenic apocalypses" witnessed not only the creation of the first direct, unambiguous technological risk to our survival, but an explosion of new ideas about how humanity could accidentally, or intentionally, kill itself. Let's discuss these briefly, in order:

First, there had been anxious warnings that machines, robots, computers, or artificial intelligences (AIs) could take over the world at least since the nineteenth century. For example, the English novelist Samuel Butler, in his 1863 article "Darwin Among the Machines," speculated that "we are ourselves creating our own successors; … In the course of ages we shall find ourselves the inferior race. … the time will come when the machines will hold the real supremacy over the world and its inhabitants." Similarly, the Czech playwright Karel Čapek's 1920 science fiction play *R.U.R.* describes a rebellion of "robots," a term he coined, which ends with the near-extinction of humanity.

But a series of breakthroughs in computer technology during the twentieth century led numerous leading theorists to worry that our computational creations could someday exceed human-level intelligence and thus come to dominate the human race. The focus here was less on machines and robots than on "artificial intelligence" (AI). For example, Alan Turing—a brilliant computer scientist who tragically committed suicide after being forced by the UK government to take a synthetic estrogen because he was gay—wrote in 1951 that "it seems probable that once the machine thinking method has started, it would not take long to outstrip our feeble powers. … At some stage therefore we should have to expect the machines to take control." The following decade, in 1965, the British mathematician I.J. Good suggested that, since designing intelligent machines is an intellectual activity, once machines reach a certain level of intelligence, they could design even more intelligent machines; these intelligent machines could then design *even more* intelligent machines, and so on. He called this positive feedback loop of recursive self-improvement an "intelligence explosion," an idea that remains highly influential among contemporary scholars in Existential Risk Studies. Good was also among the first to suggest that the outcome of an intelligence explosion will most likely be binary: that is, it will either be the very *best* or the very *worst* thing that ever happens to humanity. As he makes the point, "whether this will lead to Utopia or to the extermination of the human race will depend on how the problem is handled by the machines." Computer scientists and philosophers have developed these ideas significantly in the past two decades, culminating in the 2014 best-seller *Superintelligence*, by Nick Bostrom. This book introduced the topic to a wide audience both within and outside of academia, resulting in a fair amount of coverage in the popular media and some apocalyptic declarations by high-profile figures like Elon Musk, who said in 2018: "Mark my words, AI is far more dangerous than nukes." (I personally agree, but this is not the place to discuss why.[74])

Around the same time that Turing and Good expressed concern about intelligent computers, the theoretical physicist Richard Feynman, a quirky Nobel laureate who had worked on the Manhattan Project and witnessed the first atomic bomb test—described by a colleague as "half genius and half buffoon"—gave a lecture in 1959 titled "There's Plenty of Room at the Bottom." In it, he discussed the possibility of creating tiny machines, now called "nanobots," that could perform a variety of tasks, such as "manufacture … small elements for computers in completely automatic factories," now called "nanofactories." They could also have biomedical applications. As Feynman writes (borrowing an idea from a colleague of his),

> although it is a very wild idea, it would be interesting in surgery if you could swallow the surgeon. You put the mechanical surgeon inside the blood vessel and

> it goes into the heart and "looks" around. … It finds out which valve is the faulty one and takes a little knife and slices it out. Other small machines might be permanently incorporated in the body to assist some inadequately-functioning organ.

Yet this proposal, to investigate the possibility of building nano-scale programmable machines, remained mostly stagnant until a 1986 book titled *Engines of Creation*, by the engineer Eric Drexler. It explored the scientific plausibility of building macroscopic products by moving single atoms or molecules at a time—that is, manufacturing products with absolute atomic precision. For example, if two computers were made in this way, not only would they look identical to the human eye, but if one were to zoom-in to the atomic level, one would find their *constituent atomic particles* in the exact same places, too. But Drexler's book is most notable, with respect to our main topic of interest, for introducing a completely new anthropogenic apocalyptic scenario: what if nanobots could convert organic matter into copies of themselves? If self-replicating nanobots were released into the environment, or accidentally escaped from a nanofactory, they could convert the entire biosphere into a wriggling swarm of exponentially reproducing machines. Drexler called this the "gray goo" scenario, and the possibility of nanobots "eating the ecosystem" has been term "ecophagy." This has inspired numerous science fiction novels about gray goo catastrophes, such as Walter Jon William's *Aristoi* (1992), Wil McCarthy's *Bloom* (1998), and Alastair Reynold's *Century Rain*, in which "an alternate Earth of 300 years hence has been rendered uninhabitable by a 'Nanocaust.'"[75] It has also, unfortunately, galvanized some eco-terrorist groups to target nanotechnologists. For example, "Individuals Tending to the Wild (or Savagery)," which has a nominal presence across Central and South America, has been linked to multiple attacks in countries like Mexico, France, Spain, and Chile. The primary motivation of the group is to prevent self-replicating nanobots from destroying the world, and consequently it has targeted nanotechnologists, in particular.

Because this is intended to be a relatively short book, I will mostly skip over the topics of biological warfare, bioterrorism, and physics experiments. Suffice it to say that the heat death and nuclear conflict were not the only doomsday scenarios that rattled Russell with existential anxiety—he was also greatly worried about biological weapons being deployed in martial conflict, as he expressed in a letter to Einstein the same year of their manifesto. The molecular biologist Joshua Lederberg, who won the Nobel Prize when he was only 33 years old, shared this anxiety, publishing a 1969 article in the *Bulletin of the Atomic Scientists* revealingly titled "Biological Warfare and the Extinction of Man." That same year he spoke about the risk before the House of Representatives, declaring that "as a scientist I am profoundly concerned about the continued involvement of the United States and other nations in the development of biological warfare. This process puts the very future of human life on Earth in serious peril." The following decade heard the first warnings about the possibility of high-energy particle accelerators destroying the world.[76] This could happened a number of ways, the most *truly apocalyptic* of which involves the "nucleation" of a "vacuum bubble." If the universe is in what cosmologists call a "false vacuum" state, then a particle accelerator could theoretically tip it into a "true vacuum" state. This would create a sphere of total destruction that would expand at the speed of light in all directions, resulting in the obliteration of the entire visible universe—"the ultimate ecological catastrophe," as the theoretical physicists Sidney Coleman and Frank De Luccia described it in 1980. Physicists today claim that the probability of this outcome from smashing atoms together is extremely low. But then again, no physicists in 1954 expected the Castle Bravo test to be as powerful as it was. Science is a self-correcting, and thus fallible, process.

While all of these phenomena continue to pose *very real* threats to humanity, the take-home point for us is that this period witnessed not one, two, or three, but a whole sparkling constellation of new and newly anticipated dangers. In a matter of decades, humanity transitioned from entertaining vague worries about huge boiler explosions and another world war ending with the slaughter of every last soldier to staring, with pupils fully dilated, at an expanding cluster of terrifyingly vivid risks that could bring about our eternal demise not in the far future—millions or

billions of years henceforth, due to entropy—but on timescales relevant to currently existing people. It was no longer "doom later, sometime" but "doom soon, maybe tomorrow." As the contemporary existential risk scholar Anders Sandberg puts the point: "In the 20th century the threat of nuclear weapons … and environmental degradation made existential risk even more salient, but moved the focus toward anthropogenic risks. Now the risks were experienced as real, direct, and something that could happen within one's lifetime." Not only, then, was the universe eventually going to commit homicide by rendering human life impossible in the long run, but Homo sapiens—the self-described "wise man"—now had the technological tools to commit suicide in the near term.

Consequently, the existential mood that arose in this new "era of anthropogenic apocalypse" went far beyond the unsettling sense of vulnerability that defined the previous one. It was instead marked by *intense feelings of impending doom*, especially during the height of the Cold War. As Feynman remarked in a 1980 lecture at the University of California, Santa Barbara, reflecting on his thoughts after WWII had ended:

> I'd sat in a restaurant in New York, for example, and I looked out at the buildings and how far away, I would think, you know, how much the radius of the Hiroshima bomb damage was and so forth. How far down there was down to 34th Street? All those buildings, all smashed and so on. And I got a very strange feeling. I would go along and I would see people building a bridge. Or they'd be making a new road, and I thought, they're crazy, they just don't understand, they don't understand. Why are they making new things, it's so useless?

The unfathomable terror of a nuclear holocaust, which persists today, has led some historians to argue that the end of WWII changed our very notion of the *meaning* of death. As Weart writes, "what use was anything when a crazy accident could wipe out not only oneself but one's progeny, the memory of one's lifework, indeed everything human, perhaps all the natural world?" Indeed, a survey conducted after the 1962 Cuban Missile Crisis (which President John F. Kennedy later claimed had a 1/3 to 1/2 chance of leading to an all-out nuclear war) found that 40 percent of adolescents experienced a "great deal" of anxiety about the possibility of war.[77] Another that asked schoolchildren about the world in ten years reported that more than two-thirds mentioned war, "often in terms of somber helplessness."[78] Some children, in 1987, even tried to meet with Ronald Reagan and Mikhail Gorbachev to give them 1,000 out of 230,000 letters collected from the previous two years by youngsters in thirty-one different countries. As one of the letters from a girl in Germany read, "We want to be so old like Mr. Reagan and Mr. Gorbachev." Several years earlier, *Parade* had received some 50,000 responses to Sagan's 1983 article on the nuclear winter hypothesis. Referencing Reagan, one from a person in Chicago stated, "Surely you do not think of yourselves as the murderers of small children. But that you are, if you cannot halt this nuclear madness." Another from a junior high school student stated: "My friends are scared. Sometimes they think—Will we wake up to see the world tomorrow?," to which was added: "P.S. Please don't make a dumb move."

Apocalyptic anxiety also infected the arts, which, as a psychologist at the time put it, came to "express the despair of a humanity that no longer believes in its own future." Plenty of novelists and screenwriters wove together stories of nuclear tragedy—I have already mentioned the film, considered one of the best comedies of all time, *Dr. Strangelove*—although others found the topic so dreadful that they were unable to pick up a pen and write about it. For example, the British novelist John Braine reported in an article titled "People Kill People" that writing novels about thermonuclear bombs "frightens me too much ... whenever I think about the H-bomb, I can only give way to despair, which is to say that I can only stop thinking of it." And the American actor John Cassavetes, who starred in the box-office hit *The Dirty Dozen* (1967), admitted that, "frankly, the very thought of atomic warfare … threatens to throw me into a panic."[79] As a joke

that became widely known among the Soviets in the 1950s and 1960s expressed this pervasive feeling of existential disquietude.

> Question: What should you do in case of a nuclear attack?
> Answer: Get a shovel and a sheet, and walk slowly ... to the nearest cemetery.
> Follow-up: Why slowly?
> Answer: You mustn't start a panic.

This was the heart of the present existential mood: humanity is teetering on the edge of total self-annihilation. And if a nuclear holocaust does not destroy civilization, then pollution, climate change, gray goo, or some other anthropogenic blunder just might step up to finish the job. Consequently, some social theorists began to reconceptualize the nature of modern societies living in the shadow of threats that have become spatiotemporally *global* (affecting everyone everywhere) and *transgenerational* (affecting not just the present but future generations). A notable example of this comes from the German sociologist Ulrich Beck's 1986 book *Risk Society: Towards a New Modernity*. Writing in West Germany during the Cold War, Beck argued that "in advanced modernity the social production of *wealth* is systematically accompanied by the social production of *risks*." Of course, individuals, tribes, and nations have always encountered uncertain dangerous phenomena—"life is risky," as the cliche goes. But Beck recognized that the sort of risks facing societies at the time were different in *essence* from those that stalked us in the past. As he put the point,

> risks are not an invention of modernity. Anyone who set out to discover new countries and continents—like Columbus—certainly accepted "risks." But these were *personal* risks, not global dangers like those that arise for all of humanity from nuclear fission or the storage of radioactive waste. In that earlier period, the word "risk" had a note of bravery and adventure, not the threat of self-destruction of all life on Earth.

Indeed, Beck argued that the risks facing societies today are not just "globalized" but uniquely *political* in nature. "What *was* until now," he wrote, "*considered unpolitical becomes political—the elimination of the causes in the industrialization process itself*." What he means is that while industry has reduced scarcity, this has come at the cost of exposing humanity—indeed the entire blossoming biosphere—to novel kinds of increasingly dire threats. Consequently, as he put it, the new "risk society is a *catastrophic* society. In it the exceptional condition threatens to become the norm." Beck's book quickly became "one of the most influential European works of social analysis in the late twentieth century," and had an outsized impact on social scientific thinking about how to ensure that risk societies can remain safe, which Beck identifies as the fundamental issue facing the world toward the end of the twentieth century.

In the decades following Beck's book, the view that we stand at the brink of catastrophe has only intensified. Three publications in particular stand out for their warnings that our existential predicament on Earth is *only getting worse*. The first to offer a comprehensive survey this new topography of risk was *The End of the World: The Science and Ethics of Human Extinction*, published in 1996 by the Canadian philosopher John Leslie. In the first two chapters, Leslie lists a wide range of doomsday scenarios involving nuclear conflict, environmental degradation, biological warfare, bioterrorism, genetic engineering, nanotechnology, artificial intelligence, and physics disasters. He then considers the so-called "Doomsday Argument," a fascinating bit of armchair reasoning that leads to the conclusion that, in slogan form, we are systematically underestimating the probability of extinction. This leads him to argue that there is a 30 percent chance of extinction within the next five centuries—not a *terribly* pessimistic claim, but definitely not something to celebrate. Four years later, the co-founder of Sun Microsystems, Bill Joy, wrote a widely discussed article for *Wired* magazine called "Why the Future Doesn't Need Us." In it, Joy

focused in particular on "GNR" technologies, where this acronym refers to genetics, nanotechnology, and robotics (including AI). These technologies are so profoundly dangerous, Joy argued, that humanity *relinquish* their development "by limiting our pursuit of certain kinds of knowledge." In his words, GNR technologies

> are so powerful that they can spawn whole new classes of accidents and abuses. Most dangerously, for the first time, these accidents and abuses are widely within the reach of individuals or small groups. They will not require large facilities or rare raw materials. Knowledge alone will enable the use of them. … I think it is no exaggeration to say we are on the cusp of the further perfection of extreme evil, an evil whose possibility spreads well beyond that which weapons of mass destruction bequeathed to the nation-states, on to a surprising and terrible empowerment of extreme individuals.

The idea here is that these technologies are not only becoming more *powerful* at an exponential (or super-exponential) pace, but increasingly accessible to small groups and even lone wolves. As I have written before, the terrorist of the future will have bulldozers rather than shovels to dig mass graves for their victims. This my already be the case today. For example, it costs only a few hundred dollars to set-up a sophisticated "biohacker" lab in one's garage or basement, the genomes of many of the most horrific viruses are publicly available online, and it is not difficult to order sequences of DNA for cheap from commercial providers. At the root of this issue is that, unlike nuclear weapons, the emerging technologies associated with synthetic biology, biotechnology, nanotechnology, and artificial intelligence are "dual-use" in nature. A technology is "dual-use" if it can be used for both beneficial and harmful ends. For example, the very same centrifuges that enrich uranium for nuclear power plants can also enrich uranium for nuclear weapons, and the combination of CRISPR-Cas9 and gene drives could be used to eradicate mosquito populations (thereby reducing rates of malaria) as well as to decimate modern agriculture (thereby causing mass starvation). What is crucial to understand here is that the good and the bad are a package deal: one comes with the other, and *to eliminate either is to eliminate both*. Hence, there is a strong push to develop these technologies, given their potential to cure diseases, extend our lifespans, clean up the environment, and grow the economy. But this will come at a terrible cost: the risk of annihilation perhaps caused not by an entire state but a few people harboring a death wish for humanity.

Joy's article triggered a heated debate that has echoed through the corridors of public debate ever since. At one extreme are the "neo-Luddites," while at the other are the "transhumanists" at the other. Of course, more knowledge is generally good, or so many people, including Joy, hold. But "if open access to and unlimited development of knowledge henceforth puts us all in clear danger of extinction, then common sense demands that we reexamine even these basic, long-held beliefs."

Three years after his hullabaloo, in 2003, the renown cosmologist and Astronomer Royal Lord Martin Rees published *Our Final Hour: A Scientist's Warning*, a highly compelling examination of the topic that also underlined the unprecedented threats of emerging technologies. As Rees memorably declared, "in a global village there will be global village idiots. And with this power, just one could be too many." Indeed, his account of our existential predicament led him to a much more dismal conclusion about the future. "It may not be absurd hyperbole," he wrote,

> to assert that the most crucial location in space and time (apart from the big bang itself) could be here and now. I think the odds are no better than fifty-fifty that our present civilisation on Earth will survive to the end of the present century. Our choices and actions could ensure the perpetual future of life (not just on Earth, but perhaps far beyond it, too). Or in contrast, through malign intent, or through misadventure, twenty-first century technology could jeopardise life's

> potential, foreclosing its human and posthuman future. What happens here on Earth, in this century, could conceivably make the difference between a near eternity filled with ever more complex and subtle forms of life and one filled with nothing but base matter.

The idea that we are in a period of unique danger—the so-called "hinge of history"—has become widespread among scholars who rigorously study the future of humanity since the Atomic Age commenced in 1945. Recall from chapter 1 that many estimates of human extinction this century hover around 20 percent. For example, an informal survey of experts conducted by the Future of Humanity Institute in 2008 found a median probability of human extinction *before the twenty-second century* of 19 percent. To make this more concrete, consider that the average American has a 1-in-9,737 chance of dying in an "air and space transport accident." This means that if the figure above is accurate, the average American is at least *1,500 times more likely* to perish in a catastrophe that wipes-out humanity than in a plane crash. With respect to Rees's fifty-fifty estimate, the average American is nearly *4,000 times more likely* to witness civilization collapse. My own view, for whatever it is worth, is that human extinction itself has around a 5 percent chance of happening before 2100, but I believe that the destruction of our global village is even more probable than Rees believes—around 60 or 70 percent. However, I enthusiastically share a sentiment once expressed by the technology critic Lewis Mumford, who wrote: "I would die happy if I knew that on my tombstone could be written these words, 'This man was an absolute fool. None of the disastrous things that he reluctantly predicted ever came to pass!'"[80]

Once again, absolutely critical to this shift was the further dissolution of religion's monopoly on thoughts about the space of futurological possibility. Without a secular existential hermeneutics, the dangers posed by the new constellation of threats would not have been interpreted as endangering our collective survival on Earth. Indeed, many religious people at the time simply integrated these phenomena into their preferred eschatological narratives. (As the country music duo the Buchanan Brothers sang in 1946, referencing the "sins" of Hiroshima and Nagasaki, "You're working with the power of God's holy hand. Atomic power! Atomic power! It was given by the mighty hand of God!") The result was not only a general dismissal of naturalistic worries about human annihilation by evangelical Christians, but in some cases the prospect of a violent "end to the world" was anticipated with a degree of apocalyptic enthusiasm, since the world's end means the beginning of eternal paradise with God. For example, Weart notes that

> some fundamentalist Christians [after WWII] began to speak of true apocalypse. Atomic bombs, they announced, proved that the day foretold in biblical revelation was at hand. There had always been people at the margins of society preparing for Armageddon, but from 1945 on the most sober leaders, from presidents to popes, spoke in language that could evoke such thoughts. … [A]tomic bombs made a bridge across which apocalyptic fantasies, marching from their refuge among fringe groups, invaded all of society.

