

GREGORY BENFORD

HUMANITY AS CANCER

" . . . still I have not seen the fabulous city on the Pacific shore. Perhaps I never will. There's something in the prospect southwest from Barstow which makes one hesitate. Although recently, driving my own truck, I did succeed in penetrating as far as San Bernardino. But was hurled back by what appeared to be clouds of mustard gas rolling in from the west on a very broad front. Thus failed again. It may be however that Los Angeles will come to me. Will come to all of us, as it must (they say) to all men."

Edward Abbey - Desert Solitaire

In 1960 the journal Science published a short paper which is still sending slow-motion shock waves through the soothsayers of our time. Titled "Doomsday: Friday, 13 November, A.D. 2026," its abstract reads in full, "At this date human population will approach infinity if it grows as it has grown in the last two millennia."

Period. Its authors, Heinz van Foerster, Patricia Mora and Lawrence Amiot, were members of the staff of the department of electrical engineering at the University of Illinois, Urbana. They were not population experts, but they noted a simple oddity of mathematics. The rise in human numbers was always studied in "doubling times," the measure of how quickly population doubled. But real human numbers don't follow so clean an equation.

For a species expanding with no natural limitation aside from ordinary deaths, the rate of increase of population is proportional to the population itself. Mathematically, the population  $N$  is described by an equation in which the change in  $N$ ,  $dN$ , over a change in time  $t$ ,  $dt$ , obeys  $dN/dt = b N$

with  $b$  usually assumed to be a constant. If  $b$  is truly constant, then  $N$  will rise exponentially.

Fair enough. But if people are clever, the proportionality factor  $b$  itself will weakly increase as we learn to survive better. This means the rate of increase will rise with the population, so  $N$  increases faster than an exponential.

In fact, it can run away to infinity in a finite time. The equation describing this is a bit more complicated. To find how  $b$  changed with  $N$ , the authors simply looked at the average increase over the last two thousand years, to iron out bumps and dips, seeking the long-term behavior.

They found a chilling result. Our recent climb in  $N$  in the last few centuries is not an anomaly; instead, it fits the smooth curve of human numbers. Tracking the solution backward "post-diets" that we were a mere 9,000,000 people a million years ago. Of course such great spans aren't well fit by population counts gathered from two millennia, and the equation becomes silly. But it should be good for at least a few centuries more.

Looking into the near future, it predicts a chilling result: a singularity, with  $N$  rising faster and faster, going beyond view on Nov. 13, 2026. "The clever population annihilates itself," they remark laconically. "Our great-great-grandchildren will not starve to death. They will be squeezed to death."

The paper has never been refuted. Further checks on the growth of the

factor b have pushed the singularity date further away, to about 2049. This is comforting, moving the date by about twenty years in the thirty-four years since the paper appeared.

But the general conclusion stands. As an exercise in statistics it is stimulating, and as far as I know the authors did little with it after their first telling point.

Of course, nothing grows to the sky. Something will happen before b gets too large; the four horsemen of the apocalypse will ride again. Perhaps they already are. Still, we are not doormats. We are attempting population control, but results are slow, and pressures are mounting.

I wrote before in this column about the ideas which follow, in a piece titled "The Biological Century." I'd like to revisit an idea I floated there, with some second thoughts.

The future is coming, and it's ugly.

Or so many believe. From staid university presidents and scruffy environmentalists alike, a growing consensus holds that humanity has entered a watershed era, a time of vast disasters looming large, just over the horizon of this generation. Their case rests on far more than an equation, too.

In 1992 I went on a cross-country hike in Orange County to protest a highway soon to go in. Puffing up a hill, I struck up a conversation with a member of the eco-warrior group Earth First, who wore the signature red shirt with a clenched fist. We mounted a ridge and saw the gray sweep of concrete that lapped against the hills below.

"Looks like a sea of shit," the Earth Firster said. "Or a disease."