Reagan himself, while he was Governor of California, declared during a 1971 dinner that

> For the first time ever, everything is in place for the battle of Armageddon and the second coming of Christ. … It can't be long now. Ezekiel says that fire and brimstone will be rained upon the enemies of God's people. That must mean that they'll be destroyed by nuclear weapons. They exist now, and they never did in the past.[81]

He later averred in a 1980 television interview that "we may be the generation that sees Armageddon." Along similar lines, the Christian apocalypticist Hal Lindsay published a book titled *The Late Great Planet Earth* in 1970—it was in fact the best-selling "non-fiction" book of the

entire decade—in which nuclear weapons play a central role. The same goes for another hugely successful book on the topic, *88 Reasons Why the Rapture Will Be in 1988* by the former NASA engineer Edgar Whisenant, of which 4.5 million copies were sold. As Whisenant wrote with the nuclear winter hypothesis in mind:

> Matt. 24:3-8 speaks of wars, famines, and earthquake in the end-time. There have always been wars, but none like those of the 20th century. … With the advent of nuclear weapons, a future world war would be catastrophic. We are on a collision course, and the world will see nuclear war on sunset October 3, 1988. This is probably the reason that Jesus stated in Matt. 24:22; "… except those days should be shortened, there should be no flesh saved …"

"Only if the Bible is in error," Whisenant declared upon the book's release, "am I wrong." Hence, rather than threatening to bring about our extinction, nuclear weapons were viewed with eager curiosity through the reality-bending lens of religious ideology—especially the interpretive framework of *dispensationalism*—as the exciting fulfillment of prophetic scripture. In fact, some Christian apocalypticists have even begun to see certain emerging technologies as "signs of the times." For example, several believers have argued that the Antichrist, or "beast," could either take the form of a machine superintelligence or use machine superintelligence to acquire political power, as prophesied. As one argues, "the beast is a global superintelligence arising from humanity."[82] Another explicitly cites Nick Bostrom's 2014 book Superintelligence, writing that

> scripture has long foretold that the birth of AI will at first be lauded as awe-striking and wondrous. … People will extol its virtues as representing the pinnacle of humanity's genius. … [But] when the Antichrist calls for the death of the so-called insurgent believers, the AI will have all the information needed to exact the great purge that will be considered necessary to rid humanity of its dissidents, and unify it once and for all. Suddenly, the dragon will emerge, and no minority report will be considered.[83]

Given the ease with which new threats become characters in the eschatological dramas foretold in holy scripture, it is thus unsurprising that many of the thought-leaders mentioned above—Russell, Oppenheimer, Sagan, Ehrlich, Carson, Leslie, and Rees—were notably irreligious. Sagan himself was an outspoken atheist who spent a good portion of his career warning about the dangers of faith-based belief. Whereas the battles between religion and science during the previous periods were over scientific *ideas*, the new battle was over something much more important: our very *existence* on what Sagan poetically called, after seeing a picture of Earth taken by the Voyager 1 space probe in 1990, our "pale blue dot."

But the twentieth century, especially the second half, was a time of atheistic upheaval. It witnessed the fulfillment of Frederich Nietzsche's famous declaration, first made in his book *The Gay Science*, that "God is dead." This was published in 1882, but according to the theologian Gavin Hyman it was prematurely asserted by this mustachioed iconoclast. It was not really until the 1960s, what we can call (borrowing a term from the German theologian Gerhart Ebeling) the "age of atheism," that religion began a rapid descent in western popularity.[84] The cause of this decline is more complex than the explanation for growing disbelief during the nineteenth century—biblical criticism, moral considerations, and new scientific breakthroughs. Scholars point to factors like Marxism, second-wave feminism, the hippy counterculture, immigration from Latin America and Asia, multiculturalism, the Civil Rights movement, and quasi-atheistic belief systems imported from the East like Buddhism. These conspired together to enact a brutal assault on Christianity from multiple sides. Never before had citizens of the western world been so sure that the universe was *not* created by a supernatural deity of some sort. Never before had the intelligentsia been so convinced that humanity's future was not pre-written by a divine author in the

sky, outlined most notably in the apocalypses of Daniel and Revelation, but *being written* by scientists, the electorate, and our political leaders in *realtime*. We are alone in the universe, not just in the sense that there may be no other intelligent beings on habitable exoplanets revolving around slow-dying suns like our own, but because there is no supernatural being outside the universe looking down on us with loving, lachrymose eyes. And never before had we been so close to the precipice of extinction, posed to push ourselves over.[85]

Chapter 5: Mother Nature Wants to Kill Us

Life on this earth has often been disturbed by dreadful events. Innumerable living creatures have been victims of these catastrophes.—Georges Cuvier

One of the most striking changes in our ideas about the history of life has been acceptance of the theory that the process has been interrupted from time to time by mass extinctions. —Peter Bowler

The picture is pretty bleak, gentlemen. …The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut.—anonymous dinosaur in a Gary Larson cartoon

So far we have discussed only one *natural* threat that the scientific community as a whole accepted as real: entropy. Just as many people, in my discussions over the years, are surprised to discover that it was not until Georges Cuvier that scientists believed species could go extinct, so too are folks often incredulous that hardly anyone thought sudden natural catastrophes could cause mass extinctions *until the early 1990s*—just three decades ago. For nearly the entire Cold War era, while people on both sides of the Iron Curtain were fretting over nuclear weapons, environmental contaminants, and other newly generated anthropogenic risks, almost no credible scientist believed that, for example, a large asteroid could dash through the sky and annihilate the human species. Mother nature may *ultimately* have it in for humanity, but she is not trying to murder us in the near term.

There had been occasional squeaks throughout history about large-scale natural disasters caused by cometary impacts, as discussed in chapter 2. The Satanic School libertine and Romantic poet, Lord Byron, contended that comets had decimated earlier species of intelligent earthlings, and Edmund Halley thought the Caspian Sea had an extraterrestrial origin. Comets also played a central role in Comte de Buffon's hypothesis of Earth's formation, according to which our planet is a "dying ember" because a comet slammed into the sun and threw off a giant fragment that became Earth.[86] Later, in 1823, the German linguist J.G. Radlof proposed that a comet had struck a large planet that once existed between Mars and Jupiter, causing it to shatter. One of the resulting pieces then hurtled through the solar system and collided with Earth. He believed that this astronomical catastrophe inspired ancient mythological tales of "celestial battles."[87] Furthermore, a figure whose life story has largely been lost in the mists of history, David Milne, won the 1828 Edinburgh University astronomy prize for his fascinating "Essay on Comets." In it, Milne argued that "the masses of comets are usually small," but

> if a comet, moving with the prodigious velocity which it acquires near its perihelion, should chance to strike a planet, as for instance the Earth, then … the consequences would be truly disastrous. … The waters of the ocean … would sweep over the face of the globe … Whole species of plants and animals, existing in different quarters of the Earth, would, by this cataclysm, be at once overwhelmed and annihilated.

The early nineteenth century also witnessed the rise of a more general theory of Earth's natural past—perhaps better described as an interpretive framework—called *catastrophism*. This was the view that geological (and therefore biological) history has been punctuated by sudden, violent, sometimes global catastrophes, a word that literally means "to turn upside down.") Cuvier was, in fact, one of the leading catastrophists, although he identified the mechanism of upheaval to be rapid alterations in sea level rather than cometary impacts. On this account, the oceans have on multiple occasions quickly risen, thus destroying whole genres of terrestrial species, after which

they have retreated just as fast, causing a second mass extinction of marine creatures. As Cuvier describes this process in his 1813 book *Essay on the Theory of the Earth* (to quote him at length):

> The breaking to pieces, the raising up and overturning of the older strata, leave no doubt upon the mind that they have been reduced to the state in which we now see them, by the action of sudden and violent causes; and even the force of the motions excited in the mass of waters, is still attested by the heaps of debris and rounded pebbles which are in many places interposed between the solid strata. Life, therefore, has often been disturbed on this Earth by terrible events. Numberless living beings have been the victims of these catastrophes; some, which inhabited the dry land, have been swallowed up by inundations; others, which peopled the waters, have been laid dry, from the bottom of the sea having been suddenly raised; their very races have been extinguished forever, and have left no other memorial of their existence than some fragments, which the naturalist can scarcely recognize.

In the aftermath of such disasters, a squirming array of new species then emerge and repopulate the wounded planet. Although Cuvier, a lifelong Protestant, never associated any of these floods with the biblical story of Noah and the ark, other catastrophists did. For example, the geologist Rev. William Buckland believed that, of the many floods that had ravaged Earth in the past, the most recent was the Great Deluge. In fact, one reason the catastrophist theory appealed to people in the nineteenth century, before the rise of secularism as discussed in chapter 3, was its cozy compatibility with the Judeo-Christian worldview, according to which those six magical days of creation unfolded only a few thousand years ago. (Recall James Ussher's famous calculation that Yahweh declared—to whom it is not exactly clear—"Let there be light" in 4004 BCE.) Since catastrophes can change geological conditions relatively quickly, Earth's natural history can be condensed to fit this timeline. There was a sense in which, to borrow a term from the American writer John McPhee, the western tradition had not yet discovered "deep time," at least not with respect to Earth itself.

By 1800, though, the field of geology had established to its satisfaction that the earth must be far older than many in the eighteenth century maintained. Consequently, an alternative theory of Earth's history emerged in the marketplace of ideas: *uniformitarianism*. This had its roots in a 1785 book titled *Theory of the Earth* by James Hutton, a Scottish naturalist often dubbed the "Father of Geology." But it was not until the geologist and friend-of-Darwin, Charles Lyell, published *Principles of Geology* in 1830 that uniformitarianism became the dominant paradigm within the Earth sciences. Indeed, as we will see, it remained the only game in town for *more than a century and a half*. Although uniformitarianism bundles together a number of distinct ideas, the central thrust was that, in slogan form, "the present is the key to the past." This means that if scientists do not observe a physical process occurring in the contemporary world, they are not justified in claiming that it happened in the past. Thus, since we do not see the kind of sudden, violent, global-scale natural disasters posited by the catastrophists in operation today, there is no scientific basis for explaining geological features in terms of such disasters. From the uniformitarian perspective, catastrophist explanations are too facile: whenever something lacks a good explanation, they simply declare "Well then it must have been caused by some type of rare world-altering event of which we have no direct experience." Or as Darwin, a diehard uniformitarian, put the point in the *Origin* with a pinch of sardonic mockery: "So profound is our ignorance, and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world!"

Another central idea was that Earth is extremely old. As Hutton, who argued for a cyclical, gradualistic model of geological change, closed his 1788 treatise:

> If the succession of worlds is established in the system of nature, it is in vain to look for anything higher in the origin of the earth. The result, therefore, of our present enquiry is, that we find no vestige of a beginning—no prospect of an end.

According to the standard account of science textbooks, it was these words, popularized by Lyell in the early nineteenth century, that introduced the notion of deep time within *geology*. Some scholars have even argued that this new understanding of Earth's development and age was no less groundbreaking than the Copernican and Darwinian revolutions—the first dethroned humanity from the center of the universe, the second demolished the ontological gap between humans and all other creatures. Because of the Huttonian view, our place in the universe once again shifted: Earth no longer appeared to have been created just for humanity. Rather, it has existed for an indefinitely long time before us, and will persist for longer than our puny imaginations can conceive—another blow to our sense of cosmic specialness.

According to Lyell, catastrophism was shoddy science because it was infected by religious beliefs based on faith rather than evidence. The uniformitarian doctrine, in contrast, was founded on empirical observations made by geologists doing good field work. This is the narrative that emerged from Lyell's writings and that influenced thoughts about geological theory for much of the field's history. Lyell was a lawyer by training, and thus utilized his rhetorical skills in arguing his case. As the great biologist Stephen Jay Gould writes, referring to the legal documents that lawyers present in courts to establish an argument,

> Lyell built his own edifice with the most brilliant brief ever written by a scientist. … [He] was a great writer, and much of his enormous success reflects his verbal skills—not mere felicity in choice of words, but an uncanny ability to formulate and develop arguments, and to find apt analogies and metaphors for their support.

But Lyell's claims about catastrophism versus uniformitarianism were quite misleading. In fact, uniformitarianism encountered two significant scientific problems, one specific to the nineteenth century and another that persisted until its overthrow at the end of the twentieth century. Taking these in order: first, the notion that there is "no vestige of a beginning" was in direct tension with the two laws of thermodynamics (the first states that energy can be neither created nor destroyed). These unambiguously imply that Earth is cooling down from a previously molten or gaseous state, which some scientists at the time, following Immanuel Kant's "nebular hypothesis," believed was caused by friction when Earth formed in the solar nebula. Hence, Lord Kelvin himself became increasingly irritated by geology's insistence on indefinite timespans. According to his calculations, Earth could not be older than about 100 million years, much longer than the biblical timeline based on the "Mosaic chronology" but still shorter than uniformitarians maintained. To quote—of all people—the author of classics like *Adventures of Huckleberry Finn*, Mark Twain, whose many witticisms still tickle the brains of readers today:

> It takes a long time to prepare a world for man, such a thing is not done in a day. Some of the great scientists, carefully ciphering the evidences furnished by geology, have arrived at the conviction that our world is prodigiously old, and they may be right, but Lord Kelvin is not of their opinion. He takes the cautious, conservative view, in order to be on the safe side, and feels sure it is not so old as they think. As Lord Kelvin is the highest authority in science now living, I think we must yield to him and accept his view. He does not concede that the world is more than a hundred million years old. He believes it is that old, but not older.

The uniformitarians were thus stuck between a central tenet of their theory and the best physics of the day, an uncomfortable situation that did not beleaguer the catastrophists. But this story has an unexpected twist: the best physics of the day was actually wrong—that is, in the sense of being

incomplete rather than *incorrect*. What Kelvin missed is that Earth contains a second source of energy in addition to the "primordial heat" left over from its formation: atomic energy, released by the natural alchemy of radioactive decay. Basically, Earth's interior contains radioactive elements like uranium, thorium, and potassium that generate heat when they undergo transmutation. This means that Earth could be much older than Kelvin had estimated—although of course Kelvin cannot be criticized for not knowing what he could not have known (radioactivity was discovered in 1896). As it happens, Charles Darwin's son, the astronomer George Darwin, discussed the implications of radioactivity for the age of the sun in a 1903 letter to *Nature*. "We have recently learnt the existence of another source of energy," he wrote, "and that the amount of energy available is so great as to render it impossible to say how long the sun's heat has already existed, or how long it will last in the future." The point is that there were many decades when uniformitarianism, not catastrophism, was the more scientifically problematic theory. The myth-weaving of Lyell's book shaped a story of scientific progress that did not reflect reality.

But there were other problems as well. For example, the fossil record clearly indicates that large numbers of species have died out over relatively short increments of time. With a stentorian boom, the paleontological evidence screams "mass extinctions!" Yet the uniformitarian view is that, since global catastrophes do not occur, there have never been any mass extinctions either. The *appearance* of such events in the fossil record is nothing more than an artifact of its incompleteness. On this view, since fossilization is the exception rather than the rule, the surprising fact is not that we find many species suddenly disappearing at some stratigraphic layer but that we find any fossilized creatures in the first place. Evidence of absence is not, so to speak, evidence of absence. How then did species go extinct? Slowly and alone, according to Darwin. That is to say, Darwin argued in the *Origin* that "the complete extinction of the species of a group is generally a slower process than their production." In other words, species do not disappear suddenly, in a flash of geological time. Furthermore, the underlying cause of extinction is the Malthusian "struggle for existence" rather than great upheavals—hiccups of death interrupting stasis. This means that, since each species is engaged in its own struggle in a world of finite resources, there may be no connection of any sort between one extinction and another. As Elizabeth Kolbert puts it, "extinction is a lonely affair."

The crisis between data and theory only became more pressing over the 150 years during which uniformitarianism reigned supreme. The fossil record would not stop screaming—louder and louder. Consequently, paleontologists were forced to devise increasingly tortuous explanations of why the accumulating body of evidence did not in fact support the claim that catastrophes and mass extinctions are real features of life's history. Kolbert recounts these intellectual acrobatics as follows:

> Perhaps there had been some sort of "crisis" at the close of the Cretaceous [when the dinosaurs disappeared], but it had to have been a very slow crisis. Maybe the losses at the end of the period did constitute a "mass extinction." But mass extinctions were not to be confused with "catastrophes."

Yet none of these woes prevented the uniformitarian paradigm from remaining dominant for most of the twentieth century. There were—because there always are—some dissidents who swam against the current. For example, the American meteoriticist Harvey Nininger conjectured in a 1942 *Popular Astronomy* article that "asteroid impacts were responsible for geological boundary events and associated mass extinctions, controlling in part the evolution of life on Earth."[88] A similar idea was proposed by Max Walker de Laubenfels, an American spongiologist, who conjectured that the dinosaurs might have perished because of intense heat created by a meteorite crashing into Earth. But despite the discovery of large Earth-crossing asteroids in the 1930s, few believed that, as the biologist Trevor Palmer writes, celestial bodies

> pose a physical threat to the Earth, as far as could be ascertained from two centuries of scientific observation. Although 200 years was not a long time in relation to the age of the Earth, the reassuring conclusions from this brief period could easily be extrapolated in view of the prevailing uniformitarian paradigm.

But what about large craters on Earth and its natural satellite, the moon? Surely, one might think, these were evidence of major impact events. In fact, scientists at the time believed them to result from terrestrial rather than extraterrestrial phenomena. For example, one geologist argued that certain craters in the US "had been formed by the explosive release of gases from Earth." It was not until around 1960 that scientists began to accept that the craters dotting Earth were caused by impact events.[89]

Others, such as the German paleontologist Otto Schindewolf, proposed in 1954 that neighboring supernovae explosions could produce enough harmful radiation to kill off large numbers of species at once. (Interestingly, he initially accepted the claim, defended by an Italian naturalist Giovanni Battista Brocchi in 1814, that species, like individuals, have intrinsically limited "lifespans" and *this* is why they eventually disappear.) A handful of scientists embraced Schindewolf's intriguing conjecture, although a 1960 paper titled "On Causes of Extinction of Large Groups of Organisms" by F.M. Dyssa and colleagues identified extreme vulcanism as the source of lethal radiation (from radioactive elements). And Norman Newell, an American geologist, argued in 1962 that mass extinctions are real features of life's biography, and that they correspond to stratigraphic boundaries that demarcate different geological periods like the Cretaceous, Triassic, Permian, and Devonian. However, the etiology of these die-offs was changing sea levels, as Cuvier had maintained.

Hence, there was a cluster of hypotheses that pushed against the prevailing orthodoxy. Many of these were surveyed by the science fiction writer Isaac Asimov in his 1979 book *A Choice of Catastrophes*. Asimov considered both natural and anthropogenic risks, organizing them into five basic categories of events that "could bring about the end of human history." However, Asimov stops short of linking some disasters with human extinction, emphasizing instead the regional consequences of them occurring. For example, he writes that although a "meteor strike … may be disastrous and do untold damage, it is not at all likely to be catastrophic in the sense that the sun's becoming a red giant would be. A meteorite is not likely to destroy the Earth or to wipe out humanity or even to topple our civilization." Yet this book was more or less a one-off, and so far as I can tell it did not significantly influence discussions of human extinctions when it was published—although it did inspire an anthology two years later titled titled *Catastrophes!*, in which twenty of "science fiction's most exciting, frightening, and perhaps prophetic authors," as the back cover puts it, elaborate different scenarios in Asimov's five categories.

Finally, no account of catastrophism's eclipse during the twentieth century would be complete without mentioning the Russian scholar Immanuel Velikovsky. An independent scholar who studied psychiatry under Wilhelm Stekel, a student of Sigmund Freud, Velikovsky's 1950 best-seller *Worlds in Collision* "inspired a popular reaction" against uniformitarianism that reverberated through American culture for several decades.[90] The book's argument begins with the idea that we should take seriously the ancient legends, myths, tales, and lore about natural catastrophes having devastated the planet. As Velikovsky wrote in the book's preface,

> the historical-cosmological story of this book is based in the evidence of historical texts of many people around the globe, on classical literature, on epics of the northern races, on sacred books of the peoples of the Orient and Occident, on traditions and folklore of primitive peoples, on old astronomical inscriptions and charts, on archaeological finds, and also on geological and paleontological material.

Velikovsky then built an account of history according to which sometime around the fifteenth century BCE, Jupiter "ejected" the planet Venus, which then drifted through the solar system and, when passing by Earth, caused perturbations in Earth's orbit and axis. This resulted in a series of catastrophes that ancient civilizations recorded in the fragmentary documents and mythological stories that they bequeathed us. Although Velikovsky's subversive proclamations—some of which contradicted Newtonian physics, a huge red flag—"made him a hero in the eyes of the counterculture of the 1960s," his flawed methodology only further discredited catastrophism in the eyes of working scientists.[91] Indeed, the hostile reaction to Velikovsky was so strong that some scientific publishers refused him a platform to respond to criticisms, leading Velikovsky to describe himself as a "suppressed genius," not unlike Giordano Bruno who was found guilty of heresy by the Roman Inquisition and later burned at the stake (thus making him a "martyr for science" in the eyes of some).

So, there were occasional efforts to reconcile geological theory with the paleontological evidence, but for the most part the notion that history has been punctuated by global-scale natural disasters was rejected by the scientific community.

But this state of affairs changed dramatically between 1980 and the early 1990s. The turning point was a revolutionary paper authored by the father-son team of Luis and Walter Alvarez, which reported a startling new discovery: they found a layer of *iridium*, a chemical element, in rock samples from Italy, Denmark, and New Zealand. This was peculiar because iridium is a heavy element, so most of it had sunk into Earth's core, thus making it one of the rarest elements in Earth's crust, specifically the *lithosphere*. But it is abundant in asteroids. Furthermore, the Alvarez team dated the layer to have been formed about 65 million years ago, which is precisely when the dinosaurs died out and the Cretaceous period came to a close. Hence, like detectives on the trail of a fugitive, the Alvarez team began to suspect a connection: perhaps a giant asteroid slammed into Earth and, given the force of the impact, catapulted huge quantities of "pulverized rock" (as they put it) into the stratosphere. This dust would have spread around the planet and blocked out the sun, just as the TTAPS paper hypothesized will happen in an all-out nuclear war. Photosynthesis would cease and plants around the planet would perish, causing mass starvation among the larger herbivorous dinosaurs alive at the time, which required more food to survive than the smaller mammals that eventually became us, or the avian dinosaurs that evolved into the birds that populate our contemporary world. In other words, the dinosaurs died out because an impactor, which left its fingerprints behind in the form of a silvery-white metal, initiated what is now called an "impact winter."

This became known as the "Alvarez hypothesis," or "impact hypothesis," and it provoked an immediate response from scientists. It also received a considerable amount of coverage from the popular media—not to mention from the curious minds of children who are often able to pronounce polysyllabic names like "Ichthyosaurus" better than adults. As the historian and geologist William Glen put it, the idea was "as explosive for science and an impact would have been for Earth." The scientific community became extremely fractured over the plausibility of this radical new idea: on one side were the paleontologists, and on the other were the geoscientists. The former group was overwhelmingly hostile toward the impact idea, in part because they felt that the geoscientists had encroached upon their intellectual territory, swooping in with bold conjectures without having properly studied the methods, accumulated knowledge, and established facts of paleontological science. As a 1985 *New York Times* article reports, some complained that "the impact theory has had pernicious effects on science and scientists," charging "that controversy over the impact theory has so polarized scientific thought that publication of research reports has sometimes been blocked by personal bias." The article quotes a number of prominent paleontologists, such as Robert Bakker of the University of Colorado Museum and a leading figure of the "dinosaur renaissance" that began in the late 1960s. "The arrogance of those people is simply unbelievable," he grumbled about the Alvarez team. "They know next to nothing about how real animals evolve, live and become extinct. But despite their ignorance, the geochemists feel that all

you have to do is crank up some fancy machine and you've revolutionized science." He continued:

> The real reasons for the dinosaur extinctions have to do with temperature and sea-level changes, the spread of diseases by migration and other complex events. But the catastrophe people don't seem to think such things matter. In effect, they're saying this: "We high-tech people have all the answers, and you paleontologists are just primitive rock hounds."

Similarly, the paleontologist William Clemens dismissed the Alvarez hypothesis as "codswallop." Such opinions were widespread, and indeed an informal survey conducted at the 1985 annual meeting of the Society of Vertebrate Paleontologists found that, of the 118 paleontologists who responded, only *five* affirmed that "an asteroid or comet had caused the extinction of dinosaurs and many other land animals at the end of the Cretaceous period." Others, 32 in total, maintained that no sudden mass extinction had happened, but that species died out over millions of years during the Cretaceous. However, most respondents did concur "that some large extraterrestrial object probably did hit the earth 65 million years ago"[92]—it just didn't cause three-quarters of all species alive at the time to bite the dust. Indeed, Palmer notes that even into the *late* 1980s, "it was still far from clear whether mass extinctions were real events, rather than artifacts of the fossil record."

But there were other reasons for skepticism, too. If a massive asteroid collided with Earth 65 million years ago (scientists now believe this occurred 66 million years ago), it would have left behind an enormous crater. But no such crater was known to exist. In this case, absence of evidence is evidence of absence. After more than a decade after the Alvarez paper, this mystery was finally solved when a 100-mile-wide crater buried half-a-mile beneath the Yucatan Peninsula, near the Mexican town of Chicxulub, was discovered—or rather, it was rediscovered, since the national oil company of Mexico, called Pemex, had previously identified it in 1981. But the Pemex team (of geologists) believed that it formed from a large volcano and, although they announced the discovery at the time, "the survey details were kept secret."[93] The crater returned to scientific attention in 1990, leading to investigations that ultimately identified the presence of "shocked quartz" in the crater, which results from incredibly violent explosions; in fact, it was first noticed at the detonation sites of nuclear weapons. This was the smoking gun that the new catastrophists were looking for: a massive crater whose age coincides with the iridium layer and disappearance, and which was almost certainly the result of an asteroid collision rather than volcanic eruption. Consequently, skepticism about the Alvarez hypothesis became untenable, and indeed the scientific community as a whole, including paleontologists, quickly came to agree that, contra Thomas Jefferson, large rocks can indeed fall from the heavens, and sometimes the impact with Earth can cause mass extinctions. As Walter Alvarez wrote in his 1997 book *T. rex and the Crater of Doom*—his term for the Chicxulub crater—the winter between 1991 and 1992, shortly after the crater was identified, "seemed like the turning point." As Alvarez told Kolbert:

> Just think about it for a moment. Here you have a challenge to a uniformitarian viewpoint that basically every geologist and paleontologist had been trained in, as had their professors and their professors' professors, all the way back to Lyell. And what you saw was people looking at the evidence. And they gradually did come to change their minds.

It was now clear that Earth's history had indeed been punctuated by "profound discontinuities." And with this, the mighty edifice of uniformitarianism came crashing to the ground, replaced by a new interpretive framework called *neo-catastrophism*. Cuvier's view had been, at least in its broad strokes, right all along.

Yet this was not the only natural threat to human survival that came into focus during this traumatic period of scientific innovation. By the end of the 1980s, there was growing speculation that volcanic *supereruptions* could bring about what the geologist Michael Rampino and colleagues in 1988 called a "volcanic winter," on the model of Turco's "nuclear winter." As with the latter, a volcanic winter occurs when a massive eruption catapults debris into the stratosphere, thus blocking out the sun and causing the food chain to collapse. This terrifying new scenario was the child of two disciplines: atmospheric science—an umbrella term that subsumes climatology, meteorology, cloud physics, and oceanography—and volcanology. For centuries, scientists had suspected a link between volcanic eruptions and unusual meteorological phenomena. The first paper published on the topic was written by Jefferson's close friend, the deist and Quaker Benjamin Franklin, in 1784. At the time, Franklin was in Europe as the US minister to France. He, along with observers elsewhere in Europe, Northern Africa, and Asia, noticed a "dry fog" that dimmed the sun to such an extent that "when collected in the focus of a burning glass, they would scarce kindle brown paper." In other words, even if one had a magnifying glass a few inches above a brown piece of paper when the daytime sun is brightest, the light was too faint to set the paper on fire. Furthermore, the winter between 1738 and 1739 was extremely cold, as one would expect given the reduced solar radiation. Franklin hypothesized that these odd conditions of cloudiness and frigid weather were the result of a 1738 volcanic eruption that had occurred in Iceland: the Laki eruption. This paper initiated the modern study of volcanoes and climatic anomalies.

Almost a century and a half later, in 1883, a large eruption occurred on the island of Krakatoa, in Indonesia. Studies of this event resulted in a publication by the so-called "Krakatoa Commission" that affirmed a direct connection between major volcanic events and changes in the optical properties of the atmosphere. Consistent with these findings, Camille Flammarion—popularizer of the long-term threat posed by entropy—also observed that the Krakatoa eruption had launched "fine dust … in to the heights of the atmosphere," and that this dust may have altered the appearance of a lunar eclipse in 1884. As he wrote that same year,

> The eclipse of October 4, 1884 is notable to have been just a few degrees greater in its visibility than the others. Perhaps the sky was very cloudy around the edge of the Earth's disk seen from the Moon around that time. Perhaps also the opacity of the upper layers of the atmosphere due to the diffusion of Krakatoa dust (which have not yet disappeared) may have contributed to the absence of refraction of solar rays usually redirected at the Moon.[94]

Further studies in the early twentieth century came to similar conclusions, although the data was not absolutely conclusive and some studies found no correlation between reduced solar radiation, cooling of Earth's surface, and volcanic events.[95] But as research progressed, scientists began to suspect that the factor capable of dimming the sun was not volcanic ash *per se*, but certain chemical compounds that such ash could contain more or less of—in particular, *sulfur dioxide*. In other words, a large eruption could spew huge quantities of ash but small amounts of sulfur dioxide, and the ash of smaller eruptions could coincide with much larger amounts. This is important because when sulfur dioxide reaches the stratosphere, above the weather, it undergoes a chemical reaction to become sulfuric acid, and sulfuric acid particles act like little molecular mirrors that reflect—or "backscatter"—incoming light. So, while nuclear winters are caused by stratospheric soot and impact winters are caused by dust, volcanic winters are the result of sulfur dioxide becoming sulfuric acid. Similar mechanisms, but different. This gained prominence in the 1970s after scientists showed that a previously observed "permanent layer" of sulfuric acid in the stratosphere had a volcanic origin. The evidence was accumulating and the pieces were starting to fit together.

Meanwhile, volcanologists were busy investigating the physical properties of volcanic eruptions. One of the most notable contributions came from the volcanologists Chris Newhall and

Stephen Self, who proposed in 1982 what they called the "Volcanic Explosivity Index," or VEI. This specified eight different categories of eruptions based on the total volume of ejecta (the particles expelled during an eruption) and the height of the eruption cloud. Each category was also given a qualitative description:

VEI 1: Effusive
VEI 2: Gentle
VEI 3: Explosive
VEI 4: Catastrophic
VEI 5: Cataclysmic
VEI 6: Paroxysmic
VEI 7: Super-colossal
VEI 8: Mega-colossal

There were also new insights about the chemical composition of volcanic ejecta, and how climatic conditions, the location of the erupting volcano, and the time of year influenced the resulting effects. For example, an important 1970 paper by H.H. Lamb not only offered strong evidence for volcanic effects on the climate but tabulated "a chronology of important volcanic eruptions for the period subsequent to AD 1500 and his definition of the volcanic dust veil index (d.v.i.), an estimate of the amount of fine volcanic ash or dust lofted into the upper atmosphere by specific historical eruptions."[96]

The picture that began to emerge from these new studies in atmospheric science and volcanology was this: past volcanic eruptions are indeed associated with cooling periods, there have been mega-colossal eruptions powerful enough to puncture the stratosphere with ash, and the chemical element responsible for global cooling is sulfur dioxide. Everything was starting to make sense: the data and theories both converged on the startling proposition that volcanic winters can occur. But then came an incredible opportunity to actually *test* these ideas in realtime. First, there was the 1980 Mount St. Helens eruption in Washington State, which injected ash into the stratosphere. However, it did not produce large quantities of sulfur dioxide. Then two years later, the El Chichón volcano erupted in Mexico. The volume of ejecta was comparable to the Mount St. Helens eruption, but it was rich in sulfur dioxide. So, if the scientists got the science right, more cooling should result from El Chichón than Mount St. Helens—and this is more or less exactly what happened. The volcanic winter hypothesis thus passed its first real-world test.

But questions remained. Could the cooling caused by volcanoes affect the *entire* globe? And exactly how much cooling could occur? Could volcanic winters result in freezing or subfreezing temperatures? Might they have caused mass extinctions in the past? Could they threaten humanity in the present? By the end of the 1980s, these questions acquired a sense of urgency among some scientists. As Self and Rampino wrote in a 1988 paper titled "The Relationship Between Volcanic Eruptions and Climate Change: Still a Conundrum?," the link between these two phenomena "remains a thorny question." They continued: "A still unanswered question is, What are the maximum possible effects on climate from volcanic eruptions? Would a "volcanic winter" be possible with at least several months of extremely cold weather in mid-latitudes and with disastrous effects on agriculture?" The authors conclude the paper with the following alarming remarks about the prospect of humanity surviving a catastrophic supereruption:

> The conundrum of the volcanic influence on our climate remains. We have made some progress toward understanding the connection, but we still cannot forecast those regional and seasonal atmospheric effects of eruptions that would be most important in terms of impact on agriculture, transportation, and health. Our historical experience has been with only relatively small eruptions. We must learn more about the effects of large eruptions. … One thing, however, seems pre-

> dictable: The next *very large* eruption should demonstrate quite clearly the effects of volcanism on our weather and climate.

Yet four years later, Rampino and Self published an article in which they argued that the Toba supereruption on the island of Sumatra, Indonesia, some 75,000 years ago "might have produced a 'volcanic winter'—a brief, pronounced regional and perhaps hemispheric cooling caused by the volcanic dust—followed by a few years with maximum estimated annual hemispheric surface-temperature decreases" of three to five degrees Celsius. Or as they summarized this in 1993, their research suggested "that climate cooling for 1 or 2 years after the eruption could have been quite severe, representing 'volcanic winter' conditions similar to those proposed in scenarios of nuclear winter following a major nuclear exchange." This is excerpted from a paper written in response to another by the science journalist Ann Gibbons, which suggests that a population bottleneck that occurred about 75,000 years ago, known to occur based on analyses of DNA enveloped a part of human cells that used to be its own cell 1.5 billion years ago—an organelle called the "*mitochondrion*"—may resulted from this eruption. According to genetic studies, the entire human population appears to have shrunk to a mere *1,000 breeding pairs*, meaning that humanity may have come terrifyingly close to extinction long ago in the Pleistocene, amidst brutally cold temperatures and darkened skies following a VEI 8 eruption in Southeast Asia. *Homo sapiens*, which has destroyed and endangered so many species over the past few centuries, was once an endangered species itself. This idea is now called the "Toba catastrophe."

As may be clear by now, the nuclear, impact, and volcanic winter hypotheses all influenced each other. The basic chronology went like this: work in the 1970s on temperature fluctuations and volcanic eruptions inspired the impact winter and nuclear winter hypotheses. Indeed, the Alvarez team's argument that stratospheric dust could alter the global climate was based in part on what they described as "the largest well-studied terrestrial explosion in historical times," namely, the Krakatoa eruption. And the TTAPS paper begins with the sentence: "The potential global atmospheric and climatic consequences of nuclear war are investigated using models previously developed to study the effects of volcanic eruptions." In fact, many of the TTAPS authors were themselves atmospheric scientists who were researching the optical effects of dust in the atmosphere. (Sagan actually contributed little of scientific value to the TTAPS study.) For instance, a 1982 paper titled "Evolution of An Impact-Generated Dust Cloud and its Effects on the Atmosphere" included Toon, Pollack, Ackerman, and Turco among its authors. The study found that under certain conditions,

> light levels [would be] too low for vision for 1 to 6 months and too low for photosynthesis for 2 months to 1 year. Calculations of the surface temperature show that … continental surface temperatures drop below freezing for approximately twice as long as sub-photosynthetic light levels persist.

The Alvarez hypothesis was also a major impetus for the nuclear winter hypothesis.[97] (In fact, Luis Alvarez witnessed not only the first atomic detonation in the New Mexican desert but the bombing of Hiroshima, both from an observational aircraft.) As the TTAPS authors note in their 1983 paper, "the discovery that dense clouds of soil particles may have played a major role in past mass extinctions of life on Earth has encouraged the reconsideration of nuclear war effects." Yet it was the nuclear winter hypothesis, in particular, that later inspired the volcanic winter hypothesis at the end of the 1980s. As Rampino and colleagues affirm in a 1988 paper simply titled "Volcanic Winters,"

> beyond the local devastation and regional effects, it is known that some historical eruptions had a noticeable impact on climate and agriculture on a hemispheric to global basis. This being the case, much larger eruptions may possibly have caused severe "volcanic winters," perhaps similar to the recently proposed "nu-

> clear winter." These "supereruptions" must therefore be considered in discussions of natural hazards that might have global consequences

One idea led to another, which led to another, which in turn influenced the original. These hypotheses were so tightly coupled together that some paleontologists complained in the mid-1980s that

> dissenters from the meteorite theory have faced obstacles in their careers and are sometimes even privately branded as militarists, on the supposed ground that anyone who questions the catastrophic theory of dinosaur extinction also questions the theory that a lethal "nuclear winter" similar to the climatic effect of a meteorite impact would follow a nuclear war.[98]

Taking a step back, the outcome of all this was that over the course of *just over a decade*, humanity transitioned from the reassuring belief that Mother Nature has no malign intention of committing filicide in the near future to believing that Earth and the heavens could strike a fatal blow to humanity at any moment. If the culprit is not an asteroid, comet, or supervolcano, then it might even be some cosmic calamity like a supernova, as Schindewolf suggested in 1954. Or perhaps gamma-ray bursts, first identified as an existential threat in the 1990s, could destroy the ozone layer around Earth and thus expose its inhabitants to deadly amounts of UV radiation. The number of scenarios exploded, which scholars more recently have suggested implies that there may be even more natural hazards that we have not yet identified.

This cluster of scientific discoveries about the violent habits of nature reinforced the previous moods of *existential vulnerability* and *imminent doom*. But it did more than this. The new existential mood arose from the realization that *there is no place safe in the universe*. We are not safe in the global village that we built using twentieth century technologies, nor are we safe from the cosmic shadows and phantasms that surround this little village. The threats are closing in from all sides: they are near and long term, natural and anthropogenic. They come from the beneath and above. Some are completely unprecedented dangers (nuclear war), meaning that we have no track record of surviving them, while others have proven capable of wiping out nearly all life on the planet (asteroid impacts). If one threat doesn't do us in, another very well might. Hence, humanity faces a dilemma moving forward: if we continue on the path of technological development, then we will remain susceptible to nuclear war and biospheric ruination. Yet if we were to abandon civilization and "return to the Pleistocene," we will become more vulnerable to an impact or volcanic winter, since technology holds the promise of mitigating these risks. (As the science fiction writer Larry Niven once quipped, "the dinosaurs became extinct because they didn't have a space program.") We are not safe. Neo-catastrophism was the new game in town.

Chapter 6: Creatures of the Twilight

What, Mr. Speaker! And so we are to beggar ourselves for fear of vexing posterity! Now, I would ask the honourable gentleman, and this still more honourable House, why we should put ourselves out of our way to do anything for posterity—for what has posterity done for us?—Sir Boyle Roche

We have no right to take steps that may destroy the legacy of the past and that may make conditions unpleasant, or even impossible, for future generations.—Robert McKim[99]

Posterity is for the philosopher what the "other world" is for the man of religion.—Denis Diderot

So where have we ended up in space and time? The story so far has transported us across several millennia, from an innocent childhood to a traumatized adolescence, during which we became painfully aware of our mortality as a species. Over only the past *seven decades* or so, humanity underwent a harrowing journey from believing that human extinction, if it is even possible, is a distant peak of the temporal horizon to worrying that we could stumble, or trip ourselves, into the eternal grave of extinction quite literally *tomorrow*. Note that seven decades is 0.02 percent of the lifespan of our species so far, which emerged in the grassy savanna of East Africa some 300,000 years ago. This means that a whopping 99.98 percent of our existence was completely unencumbered by fears of total annihilation. Even more, if one extrapolates the recent history of creating and discovering scientifically credible kill mechanisms since 1954, there is every reason to expect entirely *new threats* to crystalize in the coming decades and centuries. There could be any number of "unknown unknowns"—meaning that we are not even aware that we are unaware of them—hiding in the cosmic shadows, ready to leap out at us when we least expect. And further technological breakthroughs could introduce novel risk scenarios that are as unimaginable to us right now as nanotechnology and geoengineering were to Lord Kelvin and Charles Darwin just two centuries ago.

So far we have focused on how science and technology altered how we understand our existential predicament in the universe. But alongside the most recent periods of traumatic scientific discovery (chapter 5), a completely new perspective on the *meaning* or *significance* of human extinction began to take shape. As chapter 1 states, this revolution was more *conceptual* than *empirical* in nature, although it almost certainly would not have arisen—there would have been no reason for it to—if scientists had not arrived at the startling conclusion that near-term extinction is not merely possible, but probable. Bundled together in this perspective are three main ingredients, the first two of which are *descriptive* (they concern what is or could be) and the last of which is *normative* (it concerns what should be):

> (1) That our evolutionary lineage (which consists of all our descendants) could last for an *extremely long* time.
> (2) That the future could be much *better than* the past and present; a techno-utopian world awaits our lineage if we play our cards right.
> And …
> (3) That there are overwhelming *moral reasons* for ensuring that we both last for as long as physically possible and create a techno-utopian world of near-infinite value.

I will consider these in order, arguing that they first came together systematically in the work of scholars in the 1980s, but did not engender a well-defined *research program* until the early 2000s.