That same month the National Academy of Sciences and Britain's Royal Society jointly warned of the dangerous links between population and environmental damage. Following this up, the Union of Concerned Scientists mustered 1500 experts to sign a "World Scientists' Warning to Humanity" and published it in leading newspapers. Heavy hitters, these, including the predictable (Linus Pauling, Paul Ehrlich, Carl Sagan), the inexpert but sanctified (Desmond Tutu), but also the heads of many scientific societies, Nobel Laureates, and authorities of many fields. One such Laureate, Henry Kendall of M.I.T., is leading the New Cassandras in a campaign to muse the intelligentsia.

His case is easy to make. World population grows by 90 million yearly and will double within half a century, maybe less. More people have been born in the last forty years than in the previous three million years. About 8 percent of all human beings ever born live today. We are gaining at about 1.7 percent a year.

Meanwhile, the Green Revolution is apparently over: world per-capita crops have declined. About ten percent of the Earth's agricultural land area has been damaged by humans. Water may be the first major resource to go; half of all nations now have water shortages. Even in the American midwest and southwest, farmers are sucking "fossil water" laid down in the ice ages, pulling it from aquifers which will deplete within a generation.

But such policy-wonk numbers, the ecologists remind us, are too human-centered. Our swelling numbers have their greatest impact on defenseless species in rain forests, savannahs and coral reefs. Biologist E.O. Wilson of Harvard warns that we could lose thirty percent of all species within half a century, and that might be only

the beginning.

Humans exert selective pressures on the biological world. North Atlantic waters show a clear pattern of over-fishing, and ever-shrewd nature has filled these new niches with "trash fish" like skates and spiny dogfish which we cannot eat and thus do not take out.

Monoculture crops worldwide gain efficiency by growing the same staple-wheat, rice, corn, trees-over a large area, but this is inherently more fragile. Diseases and predators prey easily and already erosion is a major threat in many such areas.

Environmental damage grows not merely because our numbers rise, but because our expectations do, too. The masses jammed into Buenos Aires want a better life -- which means more consumer goods. The chain between such ambitions and the clearing of distant forests is, though long, quite clear.

Most environmentalists are technophobic, reluctant to admit that the greatest enemy of the rain forests is not Dow Chemical but rather sunburned, ambitious men newly armed with chain saws, eager to better their lot in life.

Still, hand-wringing is not new and skepticism about it is well earned. Paul Ehrlich's alarmist "The Population Bomb" has yet to explode, twenty-five years after publication, though some demographers feel that Ehrlich may simply be a few decades off.

And there are counter-trends. Many are laboring to see that the factor  $b$  does not increase.

The "developing world" -- to use the latest evasive tag attempting to cover societies as diverse as Singapore and Somalia-- is the great engine of population growth, but its pattern is not an exponential runaway. Taken all together, the poorer nations' growth rates seem to have reached a plateau.

This may echo the industrial world, whose net growth curve broadly peaked around 1900 at a rate of about one percent a year, and is now a fourth of that. The poor countries may have entered just such a transition era. Some nations began peaking in the 1970s and others join them. Still, the plateau average rate is 2.5 percent per year, so they have a long way to fall.

Will they decline? Environmentalists and professors alike fear they won't.

Our numbers respond to both feedback loops and to feed-forward anticipations. Gloom, doom- well known intellectual commodities, finding a perpetual market. The 1960 paper is still the firmest basis for hand-wringing. Few experts believe the planet can sustain a population doubling in parallel with rising economic desires. This is how the Earth Firsters merge with the academics -- a profoundly pessimistic view of our collective future, shared from the hushed halls of Harvard to the jerky hip-hop images of MTV.

This sea change we already see in severe cultural collision, such as immigration. MIT's Kendall predicts a doubling of Mexico's immigration into the USA within a decade. Shantytowns along the USA southwestern border recall the slums of Rio. Last year the USA added 970,000 new legal immigrants, plus 132,000 refugees and the INS estimates that slightly over a million illegal immigrants came to stay. Our growth rate is nearly at one percent per year. Since our native population is near the Zero Population Growth level so

publicized in the 1970s, this means immigration is virtually the sole cause of US growth, and places us far ahead of other industrial nations.