There are three main ingredients in the new existential mood. The first is what we can call "deep-future" thinking, on the model of McPhee's term "deep time" (which refers to how we began to think differently about history rather than the future).[100] The second concerns an idea discussed above, for which Sir Julian Huxley coined the term "transhumanism" in his 1927 *Religion Without Revelation*. And the third comes from an ethical theory called *utilitarianism*—in particular, *total utilitarianism*—first discussed in systematic detail by the late eighteenth-century philosopher Jeremy Bentham. Let's start by considering the development of these ideas in turn:

Our ancestors have quite possibly *always* thought about future things beyond what the psychologist Abraham Maslow called "our basic needs," such as eating and drinking. The archaeological evidence indicates that ritual burials were practiced at least 100,00 years ago, back when saber-toothed cats and woolly rhinos ruled the icy planet and the oceans were 400 feet lower than today. It may even have been the case that our hominid cousins the Neanderthals engaged in mortuary rituals. For example, anthropologists have argued that the Des-Cubierta Cave in Spain was used by these bipedal beasts "as a specific place to mourn and remember the dead." This is because the mandible and dental fragments of a Neanderthal toddler were found inside the cave, around which a number of hearths were built, each containing horns from bison and aurochs, antlers from red deer. The skull of a rhino was also placed nearby.[101] Such discoveries are notable because returning someone to the earth with such care suggests that Neanderthals imagined the deceased living on in another realm, the afterlife, perhaps venturing through an infinite series of transmigrations of the soul, as some of the earliest religions claimed is the case. Even more, as chapter 2 discussed, some people thought not only about the future predicament of *humans* but the long-term fate of *humanity*. Recall that Hindu eschatology posits an endless series of cycles that are 4.32 billion years long, and the "incalculable eons" of Buddhism were said to unfold across inconceivably huge stretches of the temporal landscape. And of course the notion of *eternal life* with God in heaven was central to the eschatological stories of Christianity, Islam, and Zoroastrianism—all of which may have begun as apocalyptic movements that anticipated an imminent end to the present era.[102]

But visions of the future near and far began to shed the constricting skin of religious dogma with the post-Enlightenment secularization of western intellectual culture. Some of these embodied *utopian* hopes for a world made better through human effort ("meliorism"), while others were what we can call *collapsitarian*, meaning that they anticipated the eventual unraveling of society. Still others combined both of these elements, just like the above-mentioned religions, whereby the apocalypse is a necessary precursor of utopia. In the first camp, one finds the French philosopher Marquis de Condorcet, who offered a triumphant "Grand Narrative" of human history in his 1795 *Sketch for a Historical Picture of the Progress of the Human Mind*. As the historian Warren Wager points out, "its final pages glow with the expectation of a golden future for all mankind."[103]

Immanuel Kant himself provides an example of this pivot towards longer-term considerations of our future on Earth. For instance, his 1789 treatise "Conflict of the Faculties," which I quoted in chapter 2, delineates three hypotheses of humanity's moral growth:

> The human race exists either in continual retrogression toward wickedness, or in perpetual progression toward improvement in its moral destination, or in eternal stagnation in its present stage of moral worth among creatures (a stagnation with which eternal rotation in orbit around the same point is one and the same).

Kant called these *terrorism*, *eudaimonism*, and *abderitism*, respectively. He then dismissed the first outcome, arguing that a "decline into wickedness cannot be incessant in the human race, for at a certain stage of disintegration it would destroy itself." (Once again, he *appears* to be referencing human extinction in our modern scientific sense.) Although Kant notes that the third may be the most common view, he endorsed the second, writing: "Here, therefore, is a proposition valid for the most rigorous theory, in spite of all skeptics, and not just a well-meaning and practically commendable proposition: the human race has always been in progress toward the better and will continue to be so henceforth."

Other Grand Narratives, complete with eschatological storylines, were proposed by Georg Wilhelm Friedrich Hegel, a prominent philosopher in eighteenth/nineteenth-century Germany, and Auguste Comte, who founded modern sociology and referred to himself as the "High Priest of Humanity." On the collapsitarian side one finds theorists like Thomas Malthus, who as we have seen predicted collapse based on the principle that food grows linearly whereas human populations expand geometrically.

Perhaps the most influential Grand Narrative ever invented, though, came from the hirsute German economist Karl Marx. Building on the ideas of Hegel (who was an "idealist" rather than a "materialist"), he outlined not just a sprawling account of civilizational development but a thoroughgoing *secular eschatology* of what lies ahead. In fact, Marx's account seems to have plagiarized, at least in its general structure, the prophetic tale of Christian scripture. On this interpretation, the initial condition of our ancestors was a state of primitive communism (the Garden of Eden), after which they passed through various stages (or dispensations) like feudalism and capitalism. In the end, class struggle between the capitalists (reprobates) and workers (elect) will usher in a paradisaical new world of pure communism (heaven). This will be catalyzed by the revolutionary (or revelatory) insights of Marx (the messianic prophet), who introduced humanity to the salvific message of "dialectical materialism." Yet this transition will require, as the historians Daniel Chirot and Clark McCauley write, "a final, terrible revolution" (the Battle of Armageddon) that will "wipe out capitalism, alienation, exploitation, and inequality" (sin and evil).

The point is this: not only were such eschatologies increasingly secular—Marx's being quite aggressively atheistic—but driving these new visions was a growing sense of "the progressive entanglement of the present, both theoretically and practically, within an ever-deepening horizon of futurity," as Moynihan puts it.

And of course this sort of secular interest in our collective future enraptured later science fiction writers like Camille Flammarion and Olaf Stapledon, both of whom explored various aspects of how cosmic history could unfold in the deep future. In fact, Stapledon's 1937 book *The Star Maker* covers far more territory than *Last and First Men*. It is a history not of human evolution over the course of two billion years but cosmic evolution some *500 billion* years henceforth.

But no figure in the past few centuries has done more to promote deep-future thinking than H.G. Wells. As the historian Warren Wagar observes, "all the tendencies in earlier futurist thought coalesced" in Wells's writings, both fictional and non-fictional. Indeed, Wagar argues—and I concur—that Wells more or less founded the field of Future Studies (or Futurology) with his 1901 book *Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought,*, which was the first widely read, comprehensive survey of futuristic possibilities. The success of this book—it was a bestseller—resulted in Wells being invited to give a lecture at

the Royal Institution of London, which he did the following year. Titled "The Discovery of the Future," he argued for the creation of an academic discipline focused on humanity's future using the tools of scientific investigation. "I believe quite firmly," Wells stated, "that an inductive knowledge of a great number of things in the future is becoming a human possibility. I believe that the time is drawing near when it will be possible to suggest a systematic exploration of the future." he continued:

> So far nothing has been attempted, so far no first-class mind has ever focused itself upon these issues; but suppose the laws of social and political development, for example, were given as many brains, were given as much attention, criticism, and discussion as we have given to the laws of chemical combination during the last fifty years, what might we not expect?

The lecture concludes with a wonderfully inspiring call to think of tomorrow not in terms of days but entire epochs of civilizational development and human progress:

> It is possible to believe that all the past is but the beginning of a beginning, and that all that is and has been is but the twilight of the dawn. It is possible to believe that all that the human mind has ever accomplished is but the dream before the awakening. We cannot see, there is no need for us to see, what this world will be like when the day has fully come. *We are creatures of the twilight*. But it is out of our race and lineage that minds will spring, that will reach back to us in our littleness to know us better than we know ourselves, and that will reach forward fearlessly to comprehend this future that defeats our eyes (italics added).

The day Wells delivered this lecture is, Wagar declares, "the day when the study of the future was born." Wells followed-up on these ideas exactly three decades later with an essay for the BBC radio titled "Wanted: Professors of Foresight." In this, Wells bemoaned the fact that "there is not a single Professor of Foresight in the world," although he adds that "I am by way of being an amateur." He continued,

> isn't is plain that we ought to have not simply one or two Professors of Foresight but whole Faculties and Departments of Foresight doing all they can to anticipate and prepare for the consequences of this gathering together, this bunching up, which is now going on, of what were once widely dispersed human relationships? We need to organise Foresight in these matters very urgently indeed.

Wells's hortatory remarks did not have an immediate effect on the organizational structure of academia, although Future Studies did emerge as a distinct field in the 1960s. Today it is typically characterized as studying "the three P's and a W." The P's refer to the *possible*, *probable*, and *preferable* futures and the W refers to *wildcards*, or high-impact but low-frequency events that the statistician and noted curmudgeon Nassim Taleb calls "black swans." Early work within this new Wellsian field included contributions from the likes of Bertrand de Jouvenel, Dennis Gabor, Marshall McLuhan, Buckminster Fuller, and Rachel Carson. Among the first professors of Future Studies was an Iranian-American scholar Fereidoun M. Esfandiary, who later changed his name to FNM-2030 in part because he hoped to live at least until his 100th birthday, and was born in 1930. (Sadly, FM-2030 died at 69.) And the aforementioned author of *Nuclear Disaster*, Tom Stonier, was often called "the professor of futurology" for his pioneering work on techno-scientific trends.

But the birth of deep-future thinking was not *complete* until the formation of a subfield of cosmology that the astrophysicist Fred C. Adams and astronomer Gregory Laughlin have called "physical eschatology." This refers to the scientific investigation of the long-term evolution of the

cosmos—and by implication, of the fate of humanity. Since Rudolf Clausius and Lord Kelvin, physicists have known that the universe is gradually winding down due to entropy. But they did not know that it is also expanding, a discovery based in part on the fact that, as the American astronomer Edwin Hubble noticed in 1929, everywhere we look, clusters of galaxies are moving away from us—which is exactly what every piece of shrapnel expelled by a bomb would observe if they were to look around at all the other pieces of shrapnel. Hence, if one rewinds the tape, everything that exists in the universe converges upon a single point, a "singularity." This implies that the universe had a beginning, now called the Big Bang, which refers to the moment at which space began to expand. As mentioned before, this based idea was first proposed by Edgar Allan Poe in 1848.

Some cosmologists have argued that the universe will expand forever, ultimately succumbing to the heat death that is also sometimes dubbed the Big Freeze. But this was challenged in 1969 by a short paper titled "The Collapse of the Universe: An Eschatological Study" by the cosmologist Lord Martin Rees. It examined evidence for an alternative scenario in which our cosmic abode terminates not in a Big Freeze but Big Crunch, whereby the expansion of the universe reverses due to gravity, resulting in a catastrophic contraction back to the original state in which it began. As Rees writes, "all structural features of the cosmic scene would be destroyed during this devastating compression." On this view, time is ultimately a circle rather than an arrow. Or as Rees puts it, perhaps "the universe is perpetually oscillating, and this contraction is merely a prelude to a subsequent re-expansion [such that] stars, galaxies, and clusters must form anew in each cycle." Today, cosmologists believe that the gravitational forces between galaxy clusters is such that the universe will not in fact collapse back on itself in a catastrophic act of cosmic violence, but expand forever, thus resulting in a future configuration whereby matter and energy are uniformly distributed throughout. The point is many physicists identify Rees's paper as the founding document of physical eschatology. Indeed, not only was it the first time the word "eschatology" was used in a scientific—specifically, cosmological—rather than theological context, but it triggered a flurry of important papers on the topic the following decade.

This focused the eyes of working scientists on not just the future millions or billions of years from now, as Wells and Stapledon did in their books and lectures, but spans of time many orders of magnitude greater. For example, research in physical eschatology suggests that Earth will remain habitable to complex organisms like ourselves for another 1 billion years or so. Five billion years later, our galactic home, the Milky Way, will collide with the Andromeda galaxy. In about 10^{14} years, stars will stop shining, thus plunging the entire universe into a bone-chillingly cold darkness. Yet occasional scintillas of light will puncture the canopy as brown dwarfs (a type of "substar") randomly collide with each other, resulting in objects "massive enough to sustain hydrogen fusion," which, like nuclear fission, releases energy stored within the nucleus of atoms. Other sources of light will emerge from the decay of protons within white dwarfs, although "an entire galaxy of these stars will appear dimmer than our present-day Sun." By 10^{40} years from now—that is, a 1 followed by 40 zeros—all of these protons will have decayed. This constitutes a "milestone [that] marks a definitive end to life as we know it, as no carbon-based life can survive the cosmic catastrophe induced by proton decay."[104] Then, between 10^{70} and 10^{100} years from now, all that will remain are those spacetime-deforming black holes, but even these will not last forever due to what physicists call "Hawking radiation." Once this process reaches completion, the universe will only contain a potpourri of subatomic particles, like electrons, positrons, neutrinos, photons, and dark matter particles. But in a remarkable plot twist that would bend the arrow of time back on itself without Rees's Big Crunch, the universe could spontaneously transition from a "false vacuum" to a "true vacuum" state—an event discussed above in the context of high-powered particular accelerators. As Fred Adams, one of the astrophysicists who coined the term "physical eschatology." writes,

> if the universe were to experience a vacuum phase transition, it remains possible (but is not guaranteed) that specific aspects of the laws of physics (e.g., the mass-

es of the particles and/or the strengths of the forces) could change, thereby giving the universe a chance for a fresh start.

Thus, by the late twentieth century, deep-future thinking had been firmly established among those "in the know." This led some futurists to begin asking about the *preferable futures* that could materialize within the space of possibility delimited by physical eschatology. But what exactly should we prefer to be the case in the near- and long-term future? This leads to the second ingredient mentioned above, namely, transhumanism. Recall Huxley's proclamation from chapter 3 that humanity is beginning to learn how to alter its own essential properties. To quote Huxley once again: "The study of heredity and population-growth, and the knowledge of eugenics and of birth-control are pointing the way to wholly new aims—to a conscious control by man of his own nature and racial destiny." The initial strategy for taking control of our evolutionary path was "selective breeding," as Francis Galton advocated. By encouraging "superior" individuals while discouraging "inferior" individuals from having children, the overall quality of the "human stock" could be improved over multiple generations—or so the troubling line of reasoning went. This is why California force-sterilized some 20,000 people between 1909 and 1963, and the Nazis conducted human experiments with X-rays on people deemed to be "unfit," to prevent them from procreating.

But the accelerating development of increasingly powerful emerging technologies led transhumanists in the final two decades of the twentieth century—initially calling themselves "extropians," where "extropy" was supposed to contrast with "entropy"—to abandon these old methods. Instead, this new generation of futurists emphasized the possibility of using what the transhumanist philosopher Mark Walker calls "person-engineering technologies" to improve the human form, or phenotype. This initiated a swivel in thinking about technological interventions as *enhancive* rather than *therapeutic*: perhaps we could utilize biotechnology, synthetic biology, nanotechnology, and artificial intelligence to radically augment our cognition, emotions, healthspan, and even morality. The idea was that humanity occupies a tiny location within a massive space of possible "modes of being," some of which could be *far better*, according to some criteria, than the current human mode. Thus, by undergoing radical human enhancement—by upgrading to what Max Tegmark calls "Life 3.0"—we could become one or more new "posthuman" species with superintelligent minds, complete control over our emotions, indefinitely long healthspans, and ever-wider circles of moral concern. We might call these future beings *Homo cyborgensis* or *Posthomo sapiens*, or perhaps the best binomen comes from the Israeli historian Yuval Noah Harari's: *Homo deus*, which translates as "human god." (As Harari writes, "history began when humans invented gods, and will end when humans become gods.")

Indeed, a prominent theme among transhumanists in the late 1990s and early 2000s was cryonics, whereby one's body or brain (plus the brain stem) are frozen after death. Once techniques to reanimate the body are developed, these individuals could then be revived. By this point, the argument goes, rejuvenation therapies will have been developed later this century, thus enabling these "born again" people, if you will, to live forever. Or if reanimation is not possible, their brains could be scanned in microstructural detail and then emulated on a supercomputer, thus bringing them back to life in either a robotic body, moving about in the physical world, or a simulated universe, where reality is virtual but the inner experience, or phenomenology, of being alive remains intact. This is variously called "mind uploading" and "whole-brain emulation."

Some transhumanists even imagined a future in which biotechnology could enable humanity to reengineer *the entire biosphere* to eliminate the suffering caused to wild animals by predation, starvation, and other natural evils. For example, according to "*r*/*K* selection theory," some species have evolved a strategy for propagating themselves that involves producing huge numbers of offspring, each of which has a low probability of surviving. The result is a tremendous amount of suffering and death. But if we could design technologies to intervene on this process, perhaps we could expunge this source of gratuitous biological misery. The most notable

advocate of this grand and visionary "abolitionist project" has been the utilitarian philosopher David Pearce, who co-founded the World Transhumanist Association in 1998 with Bostrom.

So, to summarize, in place of Galtonian eugenics—which many transhumanists today vehemently reject, given the moral catastrophe of Nazi Germany—the new transhumanists advocated for what they call *morphological freedom*. As Max More, who coined the term "extropy," wrote in 1993, this refers to "the ability to alter bodily form at will through technologies such as surgery, genetic engineering, nanotechnology, [and mind-]uploading."[105] This freedom should, indeed, constitute a *human right* to use person-engineering technologies to alter ourselves however we like. The point is that person-engineering technologies and morphological freedom could enable present-day people, or our descendants, to escape the human curses of ignorance, foolishness, suffering, senescence, and ultimately death. The future could thus be *unimaginably marvelous*—a techno-utopia, a paradise, a heaven on Earth or beyond, that current humans with all the onerous limitations bequeathed to us by contingent evolution can scarcely begin to comprehend. As Bostrom, arguably the most prominent transhumanist of the twenty-first century so far, writes in his semi-poetic "Letter from Utopia," which is addressed "Dear Human" and signed "Your Possible Future Self": "How can I tell you about Utopia and not leave you mystified? With what words could I convey the wonder? My pen, I fear, is as unequal to the task as if I had tried to use it against a charging war elephant." The letter continues with an effusive ballet through a delicate phantasmagoria of imagery:

> My mind is wide and deep. I have read all your libraries, in the blink of an eye. I have experienced human life in many forms and places. Jungle and desert and crackling arctic ice; slum and palace and office, and suburban creek, project, sweatshop, and farm and farm and farm, and a factory floor with a whistle, and the empty home with long afternoons. I have sailed on the seas of high culture, and swum, and snorkeled, and dived. Quite some marvelous edifices build up over a thousand years by the efforts of homunculi, just as the humble polyps in time amass a coral reef. And I've seen the shoals of biography fishes, each one a life story, scintillate under heaving ocean waters.

The anonymous author then adds that

> you could say I am happy, that I feel good. That I feel surpassing bliss and delight. Yes, but these are words to describe human experience. They are like arrows shot at the moon. What I feel is as far beyond feelings as what I think is beyond thoughts. Oh, I wish I could show you what I have in mind! If I could but share one second with you!

But "to reach Utopia," the letter declares, "you must discover the means to three fundamental transformations. The first is becoming immortal through rejuvenation therapies. The second is becoming superintelligent, since "it is in the spacetime of awareness that Utopia will exist." And the third is to maximize pleasure because "a few grains of this magic ingredient are worth more than a king's treasure." Other influential transhumanists have identified alternative routes to the Promised Land. For example, the inventor and futurist Ray Kurzweil, who was inducted into the National Inventors Hall of Fame in 2002 and is currently a director of engineering at Google, argues that techno-utopia will be ushered in by a history-rupturing event called the "technological Singularity." This will enable us

> to transcend our frail bodies with all their limitations. Illness, as we know it, will be eradicated. Through the use of nanotechnology, we will be able to manufacture almost any physical product upon demand, world hunger and poverty will be solved, and pollution will vanish. Human existence will undergo a quantum leap

> in evolution. We will be able to live as long as we choose. The coming into being of such a world is, in essence, the Singularity.

The transhumanist movement of the late twentieth and early twenty-first centuries thus introduced a novel secular vision of utopia, one that was inextricably bound up with the hope that emerging technologies that could enable us or our descendants to transcend the treacherous baggage of biology and explore an indefinite variety of posthuman modes of being. The result will be a paradisaical world in which the *human condition* has been replaced by a *posthuman condition*, one in which perhaps even the entire biosphere can be redesigned to optimized for happiness, pleasure, and harmony. This leads us to the final ingredient of the new existential mood.

Let's start with the fact that, over the past three millennia, the western tradition of moral philosophy has spawned three main traditions. The oldest, with roots in the work of Aristotle (as well as Mencius and Confucius in the east), is *virtue ethics*. Many centuries later, Kant outlined a different approach called *deontology*. Whereas virtue ethics focuses on the importance of developing virtuous character traits like courage, wisdom, temperance, generosity, and friendliness, deontology posits that whether a moral choice is right or wrong depends entirely upon whether or not one follows certain rules, such as "Do not steal" and "Do not murder." Kant himself argued that these rules—based on the Moral Law—are absolute in the sense that they must never be violated.[106] Thus, he quite literally argued that it would be morally wrong to lie to a murderer who asked about the location of his next victim: if one knows where this victim is, then one should not mislead the murderer (although Kant attempted to resolve this problem by suggesting that one could simply remain silent). The third and most recent tradition is *utilitarianism*, which as mentioned above originated with the work of Jeremy Bentham in the late eighteenth century, although hints can be found in earlier philosophers. This view is also rule-based, although the rule that classical utilitarianism says one should follow is simply "to maximize the total amount of pleasure (or happiness, or utility) that results from one's actions." Hence, it would be wrong to murder not because it would violet the rule against murdering someone, but because it would decrease the overall quantity of pleasure in the world, and it would be wrong *not* to mislead a murderer for the very same reason. As Bentham's student John Stuart Mill (not to be confused with the theologian John Mill mentioned in chapter 3) put the idea in his canonical 1863 book *Utilitarianism*, "the creed which accepts as the foundation of morals, Utility, or the Greatest Happiness Principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness."

An important difference between utilitarianism and deontology has often been expressed by the slogan that "utilitarianism puts the *good* before the *right* whereas deontology puts the *right* before the *good*."[107] To be clear about this, ethics is fundamentally about what one *ought to do* in certain circumstances. Kant claimed that what one should do is completely disconnected from which outcomes are deemed to be good or bad in the world. The example of the murderer is a case in point: helping a murderer find his victim would clearly—everyone agrees, even Kant—be *bad*. But Kant would retort, "So what? Being a morally good person has *nothing to do* with the consequences of one's actions. It has to do with obeying the Moral Law" (a position that comports with traditional Christian morality, as encoded by the Ten Commandments, which are imperatives that one must follow no matter what). Utilitarians like Bentham and Mill disagreed. On their view, considerations of good and bad outcomes in the world is all that matters when it comes to determining which actions are right and wrong (and hence what one ought to do). Furthermore, they contended that a good outcome is one in which more net value obtains than would otherwise be the case. This idea was developed further in the nineteenth century by the British philosopher and atheist Henry Sidgwick. In his important but ponderous 1874 book *The Methods of Ethics*, Sidgwick argued that we should view the goodness or badness of outcomes from what he called "the point of view of the universe." This means that one should evaluate things as if one is peering down on human affairs from the perspective of a disembodied eye. The aim is to get a truly

objective picture of different possible states of affairs, and from this position determine the ethical status of the actions of an agent.

This shift in thinking about ethics has some hugely significant implications. For example, since the universe could remain habitable for another 10^{40} years (or so) from now, an inscrutably large number of people could exist in the future. And if these people have net-positive lives, or what philosophers like to call "worthwhile lives," then when it is all said and done the universe could contain huge amounts of pleasure, which is the only thing in the whole wide world that Bentham, Mill, and Sidgwick believed was *intrinsically good* (or *intrinsically valuable*—these terms are synonymous here). And a universe that contains huge amounts of value is a better one that does not. It follows that human extinction would constitute a terrible tragedy not just because dying out could cause unspeakable suffering, but because it would prevent potentially vast quantities of value from being realized within our "future light cone," or the region of the universe that is theoretically accessible to us at any given moment of time. Although there would be no humans around to experience the non-existence of humanity if we were to go extinct, this loss would nonetheless be (catastrophically) bad *from the universe's point of view*. Hence, the worst aspect of human extinction is not the process or event of *going extinct* but the state or condition of *being extinct*.

Sidgwick himself addressed this very issue, albeit in passing. Referring to "the case of celibacy," which may have been in part a reference to anti-natalism (see chapter 2), he wrote that "a universal refusal to propagate the human species would be the greatest of conceivable crimes from a Utilitarian point of view." This contention was later taken up by intellectuals in the second half of the twentieth century, such as the Oxford philosophers Jonathan Glover and the late Derek Parfit, the latter of whom began his career as [Simon quote] and is now considered to have been the most influential moral philosopher of the twentieth century's second half. In fact, Glover was […], writing in 1977 that "to end the human race would be about the worst thing it would be possible to do."[108] A few years later, in his celebrated 1984 book *Reasons and Persons*, Parfit similarly declared that "the destruction of mankind would be by far the greatest of all conceivable crimes," where "the badness of this crime would lie in the vast reduction of the possible sum of happiness." Leading up to this conclusion is a now-quite-famous thought experiment in which Parfit asked readers to imagine three scenarios. As he wrote:

> I believe that if we destroy mankind, as we now could, this outcome would be much worse than most people think. Compare three outcomes:
> 1. Peace.
> 2. A nuclear war that kills 99 percent of the world's existing population.
> 3. A nuclear war that kills 100 percent.
>
> (2) would be worse than (1), and (3) would be worse than (2). Which is the greater of these two differences? Most people believe that the greater difference is between (1) and (2). I believe that the difference between (2) and (3) is very much greater.

The reason is that, echoing Wells's 1902 comments in "The Discovery of the Future,"

> civilization began only a few thousand years ago. If we do not destroy mankind, these few thousand years may be only a tiny fraction of the whole of civilized human history. The difference between (2) and (3) may thus be the difference between this tiny fraction and all of the rest of this history. If we compare this possible history to a day, what has occurred so far is only a fraction of a second.[109]

The belief that civilization is young and could exist for eons more has popped up here and there throughout western history. For example, the first-century BCE Roman philosopher Lucretius declared that (quoting the American sociologist Robert Nisbet) "despite the grandeur of all that man has achieved on earth through his own efforts, the human race is still in its infancy, and even greater wonders may be expected." One finds a similar view expressed by another Roman philosopher from the same period, Seneca the Younger.[110] And of course there were Enlightenment *progressivists* like Marquis de Condorcet who imagined great leaps of human progress leading to increasingly marvelous conditions of living in the near and distant future. More recently, in a magisterial 1982 book *The Fate of the Earth*, the journalist Jonathan Schell

the Beach, and Jonathan Schell's The Fate of the Earth, have been labeled disreputable. The apocalyptic claims
are rejected as unproved and unlikely, and it is judged unwise to frighten the public with doomsday talk when nuclear weapons are needed, we are told, to preserve the peace. But, as the above quotations illustrate, comparably dire warnings have been made by
respectable scientists with diverse political inclinations, including
many of the American and Soviet physicists who conceived, devised and constructed the world nuclear arsenals

Similarly, the Canadian philosopher John Leslie published

[Parfit cites Schell, Leslie cites Glover]

The first book to offer a comprehensive survey of these new hazards was the aforementioned publication, in 1996, by Leslie, titled *The End of the World: The Science and Ethics of Human Extinction*. In fact, the similarities between the first two chapters of this book and Bostrom's seminal 2002 paper are, in my eyes, quite striking. Leslie examines a frightful array of existential challenges posed by genetic engineering, nanotechnology, artificial intelligence, and even "annihilation by extraterrestrials." He also discusses what I have more recently called "agential risks," or the risks posed by *omnicidal agents* who would willingly (and perhaps *eagerly*) push a "doomsday button" if one were within finger's reach.[111] (The reader unfamiliar with this literature might think that few people would actually do this, but that is absolutely not true, as my research has shown. Indeed, a colleague of mine knew two people who got their PhDs in biology for the express purpose of learning how to create an infectious disease that could wipe out humanity.)

Leslie also provided one of the most compelling defenses to date of the so-called "Doomsday Argument." This intriguing idea was proposed by the astrophysicist Brandon Carter —also the first to use the term "anthropic principle"—but Leslie's book made it a topic of serious philosophical investigation. In brief, the argument goes as follows: imagine that you have two urns in front of you. In the first, there are ten balls numbered one through 10. In the second, there are 1,000 balls numbered one through 1,000. Your task is to reach into an urn, pick a ball, look at the number, and guess which urn it came from. Imagine you do this and pick a ball numbered seven. It is far more likely that you picked a ball from the first rather than the second urn. Now consider two hypotheses about the total number of human beings who have ever existed. So far, an estimated 60 and 100 billion people have lived and died on this oblate spheroid, Earth, over the past 300,000 years. The first hypothesis says that there will be 150 billion in total; the second that there will be 100 trillion. If you treat yourself as a "random sample" of all the humans who will ever exist, then it is much more likely that the first hypothesis is true than the second. It follows that doom will probably happen sooner rather than later, so whatever your estimate of annihilation based on empirical considerations is, you should increase it. Or in slogan form: we are systematically *underestimating* the probability of extinction. Based on this argument and his em-

pirical assessments of the swarming dangers on the threat horizon before us, Leslie estimated that the likelihood of extinction within the next 500 years is 30 percent—not *terribly* pessimistic, but still unnervingly high.

So this idea was not new to Parfit, although he did give it a unique spin by identifying it as a reason to oppose human extinction.

There are two issues here worth untangling. The first concerns the lifespan of our species, and by implication our civilization. The second concerns the total number of people who could come to exist in the future—that is, how large our civilization could become and to what extent it could flourish. One could wish for humanity to exist for indefinitely long periods, perhaps because one believes that we have what philosophers call "final value," meaning that we are *valuable in an of ourselves*. A classic test called the […] for determining whether something has final value is to ask […]. Some philosophers have recently argued that human extinction would be a great tragedy because we have final value, and [Scheffler]. But for utilitarians, the goal is to not just survive but "go forth and multiply." This leads to the obvious question: just how large could the population of our descendants become? So far as I know, the very first attempt to actually crunch the numbers came from Carl Sagan's 1983 *Foreign Affairs* article about the nuclear winter hypothesis. I do not know whether Sagan was aware of Sidgwick's or Glover's ruminations, but he was well-aware of Schell's book.

his argument is worth reproducing at length:

> Some have argued that the difference between the deaths of several hundred million people in a nuclear war (as has been thought until recently to be a reasonable upper limit) and the death of every person on Earth (as now seems possible) is only a matter of one order of magnitude. For me, the difference is considerably greater. Restricting our attention only to those who die as a consequence of the war conceals its full impact. If we are required to calibrate extinction in numerical terms, I would be sure to include the number of people in future generations who would not be born. A nuclear war imperils all of our descendants, for as long as there will be humans. Even if the population remains static, with an average lifetime of the order of 100 years, over a typical time period for the biological evolution of a successful species (roughly ten million years), we are talking about some 500 trillion people yet to come. By this criterion, the stakes are one million times greater for extinction than for the more modest nuclear wars that kill "only" hundreds of millions of people. … Extinction is the undoing of the human enterprise.

This line of reasoning was greatly expanded by transhumanists and utilitarians in the early 2000s. Drawing from the insights of physical eschatology and taking seriously the possibility of space colonization, they realized that the lifespan of civilization and total number of people who could come to exist is *far greater* than Glover, Parfit, or Sagan seemed to realize, or at least explicitly discussed. For example, the Serbian astrophysicist Milan Ćirković wrote a 2001 paper for the *Journal of Transhumanism*, which was at the time published by the World Transhumanist Association, in which he argues that "the number of potentially viable human lifetimes lost per a century of postponing of the onset of galactic colonization is" at least about 10^{46}—that is, a 1 followed by 46 zeros. Bostrom later shared his own calculations based on not just spreading throughout the cosmos as *biological* beings, but converting entire exoplanets into supercomputers that run high-resolution simulations in which artificial consciousnesses can live "rich and happy lives while interacting with one another in virtual environments." This could *vastly increase* the total number of people within our future light cone, which would, once again, be *very good* from the universal gaze. As Bostrom writes, "what hangs in the balance is at least

10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 human lives (though the true number is probably larger)." Even more, "we might get additional orders of magnitude" of operations per second, and thus value, "if we make extensive use of reversible computation, if we perform the computations at colder temperatures (by waiting until the universe has cooled further), or if we make use of additional sources of energy (such as dark matter)." Hence, if one accepts the utilitarian view that we have a moral obligation to fill the universe with as much value as we can, then we have a moral obligation to colonize space and convert exoplanets into supercomputers *as soon as physically possible*. Every second of delaying colonization entails the loss of astronomical numbers of possible people, and this is, on the utilitarian view, a great moral tragedy.

We can now begin to see how these strands of thought opened the door to a new way of thinking about the *moral significance* of human extinction. From a deep-future perspective, intelligent life could exist in the universe for perhaps another 10^{40} years. According to utopian transhumanism, the quality of posthuman life in the coming centuries could be immensely greater than it is today. And by colonizing space and simulating conscious beings on exoplanetary supercomputers, the total number of people with worthwhile lives could be astronomically large. Just as Wager argued that various tendencies in futurist thought coalesced in the work of Wells, so too would I argue that these ingredients came together most completely in the work of Bostrom.[112] In particular, I would identify his 2002 article "Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards" in (what was called at the time) the *Journal of Transhumanism* as having brought together the insights of Sidgwick, Huxley, Glover, Schell, Parfit, and Sagan to establish a cohesive *research program*. I have found very little in Bostrom's work that is original to him, although his synthesis of these earlier ideas resulted in the founding of the field of Existential Risk Studies, which has changed the way some scholars now think about what constitutes a worst-case outcome for humanity in the long term.[113] According to Bostrom, an "existential risk" is essentially any future event that would permanently prevent humanity from reaching a stable state of "technological maturity." He defines this term as "the attainment of capabilities affording a level of economic productivity and control over nature close to the maximum that could feasibly be achieved." In other words, Bostrom identifies the ultimate, grand, triumphant aim of human civilization to be the maximization of economic productivity and total subjugation of nature to the absolute physical limits. Why do these capitalistic, Baconian desiderata matter? Because, he would say, their realization is necessary to crowd the universe with as many "happy" people as possible and fully explore the potentially vast corridors of the posthuman realm. And *these* matter because of the utilitarian and transhumanist imperatives specified above.

In defining an existential risk this way, Bostrom accomplished two things: first, he shifted the programmatic focus of subsequent research from the loss of all human lives entailed by an extinction event to the *opportunity cost* of having kicked the bucket. A techno-utopian paradise in which trillions and trillions and trillions (and trillions and trillions …) of happy posthumans live in computer simulations throughout the cosmos awaits humanity if we dodge the bullet of extinction. The value that this world could contain is *vastly greater* than all the value so far realized by humanity throughout recorded history, and *this* is the primary reason that human extinction would be bad. Second, extinction is not the only scenario that could prevent humanity from realizing utopia. For example, we could also fail to colonize space, or reach technological maturity for only a short time before self-destructing, and so on. Hence, Bostrom identifies a wide range of possible future scenarios, most of which are *survivable*, as being *no less morally bad* than annihilation. This leads him to propose the following four-part typology of "failure modes" that would instantiate an existential risk (quoting him):

> *Human extinction*: Humanity goes extinct prematurely, i.e., before reaching technological maturity.
> *Permanent stagnation*: Humanity survives but never reaches technological maturity. Subclasses: unrecovered collapse, plateauing, recurrent collapse.

> *Flawed realization*: Humanity reaches technological maturity but in a way that is dismally and irremediably flawed. Subclasses: unconsummated realization, ephemeral realization.
> *Subsequent ruination*: Humanity reaches technological maturity in a way that gives good future prospects, yet subsequent developments cause the permanent ruination of those prospects.

As Bostrom then notes, "most discussion of existential risk to date has focused exclusively on the first of the four classes, 'human extinction.' The present framework calls attention to three other failure modes for humanity." He continues, "like extinction, these other failure modes [are] of comparable seriousness, entailing potentially similarly enormous losses of expected value." And with this more capacious picture of what matters the most going forward, our extinction was suddenly no longer the only worst-case outcome that could obtain in the future. From the utopian-utilitarian view that Bostrom embraced, other scenarios—some endurable rather than terminal—could be *just as bad*.

The existential mood that emerged from all of this armchair theorizing was marked by a far more *intense conviction* about the *immense importance* of preventing an existential catastrophe, including human extinction. Not only would some 8 billion people perish if we were to disappear tomorrow, but a whole universe of value, from the Sidgwickian perspective, would be lost forever. Hence, Bostrom wrote in 2003 that "priority number one, two, three and four should … be to reduce existential risk," where priority number five should be to colonize the visible universe as quickly as possible. Or as he wrote ten years later in another widely cited paper titled "Existential Risk Prevention as Global Priority":

> The loss in expected value resulting from an existential catastrophe is so enormous that the objective of reducing existential risks should be a dominant consideration whenever we act out of an impersonal concern for humankind as a whole.

Bostrom thus proposed a heuristic that he calls the "maxipok rule," which instructs humanity to "maximize the probability of an 'OK outcome,' where an OK outcome is any outcome that avoids existential catastrophe." This "is not a principle of absolute validity," he adds, "since there clearly are moral ends other than the prevention of existential catastrophe." But the principle is useful "as an aid to prioritization."

Although, as mentioned, the "Bostromian paradigm" has not (yet) had the same groundbreaking effect on western thinking about our existential predicament as previous shifts, it has nonetheless left a large footprint in the sand of contemporary scholarship. Indeed, Bostrom founded the Future of Humanity Institute at the University of Oxford in 2005, which lent significant credibility to the research program that he outlined three years earlier. And a 2015 the *New Yorker* published a detailed profile of his life and work titled "The Philosopher of Doomsday." Seven years later, Lord Martin Rees and other scholars founded the Centre for the Study of Existential Risk at the University of Cambridge, whose "goal is to steer a small fraction of Cambridge's great intellectual resources, and of the reputation built on its past and present scientific pre-eminence, to the task of ensuring that our own species has a long-term future." This was followed by the Boston-based Future of Life Institute, co-founded by Max Tegmark. All of these organizations have received notable coverage by the popular media, and the Future of Life Institute includes on its Scientific Advisory Board super-famous celebrities like Morgan Freeman, Alan Alda, Elon Musk, and (formerly) the late Stephen Hawking. It also helped promote a Hollywood-esque video in 2017 about the dangers of lethal autonomous drones called "Slaughterbots," which went viral and has since gained millions of views.

Furthermore, the topic of existential risk is one of the main themes of *Vox*'s vertical "Future Perfect," which has received generous funding from the Rockefeller Foundation. This intro-

duced existential risk issues to a wide audience of non-academics, thus fomenting interest in how threats associated with biotechnology, synthetic biology, anticipated future nanotechnology, and artificial superintelligence could derail our striving toward a spacefaring posthuman civilization. As one article on the Future Perfect webpage explains the Bostromian paradigm to its readership, gesturing back to Parfit's thought experiment: "Existential risk researchers are extremely concerned with the difference between the annihilation of humanity and mass casualties that humanity can [recover from]. To everyone else, those two outcomes seem pretty similar." The author continues, but

> to academics in philosophy and public policy who study the future of humankind, an existential risk is a very specific thing: a disaster that destroys all future human potential and ensures that no generations of humans will ever leave Earth and explore our universe. The death of 7 billion people [the approximate global population at the time] is, of course, an unimaginable tragedy. But researchers who study existential risks argue that the annihilation of humanity is actually much, much worse than that. Not only do we lose existing people, but we lose all the people who could otherwise have had the chance to exist. … In this worldview, 7 billion humans dying is not just seven times as bad as 1 billion humans dying—it's much worse. This style of thinking seems plausible enough when you think about past tragedies; the Black Death, which killed at least a tenth of all humans alive at the time, was not one-tenth as bad as a hypothetical plague that wiped us all out.

The Bostromian paradigm has also given rise to one of the main charitable causes advocated by the "Effective Altruism" movement, which was introduced circa 2009 by Bostrom's colleague Toby Ord, also at Oxford. The primary aim of Effective Altruism is, as another Oxford colleague, Will MacAskill, puts it, to "do good better." This approach encourages people to evaluate the efficacy of different charitable causes using the tried-and-true tools of scientific investigation that have been developed in the centuries since Nicolas Copernicus, which initiated the Scientific Revolution in 1543. For example, Effective Altruists—some of whom initially called themselves "super-hardcore do-gooders"—have argued that one of the best ways to help people in poor countries is to supply them with bed nets rather than, say, books or new schools. Along similar lines, crunching the numbers suggests that donating to disaster relief is decidedly *not* the best way to get a big bang for your buck—although it may *feel good* to help people suffering in the aftermath of a hurricane, earthquake, tsunami, or whatever, being an *effective* altruist requires both the heart and the head. When a disaster is in sight, it is—thanks to TV and the Internet—in mind. But out of sight should not mean out of mind (a point with which I very much agree).

The two charitable causes initially singled-out by Effective Altruism were eliminating factory farming and alleviating global poverty (both being inspired by the animal rights activism and "global ethics" of the utilitarian philosopher Peter Singer). But more recently, a third major cause has joined this constellation: ensuring that humanity survives long enough to spread into the cosmos and create astronomical amounts of value, *à la* the Bostromian paradigm. As the effective altruist Benjamin Todd writes,

> most of humanity's potential lies in the future. There are actions we might take today that could have a significant impact on these future generations. For instance, if we cause a nuclear war that ends civilization, then this future will never happen at all. So, from the perspective of making a difference, the expected impact of our actions today on the far future might be the most important thing about them.

Elsewhere Todd argues that

> since the future is big, there could be far more people in the future than in the present generation. This means that if you want to help people in general, your *key concern* shouldn't be to help the present generation, but to ensure that the future goes well in the long-term.