Immigration-driven cultural strife is growing both here and in Europe. Anti-immigration forces typically fix myopically upon their local rise, Kendall says, but the only true solution must be global. "Until masses of people stop wanting to emigrate, you still have a basic problem." He is careful to shy away from the immigration issue, pitching his cool Cassandra tone to a lofty moral plane. His arguments seem far from the fever-eyed cries of the eco-warriors.

But Garrett Hardin, emeritus professor from UC Santa Barbara and Kendall ally, argues for an America-saving cut in immigration. Target: eventually, less than 200 million Americans, since this is the sustainable level. "Sustainable" is the consensus watchword, including some unsettling ideas.

To me the most significant one is Hardin's opposition to sending food aid to overpopulated areas such as Somalia. "Every time we send food to save lives in the present, we are destroying lives in the future." He invokes a cycle now well known-- aid fuels birth rates, then leads to famine within a generation. Human "die-backs" are now a routine feature of worldwide news, with "compassion fatigue" already evident in the media.

Robert Malthus, the original population prophet, thought that civilization would hit the wall in the late nineteenth century. Economists like Julian Simon of the University of Maryland dismiss the doomsayers, noting that they've been around since the Bible. "The only difference is that Ezekiel and Jeremiah were much better writers."

Simon and others marshal powerful counter-arguments, though they are seldom heard among the intelligensia. They remind us that mass human starvation in the modern world results mainly from outmoded political systems or war or both. Somalis is not overpopulated, as Hardin claims--it is the victim of obsolete African clan patriarchies trying to run bigger groups than their systems ever envisioned. In this view, starvation arises from human stupidity, most of it political stupidity. Only education, particularly science education, can help that. As for war, the major preventative is democracy -- there hasn't been a war between democracies for more than a century. Democratization of the world proceeds apace, driven by UN sanctions and TV advertising alike.

They feel we have a long way to go before we hit the Malthus wall. Water might prove to be the limiting factor. Flying over the Western U.S., it's almost entirely empty, as are a lot of other places on the planet with good climate.

That changes if you have power for desalination. For the \$100 billion we've spent on the drug war, plus \$10 billion a year we continue to spend, we could have gone a long way toward working fusion. Or we could have developed thorium breeder fission, and maybe less exotic, cheap solar cells, if fusion turned out to have unexpected difficulties. For a small fraction of our defense budget we could still do something radical in the way of power generation, before the Ogallala aquifer runs dry in a generation or two and the bread basket becomes a dust bowl.

Uplifting the bulk of humanity can suppress population growth, if well managed. It can either top out at comfortable levels, or "everywhere is Los Angeles" levels, as in the Edward Abbey quotation

I opened with. It's our choice. Refusing the third world food helps not at all, and even hurts {they grow slowly anyway from information trickle}. Giving them food without technology doesn't help either, and may even be worse.

Changing social attitudes is slow work. Much of the Catholic third world is stuck in a high growth pattern. The major problem is not religion, though. Anglo Catholics in the USA have the same fecundity as Protestants and there is no reason to think this would not also eventually turn true South of the border. Industrialization and mechanized farming are the key ideas, since children are an economic asset rather than a liability only in low tech agrarian economies. Luddites can't solve the population problem.

So solutions are available, if we wise up. But voices saying this are seldom heard. Simon and his allies are in a tiny minority. The overwhelming majority of thinkers, whether economists or biologists, see disaster ahead. That 1960 paper casts a long shadow.

I suspect there is more here than a Malthusian malaise. While there are ever more mouths, there is also possible global damage unimagined by Malthus, a far more muscular feedback effect. These could tilt the entire biosphere against many species, including us. A biologist recently remarked to me, "We've just run out of new niches. So the whole system will do a little feedback stabilizing." The vast, numbing menu of looming potential disasters -- lessening fish stocks, water, topsoil; dwindling rain forests; growing ozone holes; dying species; global warming; deepening poverty; spreading pollution -- makes the New Cassandras different.

They bring a message already deeply enshrined in the hardcore environmentalist movement, one the media have preached for decades. The issue is not the dry debate between the Simons and the Kendalls, but the sea change in moral attitudes that underlies the talk, whether it is over immigration or owls-versus-jobs.