Effective altruists initially called this the "long-term value thesis," but it has more recently been given the name *longtermism*. As Todd elaborates the idea,

> this thesis is often confused with the claim that we shouldn't *do* anything to help people in the present generation. But the long-term value thesis is about what most *matters*—what we should *do* about it is a further question. It might turn out that the best way to help those in the future is to improve the lives of people in the present, such as through providing health and education. The difference is that the major *reason* to help those in the present is to improve the long-term [*sic*].

Over the past decade, the Bostromian paradigm has gradually morphed into the longtermist paradigm, and the longtermist paradigm has come to dominate academic research on human extinction and related hazards at Oxford, Cambridge, and elsewhere. It has also inspired a growing community of self-styled "altruists" both within and outside of academia to fixate their moral gaze not so much on helping those alive today as on inflating the probability that huge numbers of people with worthwhile lives will populate our future light cone. Since most people who will ever exist will likely exist in the future, it makes sense that one should focus on *these* generations rather than current ones, at least insofar as one wishes to make the biggest positive difference in the world that one can. This is the central thrust of the new revolution in how we should understand the *meaning* of human extinction, and it is an issue that we will return to in the following chapter.

In the background of these philosophical developments, the threats posed by emerging technologies, in particular, were only becoming more and more menacing. It became increasingly clear that humanity is at greater risk of extinction than ever before, a point discussed in chapter 1. This has added to an already tense climate of existential nervousness a new sense of *urgency* to the study and mitigation of existential risks. Time really is running out, it appears—the Doomsday Clock is ticking.

So where does this leave us? First, current thinking about human extinction is dominated by the Bostromian and longtermist paradigms, which embrace the Parfitian claim that the difference between nearly everyone and absolutely everyone dying out is *astronomically huge*. Second, the ongoing development of emerging technologies, as well as the worsening state of climate change and global biodiversity loss, has led many scholars to believe that we live in perhaps the most critical moment in all of human history. To quote Max Tegmark once again from a 2016 podcast, "it's probably going to be within our lifetimes … that we're either going to self-destruct or get our act together." If we make it through the twenty-first century, though, a techno-utopia awaits. If we do not, the reason may very well be that we committed suicide as a species.

As with every other shift in existential mood, this one was also crucially enabled by the ongoing spread of secularism. Indeed, a 2007 survey by the World Transhumanist Association found that about two-thirds of its roughly 5,000 members identified as either atheists, agnostics, secular humanists, or non-theists. And recent polling of the Effective Altruism community reports that 86 percent describe themselves as "agnostic/atheist/non-religious." More generally, irreligious beliefs are on the rise throughout western civilization. For example, a 2011 study concluded that religion is being "driven to extinction" in nine western countries, namely, Australia, Austria, Canada, the Czech Republic, Finland, Ireland, New Zealand, Switzerland, and the Netherlands. And a 2019 publication from the Pew Research Center reported that the "decline of Christianity continues at a rapid pace" in the US, which remains one of the most religious countries in the Global North.

Chapter 7: Does Another Revolution Await?

All paradises, all utopias are designed by who is not there, by the people who are not allowed in.
—Toni Morrison

Apocalypse thinking is, by nature, totalistic.—Richard Landes

I hope to have shown at this point that the idea of human extinction is a quite new addition to our shared library of concepts, and even after the statement "humanity can go extinct" was no longer deemed to be self-contradictory, it was not taken seriously by many intellectuals or the public until the second half of the twentieth century. The western mind has become aware, frightfully aware, of the mortality of our species only recently. We are and have always been, of course, sojourners of planet Earth—that is just a fact from physical eschatology. But our technological capabilities have leapt far ahead of our collective wisdom, and this gap between the "can" and the "ought" has left humanity troublingly susceptible to self-destruction, not just in the far future but *tomorrow*. To paraphrase a memorable warning from the former Romanian environmental minister in 2018, humanity could become the first species in the 3.8-billion-year history of Earth-originating life to document its own extinction.

Because many people today struggle to grasp the reality of this situation—the possibility, and *inevitability*, of human extinction—I have sometimes wondered whether the Buddhist meditation of *Maraṇasati*, or "mindfulness of death," could serve as a useful template for overcoming this cognitive hurdle. In a *sutta* of the *Anguttara Nikāya*, a Buddhist scripture, the Buddha tells his disciples that "mindfulness of death developed and made much is very beneficial and ends in deathlessness." Another text by the fifth-century commentator Buddhaghosa called the *Visuddhimagga* states that "mindfulness of death is the remembering of death," and that one should "exercise attention wisely in this way: 'Death will take place.'" The same could be said about extinction: *it will take place*, if not later then sooner. Yet *humanity* itself does not have an intrinsically limited lifespan like individual humans—contra Giovanni Battista Brocchi, mentioned in chapter 5. Evolutionary lineages like ours could in theory persist until the heat death of the universe. Hence, one should meditate not just on the human population dwindling to zero and never returning, but on the hopeful truism that if we contain the growing swarm of existential threats before us, the succession of cohorts could survive and thrive for billions and billions of years to come. Call this "mindfulness of annihilation."

But the central question of this chapter is: what set of propositions can adequately *explain* the saltatory (occurring in leaps) evolution of thinking about our precariousness in the cosmos? What accounts for the sudden shifts in existential mood outlined in the previous chapters? It should be clear at this point is that novel scientific discoveries and technological innovations have been the primary *triggering factors* throughout history behind the progressive realizations that our continued existence on Earth is anything but guaranteed. The first instance was the discovery of the Second Law. Then came worries about anthropogenic risks from radioactive fallout, pollution, climate change, artificial intelligence, nanotechnology, and physics disasters. After this we finally realized that asteroids, comets, supervolcanoes, and other natural phenomena could cause mass extinctions. And most recently, while new concerns about emerging technologies were popping up in books and articles, some philosophers began arguing that, however bad the process of *going extinct* may be, the condition of *being extinct* is much, much worse.

Given the importance of science and technology to this account, and the fact that we will continue to develop (at an exponential or *superexponential* pace) them for the foreseeable future, one is left wondering what discoveries might dot the road ahead and once more revolutionize the way we think about our existential predicament. Perhaps one decade from now, a young genius will see a new pattern in the Rorschach of nature. Perhaps she will will discover a "meta-law" according to which every 14 billion years, all the current laws of nature spontaneously flip such that life as we know it becomes impossible. Then 14 billion years later, they flip again, and so on.

(Note that the universe is 13.8 billion years old right now, so this would happen relatively soon, before Earth becomes uninhabitable.) Or maybe she will find incontrovertible evidence that we live in a computer simulation that is about to get shut down—we have only a few years left. Imagine how these discoveries could shift the existential mood once more: suddenly everyone might care less about climate change and nuclear proliferation, not to mention their retirement savings. Would mass hysteria break out? Would civilization collapse into violent anarchy, a state of affairs described by the seventeenth-century philosopher Thomas Hobbes as "solitary, poor, nasty, brutish, and short"? There is no reason to believe that the story of our existential maturation has ended, that the most recent shift in existential mood will be the last. And given the fact that each shift has resulted in more rather than less anxiety about our survival, we might anticipate the next one with a considerable degree of apprehension.

It should also be clear at this point that the decline of religion, faith, superstition, church authority, and dogma has been the single most crucial *enabling condition* behind the four major shifts discussed above. If there is no Bearded Deity in the empyrean realm peering down on us, ready to intervene upon the laws of nature to ensure whenever necessary our well-being, then what reason is there for thinking that we will never meet the same sad fate as the dodo and dinosaurs? If we are no different than any other species, and if 99.9 percent of all species that have ever existed are now extinct, then how confident should we be about dodging the bullet—or bomb—of universal death? As Moynihan emphasizes, the emergence of Existential Risk Studies has been closely linked to the Enlightenment notion of self-responsibility: how the future turns out—utopian, apocalyptic, or something in-between—is entirely up to us. Or to put the point differently, there are no *moral holidays*. We cannot just take a break whenever we feel too weary or exhausted to carry on, reassured by the belief that "everything is in God's hands." It isn't, because there is no God. If we fail to prevent ourselves from succumbing a respiratory infection that travels the globe, starving in subfreezing temperatures under the pitch-black skies of a nuclear winter, or being systematically slaughtered by an artificial superintelligence with misaligned goals, then *we will die out*. Hence, the ideological backdrop to all the dismal ruminations that have haunted us since the 1850s is a secular worldview, or *Weltanschauung*, according to which taking moral holidays could be downright deadly. There is no rest for species intelligent enough to realize that they are vulnerable to extinction.

This is the heart and soul of my "theory of human extinction," which I think explains quite well the *why* and *when* of the narrative dance outlined in this book. Indeed, it would have been impossible to tell this harrowing tale without mentioning various developments in science and technology or the inexorable march of secularization in the west. But it is useful to make this theory explicit, separately, since it being true is compatible with a wide range of possible histories. For example, it might have been that physicists discovered the Second Law after developing an atomic bomb. And it could have been that uniformitarianism collapsed the same year that the first nuclear devise was detonated. Or perhaps a wiser species than us would never have built nuclear weapons in the first place, or contaminated its environment with insecticides, carbon dioxide, and other pollutants, and so on. If this counterfactual scenario had been the case rather than what has actually happened, I would not expect the idea of human extinction to be especially *prominent*, even if it were *intelligible*, since there would have been no particularly pressing *reason* to take seriously this possible outcome. But here we are, in this (Everettian) branch of the multiverse, having made a bunch of messes in the kitchen that are much easier to create than clean up. The point is that the accuracy of my periodization is independent of the plausibility of my theory.

Another development that Moynihan identifies as having stimulated new thoughts about existential risk was probability theory. This theory has roots in the Italian polymath Gerolamo Cardano's *Book on Games of Chance*, which offered the "earliest systematic attempt to make … actual probability calculations."[114] Although it was written in 1564, it remained unpublished for almost an entire century. Yet *another* century later, the French mathematician Blaise Pascal, perhaps most famous for his "wager" about the rationality of belief in God, applied Cardano's formalizations for the first time to forecasting the future. It was not long after that scientists began calculating the probability of catastrophes, including the chance of a comet colliding with Earth—which was, as we have seen, determined to be quite unlikely. In fact, our modern word "risk," which was initially spelled "*risque*" (from the French), entered the English language in the 1660s, perhaps first among "maritime traders and their underwriters," since tempestuous waters and marauding pirates posed a constant threat to goods being transported from one place to another. As Moynihan writes,

> with the coeval explosion of insurance industries, alongside inception of financial markets and speculation thereof (opening an entirely unforeseen species of calamity in the form of economic bubbles), possible futures had become profitable and jeopardy a lucrative business … And so, as the "Art of Conjecture" dawned, risk became tractable and the future increasingly came to infiltrate the present.

So where does this leave us? Moving forward, those of us who agree with Malcolm from chapter 1, the seven-year-old Swedish boy who affirmed that we really could go extinct like the dodo and dinosaurs, need not accept the Bostromian-longtermist paradigm. We can embrace deep-future thinking and define the concept of an *existential risk* in ways that do not fetishize imaginary people living in spaceships and computer simulations, or elicit dangerous fantasies about a techno-utopian paradise among the constellations above us. Perhaps we can return to the Russellian notion of "universal death," whereby this outcome would be bad—maybe the worst possible thing that could occur—because of the huge amounts of suffering, misery, and anguish that it would cause the real, living, breathing human beings who would perish in the catastrophe. And we can jettison the notion of utopia for the alternative idea of *protopia*, which I personally much prefer. This was coined by the technology guru and "Senior Maverick" at *Wired* magazine Kevin Kelly, who defined it as "a state that is better than today than yesterday, although it might be only a little better." In other words, protopian visions do not picture a grand, paradisaical future towards which civilization should be striving. Instead, it emphasizes incremental change and recognizes that moving the human enterprise forward is like driving on a dark road at night: what lies ahead, which way we should turn the steering wheel, only comes into sight as the vehicle approaches objects in the distance. As Wells said in the previous chapter, "we cannot see, there is no need for us to see, what this world will be like when the day has fully come."

My hope is that readers of this short book will have come away with a deep appreciation of what I referred to above as our *existential maturation*. I am proud of how far we have come, but worried about the future. Perhaps the historical narrative that I have outlined will inspire new thoughts from established scholars and (especially) eager young minds about the central questions of human existence, put so eloquently by the French painter Paul Gaugin like this: "Where Do We Come From? What Are We? Where Are We Going?"

Supplement 1: What Exactly Is Extinction?

Supplement 2: The Birth of Humanity

To this list I would add another factor, which I will loosely call *cosmopolitanism*. This is the view—moral, legal, political, and biological—that we belong not to this or that tribe or country, but a single unified human family. If one does not accept that all *Homo sapiens* are fully human, if one cannot appreciate that we are a global population of individuals bound together by some set of *common properties*, then one cannot fully grasp the true nature and enormity of our extinction. By way of example, some advocates of the extremist ideology called "Christian Identity," which has hugely influenced right-wing terrorism in the US, maintain that Abel's parents were Adam and Eve, but Cain's parents were *Satan* and Eve. Abel then gave rise to the "Whites" while Cain spawned the "non-Whites," including the Jewish people. Non-Whites are thus quite literally the children of the devil, and as such their deaths are not to be mourned but celebrated. With such a picture in mind, human extinction would be bad not because it would result in the death of everyone, but because it would destroy the white race. This is a deeply impoverished—not to mention horrifically immoral—understanding of what is at stake when it comes to human extinction.

Historically, the idea of a common bond among all human beings can be found in some of the oldest religious traditions, if only because of our shared genealogical origins. The Abrahamic faiths, at least on the standard interpretations, hold that humanity arose from Adam and Eve, Cain and Abel, although there are some so-called "pre-Adamites" who believe that human beings existed even earlier. Similarly, to pluck a few random examples from the annals of religious history, the Incas of western South America believed that the supreme god Viracocha created the first two people out of clay, the Bantu people of Kenya known as the Abaluyia identify this first couple as Mwambu and Sela, and the Zulu tradition of South Africa posits the progenitor of humanity to be a creator-god named "Unkulunkulu," meaning "the Ancient One."[115] The conviction that we are fundamentally alike was further reinforced by the common idea throughout history that we are ensouled bodies and embodied souls, and hence that there is an ontological chasm between us and the rest of God's glorious creation. In other words, our uniquely human *spiritual properties* form a perimeter around the community of bipedal apes with opposable thumbs.

A similar conception of our oneness was espoused by some of the ancient Greeks. In his 1965 book *The Unity of Mankind in Greek Thought*, the British classicist H.C. Baldry observes that "the notion of the unity of mankind as an attitude of mind … existed in some sense from Homer onwards, but was given varying shape and content by different writers." For example, some held that we are distinguished from the gods by our universal mortality and from the beasts by our development of the arts (*technai*) and capacity to use that discrete combinatorial system called "natural language." Among the pre-Socratics, there was even a "conscious formulation of the notion of the species of man." As Baldry wrote,

> in the period down to the end of the fifth century BCE, it is easier to find indications of what may be called a *biological approach*, involving the conception of man as a *specific* being, a distinct type with certain typical characteristics that mark him off from gods on the one hand and from animals on the other.

The great polymath Aristotle—known as "The Philosopher," although his contributions to incipient fields like biology were no less impressive—defended a related position according to which the defining feature of humanity is our capacity for language and *reason* (or *ratiocination*). Aristotle also argued in his *Nicomachean Ethics*, which laid the foundations of virtue ethics and continues to influence philosophers today like Rosalind Hursthouse, that "there is a bond of affection between all members of the human race."[116] Elsewhere, he claimed that humanity forms "a single fixed and unchanging species, 'simple and admitting of no differentiation' in the biological sense, standing by itself at the head of the *scala naturae*."[117] However, the word "species" in the zoological/botanical sense only joined the English lexicon in the early seventeenth century, and it took

another 100 years for it to be applied to humans. Of note here is the 1758 taxonomic system of Carolus Linnaeus, which gave us the Latin name "*Homo sapiens*," meaning "wise man"—quite clearly an egregious misnomer. According to the French philosopher Michael Foucault, it was this century that we began referring to ourselves as "the human species."[118]

Another important step toward a more cosmopolitan conception of humanity, as I am using the term, was the "judicial revolution" that occurred in the mid-twentieth century.[119] This is when the humanitarian notion of *human rights* solidified, founded on a common "dignity" had by all human beings. The basic idea can be traced back at least to the seventeenth-century philosopher John Locke—the "Father of Liberalism"—whose political theories greatly influenced subsequent thinkers like Thomas Jefferson. For example, Locke identified the three main rights as life, liberty, and property, which Jefferson adopted and modified in the Declaration of Independence. "All men are created equal," Jefferson wrote, "endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness." Shortly afterwards, the 1789 Declaration of the Rights of the Man and of the Citizen, fashioned with Jefferson's help, was adopted by the National Constituent Assembly at the very beginning of the French Revolution. The document opens with this statement:

> The representatives of the French people, organized as a National Assembly, believing that the ignorance, neglect, or contempt of the rights of man are the sole cause of public calamities and of the corruption of governments, have determined to set forth in a solemn declaration the natural, unalienable, and sacred rights of man, in order that this declaration, being constantly before all the members of the Social body, shall remind them continually of their rights and duties.

But human rights as we currently understand them did not become part of the established regime of international law until after WWII. Of the many charges brought against the military and political leaders during the Nuremberg and Tokyo trials were "crimes against humanity." According to the London Charter decreed by the European Advisory Commission, which was responsible for the rules and procedures of the Nuremberg trials, such crimes included

> murder, extermination, enslavement, deportation, and other inhumane acts committed against any civilian population, before or during the war; or persecutions on political, racial, or religious grounds in execution of or in connection with any crime within the jurisdiction of the Tribunal, whether or not in violation of the domestic law of the country where perpetrated.

The last sentence is the most crucial. Prior to this legal charter, the prevailing view was that if a state wishes to murder, exterminate, and so on, *its own people*, it was free to do so. Other states might disapprove of such actions, but there was no legal or moral basis for intervening in the affairs of a sovereign state doing what it wills. The revolutionary idea embodied in the notion of crimes against humanity was that there are some actions that no state is *ever* justified in taking, because doing so would violate someone's dignity, and one's dignity must never be violated. Although the very first *legal charges* of crimes "against humanity and civilization" occurred during the First World War—France, Great Britain, and Russia brought them against the Ottoman Empire for the 1915 Armenian genocide—it was the two trials mentioned above that thrust this new conception of human beings as possessing a universal, fundamental, unalienable set of rights into the public consciousness and codified them in the books of international criminal law.

The unity of humankind was also reinforced by the main topic of this book: the realization that humanity could commit suicide, and hence that the fate of every person is bound up with the fate of everyone else. One finds this sentiment in the second paragraph of the 1955 Russell-Einstein manifesto, which states: "We are speaking on this occasion, not as members of this or that nation, continent, or creed, but as human beings, members of the species Man, whose contin-

ued existence is in doubt." A few years earlier, shortly before he was asked to be president of the newly created state of Israel, Einstein argued that humanity must establish a global governing system to avoid nuclear annihilation. "Mankind can only gain protection against the danger of unimaginable destruction," he wrote, "if a supra-national organization has alone the authority to possess these weapons." The Johns Hopkins political scientist Daniel Deudney calls this idea "nuclear one worldism."

In fact, this is precisely what some political theorists were arguing at the time, too. For example, Hans Morgenthau, a luminary of twentieth-century "global studies," wrote that "the feasibility of all-out atomic war has completely destroyed [the] protective function of the nation state. No nation state is capable of protecting its citizens and its civilization against all-out atomic attack." Thus, he argued that the formation of a worldwide nation-state with a monopoly on the legitimate use of violence will need to be created. In his words: "There can be no permanent international peace without a state coextensive with the confines of the political world."[120] Similarly, the international relations theorist John Herz noted, like Beck above, that while humanity resides on a "planet of limited size," "the effect of the means of destruction has become absolute." Yet "the absolute peril in which the atomic weapon has placed mankind" could perhaps foster a new "comprehension of mankind as a group," leading to a "planetary mind" and "universalism" that would reduce the probability of a nuclear holocaust.[121] Carl Sagan (who was not a political scientist) expressed the same idea in his 1973 *The Cosmic Connection*. If we wish to avoid "destroy[ing] ourselves with the technological forces our intelligence has unleashed," we must develop "a global self-identification of mankind." Similar affirmations of the need for global solidarity abound in the literature on catastrophic risks like climate change, biodiversity loss, the sixth mass extinction, nuclear war, and so on.

Still other developments during the twentieth century that contributed to as a cause, or reflected as a symptom, the emerging sense that we are a growing human family in a shrinking global village include the famous "Earthrise" photo taken by the NASA astronaut Bill Anders in 1968, which shows a brilliant blue and white marble half-illuminated by the sun just above the lunar horizon, as well as the 1990 image taken by the Voyager 1 space probe at the behest of Carl Sagan, leading him to describe our planetary island as a "pale blue dot." And consider the significance of Neil Armstrong, the first person to leave footprints on the moon, declaring in the middle of the Cold War: "That's one small step for man, one giant leap for mankind." (He later clarified that what he meant to say was: "That's one small step for *a* man.") The twentieth century was also a time of accelerating globalization—or *mundialization*, a related but less common idea—driven by intercontinental trade, travel, and communication. This further cemented the recognition that we are all human beings with a fundamental dignity in this undulating boat together, and everyone is ultimately dependent in some way on everyone else. Indeed, the economic interdependence of the industrialized world is one theory for the so-called "Long Peace," which refers to the fact that no great powers have gone to war since WWII (although there have been plenty of proxy wars like the Korean War (1950 - 1953), during which China and the Soviet Union supported North North and the US supported South South). If one nation depends on another, then it would not be in the first's self-interest to destroy the second. The crowding together of different peoples and cultures from globalization also led to UNESCO to officially recognize Esperanto, invented by the Polish linguist L.L. Zamenhof in 1887, as a language in 1954, and later recommended it for universal NGO ("non-governmental organization") communication in 1985. The new "planetary mind" perspective on world affairs and the human condition even inspired novel developments in ethical theorizing. For example, it was round this time that the Princeton philosopher Peter Singer proposed his "global ethics" according to which, as he wrote in 1971, "it makes no moral difference whether the person I can help is a neighbor's child ten yards away from me or a Bengali whose name I shall never know, ten thousand miles away." As mentioned in the last chapter, this insight has greatly influenced one of the three main causes of the Effective Altruist community: alleviating global poverty.

The point of this hodgepodge jumble is just to say that the conceptual tools necessary for a robust sense of human oneness and solidarity on this lonely planet amidst what appears to be an otherwise lifeless universe developed in parallel along multiple dimensions. Although tribal ideologies that divide rather than unify continue to impede the cosmopolitan outlook—up to and within the era of President Donald Trump, who began his campaign with overtly racist remarks about Mexicans—never before has the sense that we are all "citizens of the world," to borrow a phrase uttered by the ancient Greek troublemaker Diogenes, been so ubiquitous. This has, I believe, shaped contemporary thinking about human extinction in nontrivial ways. For instance, if we are all part of the same large family, then the death of someone on the other side of the planet—such as a Bengali—in a global catastrophe is no less tragic than the death of my parents, siblings, or friends. Human extinction is thus far *worse* when viewed from this cosmopolitan perspective, as opposed to a Gestalt according to which, "Extinction is bad because it would kill the people I care about; the deaths of others is irrelevant."

How will this picture of humanity evolve in the future? Who knows, but it seems quite possible to me that the historical trends just delineated might not continue through this century. For example, if populism and nationalism keep spreading their noxious tentacles around the globe, the human family could dissolve into tribes that discriminate against out-group members because they are "the Other." Or perhaps the sense of global solidarity now prevalent will break down after humanity establishes colonies on Mars, which may very well happen within the coming *decades*. Given the specific conditions in which people on Mars would live, there could arise a sense that colonies founded independently by the US, China, India, and other countries have more in common with each other than the countries from which they were born. Hence, a unique "Martian" identity could drive a wedge between the Martians and the Earthians, perhaps even leading to conflict between the two. In fact, the renown political scientist Daniel Deudney argues in his 2020 book *Dark Skies* that war between Mars and Earth will very likely materialize within the anarchic realm of the solar system (where "anarchy" in the technical sense means that there is no state system with a monopoly on the legitimate use of force; it is the opposite of "hierarchy"). This would have, he claims convincingly, far worse consequences for those of us on the third, rather than fourth, rock from the sun. Just consider that the "gravity well," which refers to the amount of energy required to leave the planet, is much more shallow on Mars than on Earth, because Mars is a smaller planet and gravity is a function of the mass of an object. Furthermore, Mars is right next to the asteroid belt, which occupies the space between its orbit and Jupiter's. This matters because asteroids can be easily converted into "planetoid bombs," as they have been called, by redirecting their orbits to collide with an astronomical body like Earth. Imagine a Mars-Earth war in which there are no bullets exchanged. Rather, the Martians—fed up with those "out-of-touch" Earthians—simply redirect a cloud of 10,000 huge asteroids at our home. The war would be over almost as soon as it began. The point is that there are plausible future scenarios in which the cosmopolitan trend reverses and our descendants revert to thinking of others as "*the barbarians over there*."

Supplement 3: What if We Should Go Extinct?

Before turning to the next chapter, it is worth noting that not everyone *feared* the prospect of human annihilation. Some positively *welcomed* the disappearance of humanity, given what Siddhartha Gautama—the Buddha—identified as the second of four Noble Truths: "Life is *duḥkha*," where "*duḥkha*" is a Sanskrit word meaning suffering, unhappiness, stress, or pain. This enduring insight from the Buddha, who lived […], very likely influenced the German pessimist and atheist […] Arthur Schopenhauer, who argued in an 1851 essay "On the Sufferings of the World" that "life is *a disappointment*, nay, a cheat," and that it would be better if Earth were as lifeless as the moon. From this he argued that

if children were brought into the world by an act of pure reason alone, would the human race continue to exist? Would not a man rather have so much sympathy with the coming generation as to spare it the burden of existence, or at any rate not take it upon himself to impose that burden upon it in cold blood?

Although Schopenhauer's philosophical work, which maintained the life is not worth living, remained obscure until the 1860s, it greatly influenced the younger German philosopher Eduard von Hartmann, who extended it from a focus on *individuals* to *the world as a whole*. In his widely discussed (at the time) book *Philosophy of the Unconscious*, published in 1869, Hartmann argued that there is a "perpetual struggle" between Reason and the Will, the first being logical and the second being non-logical, and that it is our highest calling to terminate this "world-process"—in the end, the logical must be victorious by snuffing out not just all human life, but the very possibility of future beings emerging on Earth to suffer the "misery of existence" as we do. How exactly we could do this, von Hartmann admits, is beyond current comprehension. "Our knowledge is far too imperfect," he wrote, "our experience too brief, and the possible analogies too defective, for us to be able, even *approximately*, to form a picture of the end of the process." But the lack of a practical solution at the time of his writing, Hartmann maintained, does not—should not—undercut his philosophical conclusion. This resulted in a passionate debate in Germany that began in the 1870s—the so-called *pessimism controversy*, or *pessimismusstreit*—about the virtues of this perspective, during which Hartmann maintained, following Schopenhauer, that he was not advocating suicide, which critics saw as the obvious conclusion of his arguments. (Note that Schopenhauer did claim that *starvation* was a philosophically acceptable form of self-killing.) Many critics saw philosophical pessimism as dangerous: since it undercuts morality by suggesting that we should passively acquiesce to evil in the world rather than actively fighting against it. Pessimism leads to apathy, and apathy is the devil's best friend—a claim that Hartmann vigorously challenged. Others worried about the consequences of pessimism becoming widespread, such as the Irish cleric James William Barlow, who wrote in his 1882 book *The Ultimatum of Pessimism* that they "may jeopardize the very existence of mankind" by conducing "to the extinction of the human species, by failure of reproduction."

The following century, the Norwegian philosopher Peter Wessel Zapffe also took up the Schopenhauerian banner in his 1933 essay "The Last Messiah." Zapffe, who died childless by choice, argued that humans have become "unfit for life" because our cognitive abilities are *overevolved*. By analogy, he writes, some giant deer suffered because their antlers became too heavy to bear. So too has our capacity for existential angst become too onerous to handle. As Zapffe puts it, where "he" refers to humanity,

so there he stands with his visions, betrayed by the universe, in wonder and fear. The beast knew fear as well, in thunderstorms and on the lion's claw. But man became fearful of life itself—indeed, of his very being. Life—that was for the beast to feel the play of power, it was heat and games and strife and hunger, and then at last to bow before the law of course. In the beast, suffering is self-confined, in man, it knocks holes into a fear of the world and a despair of life.

He adds:

But as he stands before imminent death, he grasps its nature also, and the cosmic import of the step to come. His creative imagination constructs new, fearful prospects behind the curtain of death, and he sees that even there is no sanctuary found. And now he can discern the outline of his biologicocosmic terms: He is the universe's helpless captive, kept to fall into nameless possibilities.

The result is a "feeling of cosmic panic" that we strive to diminish through various defense mechanisms, but to no avail. This situation will continue, Zapffe declared, until there appears a "last Messiah" who "has dared strip his soul naked and submit it alive to the outmost thought of the lineage, the very idea of doom." While humanity screams out in despair, the last Messiah's message will reverberate around the world "for the first and last time," that

The life of the worlds is a roaring river, but Earth's is a pond and a backwater.
The sign of doom is written on your brows—how long will ye kick against the pin-pricks?
But there is one conquest and one crown, one redemption and one solution.
Know yourselves—be infertile and let the earth be silent after ye.

Hence, Zapffe envisions humanity disappearing by not reproducing voluntarily, an idea called *anti-natalism*. So far as I know, he never considered other kill mechanisms, such as large-scale mechanized conflict or the heat death. Hartmann does consider the gradual cooling of the earth, but writes that "long before the occurrence of such a terrestrial refrigeration the world-process altogether would have been arrested." Since the focus of Hartmann and others was, indeed, the problem of suffering in the world, I have no doubt that they would have found the idea of human extinction preceded by profound misery quite troubling, even if the outcome—eternal quietude—desirable. But while these ideas were influential during their time, they were not widely accepted, even among those who embraced a pessimistic outlook on life. For example, the German philologist Friedrich Nietzsche, whose philosophical writings influenced the Nazis, adopted a form of pessimism that was *life-affirming* rather than *life-denying*. The point is that not everyone immersed in the existential mood of the time held that human extinction, at least under certain conditions, would be bad—to the contrary. To quote a Jewish joke popular among some philosophers: "Life is so terrible, it would have been better not to have been born. Who is so lucky? Not one in a hundred thousand!"

Benatar

Efilism

Gaia Liberation Front, etc.

negative utilitarianism

BAAN scenario?

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Extra thanks to my father, John Paul Torres, and my lovely sister and brother-in-law, Sylvia and Chris Morgan, as well as their amazingly smart, curious, and super-cool children, Lucy and Zach, for all of their incredible love and support. This project would not have been possible without my brilliant and insightful girlfriend, Dr. Azita Chellappoo, who has made me rethink so many views that I once thought were obviously true.

Finally, I would like to separately thank two scholars in particular: Tom Moynihan and Dan Zimmer. I first met Tom at the University of Cambridge in the Spring of 2019. He sent me a few emails, and then took a 2.5-hour ride one day from Oxford to attend a talk I gave on the topic of this book (laying out the basic periodization and explanatory-predictive hypothesis). The talk was jointly hosted by the Centre for the Study of Existential Risk and the Department of History and Philosophy of Science. Afterwards, we chatted for a bit—but regretfully I declined getting a drink with him that evening. Nonetheless, we messaged and Skyped, and it soon became clear that his own account of the origins and evolution of *human extinction*, the idea, which he had devised independently, aligned significantly with mine. He then published an article in *Futures* that was, to my knowledge, the very first to offer an account of how the idea took shape during (in particular) the Enlightenment—and I could not have been more excited that he got some of his original ideas out there. Talking with him, bouncing ideas off him, has been integral to this project. Indeed, I am not an intellectual historian by training, and he is, so his input and criticisms have made me feel far more confident in the many claims made above. Immense thanks to Tom for being such a generous, insightful, and erudite colleague.

An oddly similar story involves Dan Zimmer, who I later introduced to Tom (sharing with both of them a document that I had complied full of notes that was upwards of 40,000 words long, which Tom added to). I also met Dan at the University of Cambridge while he was visiting from Cornell University (as a graduate student) to research the Pugwash Conferences, as I recall. We had drinks one night and I was absolutely blown away by our conversation about my book project, still quite incipient at the time. He was literally able to finish sentences about ideas that I thought were completely original to me (or again, independently, Tom). He kept asking me, "Have you thought about this?," to which I would exclaim, "Oh my goodness, yes I have—but I've never spoken with anyone before who was aware of that idea, at least not within the context of the history of the idea of human extinction." Dan's breadth of knowledge was almost frightening, and once again I had met someone—quite randomly—who had independently come up with very similar views to my own. When I explained my periodization, for example, both Tom (after the talk) and Dan (later on) both said, "Yeah, that sounds right to me. It's very similar to how I've been thinking about it."

There are two points to make about these encounters: first, it is always good when multiple scholars independently converge upon a single set of ideas, since this suggests that those ideas are probably true. And second, although I did a massive amount of research for this book, if my attention had been focused on another topic, I have no doubt that Tom or Dan would have written a similar—and perhaps far better—book as this. So I got to the finish line first out of luck, and hence am more than happy to credit them with having arrived at the basic framework outlined above no less than I did. What I get credit for is having been in a life-situation that happened to enable me to jot this down before anyone else. That's all. So, extra-special thanks to Tom and Dan for sharing insights and inspiring this book.

Bibliography

Because this is the Internet Age, not the 1950s, I am not including the citational details of books that are explicitly mentioned in the manuscript, nor am I citing quotes that have been explicitly attributed to their authors above. It is no doubt *easier* to simply google the quotes than scroll through a dense bibliographical jungle to find the target book, chapter, page number, and so on. My view is that the conventions of bibliography are profoundly antiquated, and hence should be updated immediately to save authors from wasting precious time. What follows below are the various sources that I, at one point or another, draw from but do not explicitly cite in the body-text. Instead, readers should find the corresponding footnote and then go from there. I am also leaving out unnecessary information like the issue and page numbers of journal articles, as well as the location and name of book publishers. This information is literally one click away on what the venerable Alaskan Senator Ted Stevens once described as "a series of tubes." Finally, I care deeply about citing sources—indeed, about citing sources *generously*. I have thus run, as I have with previous books, most of this manuscript through plagiarism software, just to make sure that I have not accidentally forgotten a citation—which is my worse scholarly nightmare. However, any lingering errors are my own and thus I will have to take responsibility for them.

Armstrong, Karen. 1993. *A History of God: The 4,000-Year Quest of Judaism, Christianity and Islam*.

Badash, Lawrence. 2009. *A Nuclear Winter's Tale: Science and Politics in the 1980s*.

Baldry, H.C. 1965. *The Unity of Mankind in Greek Thought*.

Beard, Simon. 2020. Parfit Bio. https://sjbeard.weebly.com/parfit-bio.html.

Bowler, Peter. 2003. *Evolution: The History of an Idea*.

Browne, Malcolm. 1985. Dinosaur Experts Resist Meteor Extinction Idea. *The New York Times*.

Cook, David. 2005. *Contemporary Muslim Apocalyptic Literature*.

Cook, David. 2011. Messianism in the Shiite Crescent. The Hudson Institute.

Curtins, Peebles. 2000. *Asteroids: A History*.

Darwin, Charles. 1871. *The Descent of Man, and Selection in Relation to Sex*.

Deudney, Daniel. 2018. Going Critical: Toward a Modified Nuclear One Worldism. *Journal of International Political Theory*.

Fenves, Peter. 2004. *Late Kant: Towards Another Law of the Earth*.

Flannery, Frances. 2016. *Understanding Apocalyptic Terrorism: Countering the Radical Mindset*.

Gray, Richard. 2016. Cave Fires and Rhino Skull Used in Neanderthal Burial Rituals. *New Scientist*.

Hyman, Gavin. 2010. *A Short History of Atheism*.

Katz, Victor. 2009. *A History of Mathematics: An Introduction*.

Kihss, Peter. 1956. Estes Warns H-Tests Can Tilt the World. *The Atlanta Constitution*.

Knipe, David. 2007. Hindu Eschatology. In the *Oxford Handbook of Eschatology*.

Kuehn, Manfred. 2001. *Kant: A Biography*.

Le Treut, Hervé, et al. Historical Overview of Climate Change. https://www.ipcc.ch/site/assets/uploads/2018/03/ar4-wg1-chapter1.pdf.

Leeming, David Adams and Margaret Adams Leeming. 2009. *A Dictionary of Creation Myths*.

Levin, Harold. 2010. *The Earth Through Time*.

Mayr, Ernst. 1981. *The Growth of Biological Thought*.

Mazlish, Bruce. 2009. *The Idea of Humanity in a Global Era*.

McCants, Will. 2015. *The ISIS Apocalypse: The History, Strategy, and Doomsday Vision of the Islamic State*.

McPhee, John. 1981. *Basin and Range*.

Nattier, Jan. 2007. Buddhist Eschatology. In the *Oxford Handbook of Eschatology*.

Orlowski, David. 2014. End Times How the Antichrist Will Use Artificial Intelligence. http://www.christianrapturebooks.com/scripture-teachings/end-times-how-the-antichrist-will-use-artificial-intelligence/.

Palmer, Trevor. 1999. *Controversy: Catastrophism and Evolution, The Ongoing Debate*.

Rampino, Michael, et al. 1988. Volcanic Winters. *Annual Review of Earth and Planetary Sciences*.

Rollock, Nicola, and David Gillborn. Critical Race Theory (CRT). British Educational Research Association.

Sandberg, Anders. 2018. Human Extinction from Natural Hazard Events. *Oxford Research Encyclopedia, Natural Hazard Science*.

Schell, Jonathan. 1982. *The Fate of the Earth*.

Schorr, Daniel. 1988. REAGAN RECANTS : His Path From Armageddon to Detente. *LA Times*. https://www.latimes.com/archives/la-xpm-1988-01-03-op-32475-story.html.

SFE. 2018. Grey Goo. *The Encyclopedia of Science Fiction*. http://www.sf-encyclopedia.com/entry/grey_goo.

Sheridan, "EyeBlueBayou." 2015. Superintelligence in the Flesh. A.I. and the Antichrist. https://aiantichrist.blogspot.com/2015/09/superintelligence-in-flesh.html.

Shermer, Michael. 2018. Utopia Is a Dangerous Ideal. We Should Aim for "Protopia." *Quartz*.

Shields, Charles Woodruff. *The Final Philosophy*.

Singer, Peter. 2015. *The Most Good You Can Do: How Effective Altruism Is Changing Ideas About Living Ethically*.

Steel, Duncan. 1997. Early Ideas About Impacts and Extinctions. NASA Ames Research Center.

Todd, Benjamin. 2017. How Important are Future Generations? 80000 Hours. https://80000hours.org/2013/08/how-important-are-future-generations/.

Wagar, Warren. 1983. H.G. Wells and the Genesis of Future Studies. *World Future Society Bulletin*.

Whitebook, Joel. 2017. ***Freud:*** *An Intellectual Biography***.**

Whybrow, Peter. 1985. A History of Fossil Collecting and Preparation Techniques.

[1] Please note that Thomas Moynihan alerted me of this quote.
[2] See the work of Mitchell Joachim, for example.
[3] Here I will mostly focus on the western tradition, although I will pluck some low-hanging fruits from outside this territory at times based on my knowledge of world religions. Indeed, the Eurocentrism of this book should not be taken to imply that other traditions—African, Asian, Native American, and so on—have nothing of value to add to such a project. To the contrary, I have no doubt that they do. The unfortunate limitation in scope only reflects the many limitations of the present author, whose profound ignorance of most subject matters stems not from indolence but the inescapable fact that time, memory, and mental energy are finite resources. Perhaps someday radical cognitive enhancements will extricate individuals (like me) from this prison of thought by enabling one to memorize every document in the Library of Congress and process information as rapidly as the digital computer in your backpack. But for now, scholars must content themselves with never knowing what they can never know.
[4] But see W.V. Quine's famous "Two Dogmas of Empiricism," as well as Herman Cappelen's 2018 book Fixing Language *An Essay on Conceptual Engineering*.
[5] As stated, this is inaccurate. It is not merely our species but our evolutionary lineage, which could bifurcate into any number of future posthuman beings—our "wide" descendants in the phraseology of David Roden—which could be wholly biological, cyborgish hybrids, or artificially machinic in their physical constitution.
[6] Specifically, the existential moods of (2) through (5), adumbrated below, are cumulative. These eclipsed the mood of (1).
[7] By this I mean that human extinction will have occurred when there are no more tokens of the type *humanity*, which I will define broadly as including our evolutionary descendants (who may be posthuman).
[8] But not in all cases. For example, we could die out by refusing to have any more children, or as discussed in a later chapter, a "vacuum bubble" could destroy Earth almost instantaneously, at the speed of light.
[9] See Knipe 2007.
[10] See Nattier 2007.
[11] may have originated with Plato's *Timaeus*, written circa 360 BCE

According to Arthur Lovejoy. See Lovejoy […].
[12] First quote is from Moynihan 2019; second quote is from Hintikka 1976.
[13] This claim was made by Martin Sauer, who wrote: "Sea cows were very numerous about the coast of Kamtshatka, and the Aleutan islands, at the time when they were first discovered; but the last of this species was killed in 1768 on Bering's island, and none have been ever seen since."
[14] See Moynihan 2019.
[15] See Fenves 2003.
[16] See Levin 2010.
[17] Quoted in Bowler 2003.
[18] See Shields 1877.