To see the future, look to the fringes. The environmentalists are a powerful lobby, but they also have a wing which will, if you get in their way, spike your tree, slip sand into your backhoe's gas tank, or sink your tuna boat.

Initially their rules -- as laid down by crusty Edward Abbey in the novel which inspired Earth First, The Monkey Wrench Gang-- were two. First, honor all life and do not hurt anyone. But Earth Firsters have strayed far from this role, preparing traps for desert bikers and loggers which could have killed-- but didn't because of the vigilance of their opponents, not themselves.

Neither have they met their second rule: Don't get caught. Many are willing to break the law and pay the price. The Arizona Five, who tried to cut an electrical tower, got nabbed by an FBI undercover agent.

Do the crime, do the time -- a principled stance, but how far can it go? Are there crimes we cannot accept?

There are hundreds of monkey-wrenchers in lesser camps such as the Animal Liberation Front, the Hunt Saboteurs who disrupt big-game sport, Albion Nation, and assorted Deep Ecologists.

These are not policy people with whom libertarians can reach gentlemanly agreement about, say, junking federal timber subsidies. They all practice varying degrees of "ecotage" which estimates place at about \$25 million a year in the US. I have met eco-warriors who

are completely unaffiliated, though, some quite well educated and no less determined.

Back on that Orange County ridgeline, gazing out over miles of dusky, besmogged concrete, the Earth Firster said something that genuinely frightened me. Not because it was a specific threat, but because it connected with my own academic world.

"Y'know, we're a cancer. And somebody's going to find a cure."

Already we are numbed by TV images of diebacks -- the sudden, catastrophic collapse of whole life support structures on a regional level, the Four Horsemen writ large. I believe, though, that two social forces will bring even more dire events in the next century.

Consider: our globe has a technological North with many accomplished bioengineers. Given our desire to extend our own lifespans, much research will go into an intricate fathoming of the human immune system, to fixing our cardiovascular plumbing, to forestall aging and the like. That is the first important and plausible point.

On the other hand, the North will increasingly be appalled with the South's runaway growth. Many poor nations will double in numbers within thirty years.

Think of watching it on high-definition TV. Megacities will sprawl, teeming with seedy, corrupt masses. Sao Paulo at 34 million, second only to pristine Tokyo. Lagos, Nigeria, which nobody ever considers, may top 17 million, despite the multitudes lost to AIDS. Kindergarten-age children digging through cow dung, looking for corn kernels the cows hadn't digested. Colorful chaos laced with dusky despair. Gangs of urchin thieves who don't know their own last names. Gutters as sewers. Families living in cardboard boxes. Babies found discarded in trash heaps.

Torrents of illegal immigration will pour over borders. Responding to deprivation, crazed politico/religious movements will froth and foment, few of them appetizing as seen from a Northern distance.

The more the North thinks of humanity as a malignancy, the more we will unconsciously long for disasters. This is the second, all-too-plausible point.

Somewhere, sometime, someone may see in these two points a massive, historically unique problem and a quite simple solution: the Designer Plague.

An airborne form of, say, a super-influenza. The Flu From Hell, carried on a cough, with a several-week incubation period, so the plague path will be hard to follow. Maybe fine-tuned, too, carrying a specific trait that confines it to tropical climes, like malaria.

We in the comfy North forget that for the bulk of humanity, diseases are kept at bay by a thin modernity in medicine, well water and clean food. Yet across this globe a swift vital traffic flows. Influenza A, which brings teary, aching fever to a hundred million of us yearly, is an old enemy, endlessly vigorous. It would make a handy weapon.

Viruses are ancient oddities. We have now mapped the RNA core of Influenza A and its surface proteins -- tiny spikes that prod the human immune system into forming cloaking antibodies. This virus can mutate, rearranging the molecular code that shapes the spike-tip proteins. Then the new virus can dodge around our bodies' immune response, feasting on us until our blood streams conjure up a fresh

antibody defense.