[19] See Moynihan 2019. He further writes: "During the 1760s, William Hunter used incipient comparative anatomical methods to argue the recently-uncovered Mastodon evidenced an organism on longer extant …, and he later did the same with the Great Irish Elk. By this time, Voltaire … and his peers publicly endorsed prehistoric extinctions. During the 1770s, the German naturalist Petrus Camper turned his attention to the Woolly Rhino, thereafter drafting a paper on extinct quadrupeds … Around this time, eye-witness reports of the demise of contemporary species began returning from the colonies: ranging from Newfoundland's great auk … to the sea-cow of the Aleutian Islands … In an influential 1793 paper, Cuvier's one-time tutor, Carl Friedrich Kielmeyer … , dwelt upon nature's profligate destruction of entire genera. And, just two years prior to Cuvier's 1796 address, the first binomial classification had been given to an extinct species of prehistoric cave-bear … ."
[20] I get the term "sportings of nature" from Cuvier 1813.
[21] See Bowler 2003.
[22] See Whybrow 1985.
[23] See Bowler 2003. Note also that the first uses of "extinct" to describe the disappearance of a species appear to have occurred in the 1670s; e.g., a book (second edition) published in 1675 states that "if the *species* of Trees may be wholly extinct, as is reported of the *Chesnut*, at least from a spontaneous growth, why may not [as well] a new *species* naturally succeed?" (Worlidge 1675). This roughly comports with the *Online Etymology Dictionary*'s (henceforth, "*Online*") claim that the term, which first appears in the early fifteenth century, acquired its meaning about species "by [the] 1690s." In contrast, *Online* records the first use of the nominalized form of the word—i.e., "extinction"— as applied to species in 1784, although the earliest use of this sense recorded by the *Oxford English Dictionary* (OED) is 1880, in a passage written by Alfred Russel Wallace, which states that "the most effective agent in the extinction of species is the pressure of other species."
[24] See Moynihan 2019.
[25] *Ibid*.
[26] *Ibid*.
[27] However, the main character of the book adds: "Yet, will not this world be re-peopled, and the children of a saved pair of lovers, in some to me unknown and unattainable seclusion, wandering to these prodigious relics of the ante-pestilential race, seek to learn how beings so wondrous in their achievements, with imaginations infinite, and powers godlike, had departed from their home to an unknown country?"
[28] See Cutis 2000.
[29] See Moynihan 2019.
[30] *Ibid*.
[31] See Palmer 1999.
[32] *Ibid*.
[33] I became aware of this article because of Moynihan 2019.
[34] See Armstrong 1993. Gavin Hyman makes a similar point, writing that "it is instructive to note that the term 'atheism' as an identifiable outlook is roughly contemporaneous with the birth of modernity itself. It has often been noted by scholars of antiquity that what we understand as 'atheism' would have been unintelligible to the classical mind. Certainly, there were disagreements on the nature of the gods or their activities, and sometimes even the denial of the existence of certain gods. But the notion, intrinsic to the modern understanding of atheism, of immanence—of the world existing quite free of any sort of transcendent realm—would have been almost unintelligible to them."
[35] This is rarely how the term has been used in more recent times, of course, although there are exceptions. For example, a 1982 book titled *Immortality or Extinction*, co-authored by a theologian, examines the question of whether life after death is possible.
[36] Although not in this chronological order. See my book *The End: What Science and Religion Tell Us About the Apocalypse* for more.

[37] The situation was, I should note, a bit more complicated than this. Shortly after the Second Law was formulated, the brilliant Austrian physicist Ludwig Boltzmann—who hung himself on vacation, perhaps because of the reception to his ideas at the time—offered a statistical theory of entropy. That is to say, the Second Law is not a brute fact about the universe—an "unexplained explainer"—but can be reduced to more fundamental phenomena. More specifically, Boltzmann leveraged the "kinetic theory of gas," which was controversial at the period, to explain why systems become more disordered over time. Simply put, there are far fewer ways that a system would be ordered than disordered. By analogy, there are are more configurations in which the papers on my desk could be messy than stacked in perfectly neat piles. Hence, for this purely statistical reason systems will tend toward increasingly chaotic states. The catch is that this does not mean that entropy will *always and necessarily* increase in isolated system, only that disordered states are far more probable than ordered ones. It follows that there could be improbable thermodynamic fluctuations that result in lower entropy configurations given enough time. The result was two possible "pictures" of the universe: first, the relatively low-entropy world in which we find ourselves could have emerged simply by chance, as a random thermodynamic fluctuation in a universe existing for indefinite spans of time. Second, the universe could have had a *beginning* that was marked by extremely low entropy, and is gradually winding down from this initial starting point. Which picture is correct? Although physicists like Clausius maintained, as quoted, that the Second Law implies that time is not a circle, it was not really until Edwin Hubble's work in 1929, which involved analyzing the redshifts of galaxies, and the subsequent discovery of the "cosmic background radiation"—the literal afterglow of the Big Bang, produced when the universe cooled below the temperature of plasma—in 1964, that the matter was settled: the universe did indeed have a beginning. Yet even if true, this does not prove that cosmic time is linear. In a 2007 book titled *Endless Universe*, by the theoretical physicists Paul Steinhardt and Neil Turok, the authors argue against the conventional view that nothing preceded the Big Bang—there was no space, no time, and no matter. Rather, they propose what they call the "Cyclic Theory" according to which space and time existed prior to the Big Bang. Our three-dimensional world, called a "brane" or, in String Theory, a "braneworld," repeatedly collides with other braneworlds in an extra dimensions. These collisions cause each to bounce back and, in the process, to initiate a new Big Bang from which matter and energy result. The new braneworld expands and cools such that, as was the case with our own universe, galaxies, stars, and planets eventually form—and perhaps from this process spring new forms of intelligent life. What is certain, though—or at least as certain as can be in science, since empirical observations can lead only to assigning *probabilities* less than 1 and greater than 0—is that our universe did indeed have a beginning, and thus cosmic time within this enclave of the multiverse is indeed, as stated, linear and directional. (Note here that one argument against Boltzmann's first "picture" of the universe: since single brains complete with memories of the past and sensory inputs consistent with an external world are simpler than entire worlds emerging randomly from thermodynamic equilibrium, one is more likely to be a single brain—a "Boltzmann brain"—than a brain embedded in a complex world full of other brains. Now consider the fact that, if the universe is indefinitely old and subject to random thermodynamic fluctuations, there will be far more Boltzmann brains in total than "real" brains. Hence, given the Principle of Indifference, *you* are literally more likely to be a Boltzmann brain with false memories in a world that is out to dissolve than not. But this solipsistic conclusion is absurd, or so one could argue, and therefore the first "picture" must be rejected.)

[38] This is a passage describing Winchell's views from from Shields 1877.

[39] As Spencer wrote to John Tyndall in an undated letter: “Regarding as I had done, equilibration as the ultimate and highest state of society, I had assumed it to be not only the ultimate but also the highest state of the universe. And your assertion that when equilibrium was reached life must cease, staggered me. Indeed not seeing my way out of the conclusion, I remember being out of spirits for some days afterwards. I still feel unsettled about the matter." To which he added, “it is not inferable from the general progress towards equilibrium that a state of universal quiescence or death will be reached; ... if a process of reasoning ends in that conclusion, a further process of reasoning points to renewals of activity and life.”
[40] See Bowler 2003.
[41] See Mayr 1981.
[42] See Kuehn 2001.
[43] See Hyman 2010.
[44] Note that Wallace disagreed with this. Thanks to Adrian Currie for pointing this out to me.
[45] Elsewhere in the *Origin*, he makes a slightly different claim, which is consistent with his progressionism: “judging from the past, we may safely infer that not one living species will transmit its unaltered likeness to a distant futurity.”
[46] See Darwin 1871. Indeed, Freud once wrote that “for incalculable ages mankind has been passing through a process of evolution of culture. … We owe to that process the best of what we have become, as well as a good part of what we suffer from. Though its causes and beginnings are obscure and its outcome uncertain, some of its characteristics are easy to perceive. It may perhaps be leading to the extinction of the human race, for in more than one way it impairs the sexual function; uncultivated races and backward strata of the population are already multiplying more rapidly than highly cultivated ones…. The physical modifications that go along with the process of civilization are striking and unambiguous. They consist in a progressive displacement of instinctual aims and a restriction of instinctual impulses…. Of the psychological characteristics of civilization two appear to be the most important: a strengthening of the intellect, which is beginning to govern instinctual life, and an internalization of the aggressive impulses, with all its consequent advantages and perils.”
[47] Later, in 1944, he wrote that “the precedents are all in favour of some entirely marginal form emerging to become humanity’s successor. … There may even be insects, ants for example, acquiring qualities that will oust and exterminate us. Forms may be arising whose weapon will be mortal human epidemics to which they are immune.”
[48] See Weart 1998.
[49] See Whitebook 2017.
[50] *Ibid*.
[51] Incidentally, *DAEDALUS* offers a notable early account of transhumanism. For example, Haldane imagines humanity gaining control over its evolutionary trajectory by controlling our genes and using ectogenesis to gestate fetuses in artificial wombs. As it happens, Haldane’s speculations had a notable influence on the dystopian novel *A Brave New World* (1932), written by Julian Huxley’s brother Aldous Huxley.
[52] Unless one considers the Sino-Japanese war, which began in 1937, to be the beginning of WWII.
[53] See Weart 1989.
[54] *Ibid*.
[55] Indeed, Hitler was also warned about this possibility in early discussions about creating an atomic bomb. As Albert Speer (1970) writes, “Heisenberg had not given any final answer to my question whether a successful nuclear fission could be kept under control with absolute certainty or might continue as a chain reaction. Hitler was plainly not delighted with the possibility that the earth under his rule might be transformed into a glowing star.”
[56] See Weart 1989.

[57] Note that same year, H.G. Wells published his final book *Mind at the End of Its Tether*, in which he waxed poetic about "the ultimate disaster that confronts our species" and the frightful possibility that "we may be spinning more and more swiftly into the vortex of extinction."
[58] See Json Daawsey: https://www.manchesterhive.com/view/9781526101327/9781526101327.00012.xml.

[59] See JANET FARRELL BRODIE

Radiation Secrecy and Censorship after Hiroshima and Nagasaki

[60] The Doomsday Clock should not be confused with the "Doomsday List" or the "Doomsday algorithm." The first is a list of "endangered" lighthouses compiled by *Lighthouse Digest*, and the second is a set of rules that enable one to determine, for any date—such as July 2, 1982—which day of the week it corresponds to.
[61] *Ibid*.
[62] Yet even before the Castle Bravo debacle, studies show that the word "panic" was fourteen times more frequent in the American press in 1953 compared to 1948.
[63] This was, incidentally, based on a December 23rd, 1954 address recited by Russell on BBC radio, titled "Man's Peril," which garnered an audience of between six and seven million people.
[64] Quoted in Schell 1982.
[65] See Weart 1989.
[66] Quoted in Kihss 1956.
[67] See Badash 2009.
[68] *Ibid*.
[69] *Ibid*.
[70] See Le Treut et al. 2007.
[71] See Beard 2020.
[72] Mann also argues that Vogt and Osborne laid the theoretical groundwork for the environmental movement of the 1960s. In his words, "they were the first to portray our ecological worries as a single Earth-sized problem for which the human species is to blame. And by stating that the problem is one interconnected, worldwide issue, rather than something local or national, they implicitly argued that ecological issues could only be solved by a unified global effort, administered by global experts—by people, that is, like Vogt and Osborn."
[73] See Weart 1989 for more.
[74] See my 2018 paper "Facing Disaster: The Great Challenges Framework," published in *Foresight*.
[75] See SFE 2018.
[76] See Sandberg 2018.
[77] Indeed, Kennedy's Secretary of Defense, Robert McNamara, wrote the following about the incident: "As I left the White House and walked through the garden to my car to return to the Pentagon on that beautiful fall evening, I feared I might never live to see another Saturday night."
[78] See Weart 1989.
[79] *Ibid*.
[80] Another notable book that I have not mentioned here is the 2008 edited collection *Global Catastrophic Risks*, which includes chapters by domain experts on all the major threats to humanity so far identified this century.
[81] See Schorr 1988.

[82] See Sheridan 2015.

[83] See Orlowski 2014.

[84] Indeed, religious adherence was on the *rise* for much of the 1950s.

[85] Special thanks to Spencer Weart's incredible book *Nuclear Fear: A History of Images*. This pointed me in a million different directions, and I do not think that the present chapter could have been written without it.
[86] Indeed, he suggested that Earth is at least 75,000 years old.
[87] See Palmer 1999.
[88] See Steel 1997.
[89] See Palmer 1999.
[90] See Bowler 1999.
[91] *Ibid*.
[92] See Browne 1985.
[93] See Palmer 1999.
[94] Thanks to John Paul Torres—my father—for this translation. He notes that "degrees" might not be the best word, although it is unclear what would be better.
[95] See Rampino et al. 1988.
[96] *Ibid*.
[97] Note also that by the early 1990s, there were speculations that a "nuclear winter" scenario could actually "be initiated by non-nuclear means." To quote Lawrence Badash at length: "The powerful chemical or free-electron lasers planned for President Reagan's Strategic Defense Initiative were expected to burn holes in the casings of Soviet missile as they rose from their silos in the boost phase. Alternatively, they might melt components of the separated warheads as they traveled on their ballistic trajectories, in one way or another rendering them harmless. But these narrow beams, whether from ground-based lasers reflected off orbiting mirrors or space-based lasers, would contain so much concentrated energy that a mere tenth of a second's illumination of combustible material on the ground would send it soaring well above its kindling temperature. Beams could be slewed rapidly from one city to another, igniting their funeral pyres even more efficiently than by nuclear explosives. 'Fires engulfing a million people would be started in a few minutes. . . . From such a near-simultaneous high density of ignition points a fire storm would almost certainly develop,' maintained Albert Latter and Ernest Martinelli."
[98] See Browne 1985.
[99] This comes from a 1985 letter to the *Bulletin of the Atomic Scientists*.
[100] See McPhee 1981.
[101] See Gray 2016.
[102] Of note is that, according to Andrew Dalby in his book *Rediscovering Homer*, Xenophanes was "the very first Greek poet who shows awareness that by writing he is creating 'fame that will reach all of Greece and never die while the Greek kind of songs survives.' He is conscious that by using writing, in the new Greek kind of song, he can address future generations in his own words, a thing that the old oral poets never thought of doing."
[103] See Wagar 1983.
[104] However, there is some speculation about the possibility of tunneling into a parallel universe—the ultimate prison escape! Consider also the following passage from John Barrow and Frank Tipler: "But though our species is doomed, our civilization and indeed the values we care about may not be. We emphasized in Chapters 8 and 9 that from the behavioural point of view intelligent machines can be regarded as people. These machines may be our ultimate heirs, our ultimate descendants, because under certain circumstances they could survive forever the extreme conditions near the Final State. Our civilization may be continued indefinitely by them, and the values of humankind may thus be transmitted to an arbitrarily distant futurity."
[105] Note that More changed his name because of his transhumanist (or extropian) ideology. "It seemed to really encapsulate," he stated in an interview, "the essence of what my goal is: always to improve, never to be static. I was going to get better at everything, become smarter, fitter, and healthier. It would be a constant reminder to keep moving forward."
[106] Other influential deontologists, such as W.D. Ross, are not *absolutist* in this sense. Indeed, the contemporary tradition of deontological ethics has roots in both Kant and Ross.

[107] Although I believe that Barbara Hermann has argued that a theory of value underlies Kant's ethical system.
[108] *Ibid*. Note that Parfit was among the most influential moral theorists of the twentieth century, although he began his career as "one of the most brilliant history students of his generation." Parfit was also known for his endearing quirks, such as eating with one hand so he could read with the other, drinking instant coffee by pouring hot water into a cup from the tap to save time, and consuming large amounts of vodka in the evening to help him sleep (he suffered from chronic insomnia). Although he published little during his life—Beard doubts "if even 1 percent of Derek's work has ever been published"—his 1984 book *Reasons and Persons* was immediately recognized as a towering and canonical contribution to the enterprise of moral philosophy.
[109] Note that Parfit also appeared to be sympathetic with transhumanism. For example, he wrote in 2017 that "what now matters most is how we respond to various risks to the survival of humani- ty. We are creating some of these risks, and discovering how we could respond to these and other risks. If we reduce these risks, and humanity survives the next few centuries, our descendants or successors could end these risks by spreading through this galaxy. ... Life can be wonderful as well as terrible, and we shall increasingly have the power to make life good. Since human history may be only just beginning, we can expect that future humans, or supra-humans, may achieve some great goods that we cannot now even imagine. In Nietzsche's words, there has never been such a new dawn and clear horizon, and such an open sea."
[110] Seneca the Younger, who tutored the Roman emperor Nero and was later sentenced to death by suicide (which he committed by slicing himself open and bleeding to death, all while calmly talking about philosophy to friends by his side), wrote in 65 AD that "there will come a time when our descendants will be amazed "the time will come when diligent research over long periods will bring to light things which now lie hidden. A single lifetime, even though entirely devoted to the sky, would not be enough for the investigation of so vast a subject … And so this knowledge will be unfolded only through long successive ages. There will come a time when our descendants will be amazed that we did not know things that are so plain to them … Let us be satisfied with what we have found out, and let our descendants also contribute something to the truth … Many discoveries are reserved for ages still to come, when memory of us will have been effaced."
[111] For example, the Gaia Liberation Front (GLF), which is headquartered in Toronto, Canada, is founded on a radical interpretation of *deep ecology*. As its "communique #1" declares: "Our mission is the total liberation of the Earth, which can be accomplished only through the extinction of the Humans as a species." This is based on the idea that "the Humans evolved on the Earth, but are no longer of the Earth. Having become alienated from the Earth, they must be regarded as an alien species." The document adds that "the evidence is overwhelming that the Humans are programmed to kill the Earth. This programming is not only cultural, but probably also genetic since the major technologies Humans use for this purpose, from agriculture and metallurgy to writing and mathematics, have all been invented independently more than once." And "in any case, every Human now carries the seeds of terracide. If any Humans survive, they may start the whole thing over again. Our policy is to take no chances." In a separate statement, the group asserts that humanity is an "alien species," "virus," or "cancer" that must be excised from the planet. Unfortunately, they say, doing this through nuclear war would result in too much collateral damage, mass sterilization would be too slow, and suicide is logistically impracticable. Yet bioengineering offers "the specific technology for doing the job right—and it's something that could be done by just one person with the necessary expertise and access to the necessary equipment." Furthermore, "genetically engineered viruses … have the advantage of attacking only the target species. To complicate the search for a cure or a vaccine, and as insurance against the possibility that some Humans might be immune to a particular virus, several different viruses could be released (with provision being made for the release of a second round after the generals and the politicians had come out of their shelters)." See my papers on "agential risk" here: www.xriskology.com.

[112] As many philosophers are and have been—see the anecdote above about Parfit—Bostrom is a rather eccentric character. He sometimes works out in the gym at four in the morning, consumes nicotine to enhance his cognition, and boasts of having set an academic record in his native Sweden (although there is no reason to think this is the case). One of the oddest social interactions I have ever had was, in fact, with Bostrom. I first met him, briefly, at a Harvard conference on human enhancement. The second time, about a decade later, was at a conference on artificial intelligence at New York University. At this point he was quite famous, having published his best-selling book *Superintelligence* a few years earlier. I introduced myself and asked him a question about an idea I was developing. He asked me to clarify something I said, but about five seconds into my response, he literally turned around and walked away. I stood there for a few moments longer in astonishment. I suspect that my question was not sufficiently interesting to capture his attention.

[113] Note that the *Journal of Transhumanism* is now called the *Journal of Evolution and Technology*.

[114] See Katz 2009.

[115] See Leeming and Leeming 2009.

[116] See Baldry 1965.

[117] *Ibid*.

[118] See Moynihan 2019.

[119] See Mazlish 2009.

[120] See Deudney 2018.

[121] See *Ibid* for more.