There is a curiosity in modern immunology, though. Antibody records of elderly patients' blood show that since 1890 all influenza epidemics have been wrought by only a few of the possible subtypes of the virus particles. Minor changes have kept the damage minimal.

Nobody knows why this is so. Influenza resides in our domesticated friends -- turkeys, pigs, fish, chickens. We have tracked flus that breed in both birds and pigs, and new strains that attack humans have come from both; the Ford administration's alarm over Swine Flu was not hysterical.

It spreads by air not through Boeing, but through ducks and sea gulls. Only the pandemic of 1918-19, misnamed "Spanish" though it came from southern China, was powerful, killing as many of us as any single war has ever done.

Influenza's potency derives from its primitive nature. Its vital RNA lacks the proofreading and editing skills which longer, more stable genomes such as ours have developed. So it is easily manipulated, and luckily the changes have been mild of late. Somehow, in the breeding ponds of Asia where farmers tend their paddy rice, only minor variants have appeared.

But in the laboratory, drastic tailoring is easier than ever before - and will get easier still. Big shifts in the influenza pattern, a new mix of genes, could bring greater infectivity and startlingly high virulence. Already, one carrier on an airplane, or (in army experiments) one sick person just walking through a tent can infect many. The big advances could lie in virulence. There are newly "emergent" viruses like Ebola that can kill up to two out of every three victims, suggesting that influenza could be brought up to this level as well.

A mass plague does not necessarily demand high tech, either. Making a custom flu strain is very difficult now (unless tinkering turns one up by accident), because we do not know yet what makes strains virulent. Instead, our old enemy smallpox could fill in. Since it was eradicated in the mid-1970's, few people have been vaccinated. By now most of the world is susceptible again. Smallpox is kept locked away in two heavily guarded sites in the world, and the medical community continues to debate whether those two samples should be destroyed. {One counter-argument holds that, after all, smallpox is a species, and we should conserve species. I am not making this up.)

But smallpox is imprisoned only in one sense. Its genome is published in the open literature, though, so in another sense it's everywhere. Like all life, smallpox is at root information. A biological virus in this sense is exactly like a computer virus. All smallpox needs to make its way out of virtual reality is for a savvy scientist to translate.

I asked a friend to imagine how he would do this. With barely a moment's hesitation he rattled off, "Well, first you turn on a standard gene synthesizer. You use the published genome sequences to run some fragments of its DNA genome out. Keep it in manageable fragments, so you can then splice them. You put the naked genome into a cell which has been infected by a related pox virus, see? That supplies the needed vital enzymes. After that you get complete viruses, which you can amplify in cell culture. Dead easy. Then you're off -- just spread it around. Hozzat for scary?"

With modified proteins, airborne particles can turn ten or even a

hundred times more deadly. And in the next few decades, myriad biotech workers will know how to alter vital information.

How many will belong to the Animal Liberation Front? It won't take many. Friends of mine who work on disease control estimate that with a bit of luck a new strain of influenza could be developed by a single researcher, using a room of equipment. And there are such isolated specialists: in the 1950s the Soviets experimented with the Spanish Flu and it got out, killing thousands -- a fact they successfully suppressed for decades.

How many would it take to spread such a designer plague? Dozens would suffice.

Think of their rationalizations. Humanity as cancer. The Deep Ecology Credo: all life is equally sacred.

Look at the big picture. Why not save millions of species a year by trimming the numbers of a mere single species?

And consider simple human misery. The aftermath of the Black Plague was a burst of prosperity, as the living inherited the wealth of the dead. Suddenly there were more crop-lands per person, more homes and horses and even hats. Enough, an Earth Firster gone wrong might argue, to get the battered South back on its economic feet. A blessing, really.

And they would do their time for doing the crime, to be sure. The essential point here is that theirs would be a moral argument proceeding from a wildly different premise: all life is equal.

Would anyone be mad enough to kill billions, hoping to stave off the ecological and cultural collapse of nations, of continents, of whole societies? It seems despicable, mad-and quite plausible, to me. Speculations along these lines have already been voiced by molecular biologists.

Such dark possibilities come with any major advance in human capabilities. Only by anticipating them, as H.G. Wells foresaw atomic war, can we do the thinking and imagining that might prevent them.

Containing such threats only superficially resembles the nuclear proliferation problem. The first response to such a threat will probably be more state policing. But plutonium is scarce, so the plutonium pipeline is easily policed. The flu is everywhere, and so are genetic laboratories. There will never be enough cops.

Outside regulation will be nearly helpless. The very power of medical biotechnology lies in its ease of self-reproduction. A small conspiracy could develop Influenza A into a new, virulent form, test it on animal populations, and then spread it with already immunized carriers.

For immunization would go hand in hand with the very bioengineering that made SuperFlu. If one knows the map, one can chart a path through the obstacles. It is technically simple to develop a vaccine alongside the SuperFlu, and even design it so that the carriers could be safe from the effects.

Further shrewd games suggest themselves. With a vaccine in hand, the North could speedily immunize its population. Still, medical resources would be strained even in the North, the public outcry deafening. Inoculating in the South would be far more difficult, from slow transport, inevitable corruption and the sheer numbers of the



afflicted.

So even if the plotters were caught early on in the spreading of the designer plague, the North would face a vexing moral chasm. Exert themselves to save many in the South, or be sure all their own populations were safe first?

And other, quieter voices would say, wait a minute. Sure, the fanatics were wrong, evil-- but if this disease runs its course, it will solve a lot of problems . . .

Standard bureaucratic regulation cannot contain this potential, quite original evil. The probable sources are small and diffused.

What could stop the SuperFlu? At a minimum, we should deplore the superheated rhetoric of humanity-as-cancer. Behind such headline-grabbing oversimplifications lurk some obnoxious assumptions and poor reasoning.

Far more effectively, we can reaffirm basic humanist values. Not all life is equivalent. While other species of course have an essential place, we cannot evade the fact that we are now the stewards of their world.

This means that the figures likely to resort to mass murder through biotechnology must be reached. Modern America stresses narrowly trained specialists, not broad education. We should fear the politicized experts. If they remain outsiders, their demands ignored, they will become steadily more dangerous.

There is a further constellation of arguments which might reach the ecowarriors, given time. Experience shows that populations stabilize when technology, women's education, and childhood life expectancy rise above a critical level. But on the way to this point lies a disaster zone: technology improves life expectancy and fuels a population boom, which then exacts a terrible toll from the environment.

To get the third world through the danger zone demands that they not follow our path to industrialization. Going through the "gray" technology of the nineteenth century would indeed yield mass pollution and gobble up resources. What the developing world needs is not giant dams, but cheap solar power collectors. Not steelworks, but composite material assembly sheds, weaving renewable organic resources into hard, light products. They need our future, not our past.

Lewis Thomas points out that it's this way in medicine. Low tech medicine is cheap--people get polio (say) or Salmonella, and die. Medium tech is nasty and expensive -- iron lungs and keeping people alive when there is no good treatment for a disease is costly. Really high tech medicine, vaccine and antibiotics, is relatively cheap again, and everyone lives. The same thing happens with technology in developing countries -- it has to be all or nothing. In between is the killer.

This suggests that techno-savvy development should probably be concentrated massively on small areas, to get them to a "post-industrial" level. This will avoid spreading investment thinly and falling short of the critical point. Such small, intensive cases will be experiments, yielding different schemes, seeing what works. If even the Earth Firsters can come to see that development need not mean deforestation and the Glen Canyon Dam, a new direction in resolute ecovirtue could open.

For the moment they are mere cranks, oddities, wild-eyed nobodies on their rickety soapboxes. But their numbers rise. Their actions gather allies. Their anger soars. We must defuse that anger with actions of our own.

The zealot who could design a SuperFlu might well come from citadels of high moral purpose, too. Many Deep Ecologists spring from our universities. They have surplus cash and need a cause larger than themselves. Their moral fervor runs parallel with high education and not a little dedication. After all, the most notorious mass murderer of our century came from the culture of Mozart and Goethe, favored animal rights, and was a fastidious vegetarian.