

# Industrialization: Prelude to Collapse

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(Excerpt from *Overshoot: The Ecological Basis of Revolutionary Change*)

## Unrecognized Preview

The Industrial Revolution made us precariously dependent on nature's dwindling legacy of non-renewable resources, even though we did not at first recognize this fact. Many major events of modern history were unforeseen results of actions taken with inadequate awareness of ecological mechanisms. Peoples and governments never intended some of the outcomes their actions would incur.

To see where we are now headed, when our destiny has departed so radically from our aspirations, we must examine some historic indices that point to the conclusion that even the concept of succession (as explored in previous chapters) understates the ultimate consequences of our own exuberance. We can begin by taking a fresh look at the Great Depression of the 1930s, an episode people saw largely in the shallower terms of economics and politics when they were living through it. [1] From an ecologically informed perspective, what else can we now see in it?

The Great Depression, looked at ecologically, was a preview of the fate toward which mankind has been drawn by the kinds of progress that have depended on consuming exhaustible resources. We need to see why it was not recognized for the preview it was; this will help us to grasp at last the meaning missed earlier.

We did not know we were watching a preview because, when the world economy fell apart in 1929-32, it was not from exhaustion of essential fuels or materials. From the very definition of carrying capacity—the maximum *indefinitely* supportable ecological load—we can now see that non-renewable resources provide *no* real carrying capacity; they provide only phantom carrying capacity. If coming to depend on phantom carrying capacity is a Faustian bargain that mortgages the future of *Homo colossus* as the price of an exuberant present, *that* mortgage was not yet being foreclosed in the Great Depression. Even so, much of the suffering that befell so much of mankind in the 1930s does need to be seen as the result of a carrying capacity deficit. The fact that the deficit did not stem from resource exhaustion in that instance makes it no less indicative of the kinds of grief entailed by resource depletion. Accordingly, we need to understand what did bring on a carrying capacity deficit in the 1930s.

## Carrying Capacity and Liebig's Law

To attain such an understanding we need to step outside the usual economic or political frames of thought, go back two-thirds of a century before the 1929 crash, and reexamine for its profound human relevance a principle of agricultural chemistry formulated in 1863 by a German scientist, Justus von Liebig. [2] That principle set forth with great clarity the concept of the "limiting factor" briefly mentioned in Chapter 8. Carrying capacity is, as we

saw there, limited not just by food supply, but potentially by any substance or circumstance that is indispensable but inadequate. The fundamental principle is this: whatever necessity is least abundantly available (relative to per capita requirements) sets an environment's carrying capacity.

While there is no way to repeal this principle, which is known as "the law of the minimum," or Liebig's law, there is a way to make its application less restrictive. People living in an environment where carrying capacity is limited by a shortage of one essential resource can develop exchange relationships with residents of another area that happens to be blessed with a surplus of that resource but happens to lack some other resource that is plentiful where the first one was scarce.

Trade does not repeal Liebig's law. Only by knowing Liebig's law, however, can we see clearly what trade does do, in ecological terms. Trade enlarges the scope of application of the law of the minimum. The composite carrying capacity of two or more areas with different resource configurations can be greater than the sum of their separate carrying capacities. Call this the principle of scope enlargement; it can be expressed in mathematical notation as follows:

$$CC_{(A+B)} > CC_A + CC_B$$

The combined environment (A + B) still has finite carrying capacity, and that carrying capacity is still set by the necessary resource available in least (composite) abundance. But if the two environments are truly joined, by trade, then scarcities that are local to A or B no longer have to be limiting.

A good many of the events of human history need to be seen as efforts to implement the principle of scope enlargement. Most such events came about as results of decisions and activities by men who never heard of Liebig or his law of the minimum. Now, however, knowing the law, and understanding also the scope-enlargement principle, we can see important processes of history in a new light. Progress in transport technology, together with advancements in the organization of commerce, often achieved only after conquest or political consolidation, have had the effect of enlarging the world's human carrying capacity by enabling more and more local populations (or their lifestyles) to be limited not by local scarcity, but by abundance at a distance.

## **Vulnerability to Scope Reduction**

As human numbers (and appetites) grew in response to this exchange-based enlargement of composite carrying capacity, continued access to non-local resources became increasingly vital to human well-being and survival. As the ecological load increased beyond what could have been supported by the sum of the separate carrying capacities of the formerly insulated local environments, mankind's vulnerability to any disruption of trade became more and more critical. The aftermath of the crash of 1929 demonstrated that vulnerability.

Unfortunately, modern transport systems, and some aspects of modern organization, are based very heavily upon exhaustible resource exploitation. Insofar as this is true, they must eventually founder upon the rocks of resource exhaustion. But even before they might succumb to such physical disaster, the trade arrangements upon which the earth's extended carrying capacity for *Homo colossus* has come to depend can be torn apart by

*social* catastrophe. [3] It is important to recognize at last that that is what happened in 1929-32. In fact, some of it began happening during, or as a repercussion of the Great War of 1914-18.

World War I disrupted relationships between the various peoples of Europe and between Europe, the New World, and the Orient. It also resulted in reallocation of the still colonial parts of the world among the various imperial powers seeking to exploit them as ghost acreage. Not all aspects of these changes wrought by the war would have reduced the scope of application of Liebig's law, but some certainly did, for some peoples, to some extent.

In the case of defeated Germany, access to resources from outside German territory was cut off. At the same time, the staggering requirement of reparations payments to the victorious Allies aggravated the load to be borne by Germany's limited indigenous carrying capacity. Even internally, Germany suffered as inflation shattered the vital exchange relations between its diverse localities and between the occupational categories (quasi-species) into which its culturally advanced population had become differentiated. [4] Destruction of the value of currency meant destruction of the medium of mutualism; as inter-occupational symbiosis crumbled, hardship was rampant.

The astronomical German inflation was thus no mere fluke of history. Rather, it was a preview of the larger preview to come, when other forms of financial disruption would rend the fabric of trade throughout the world. By thus compelling a reduction of the scope of application of Liebig's law back down to local resource bases, such trade dislocation would convert existing loads of human resource-consumers, previously supportable by composite carrying capacity, into overloads no longer fully supportable by fragmented carrying capacities.

In America in the 1920s, after a brief post-war depression, a period of neo-exuberance set in, leading in the later years of the decade to such an *expectation* of perpetual progress and prosperity that some people found they could prosper from the expectation itself. "Speculation" in the stock market became the expected way to get rich. [5] Inhibitions against speculation were relaxed; people supposed the American prototype democracy, having enabled the Allies finally to triumph over Kaiser Germany, had made the world safe for getting rich and had established the right of everyone to try to do so.

The essential contrast between speculation and genuine investment is this: speculators buy stock not for the purpose of acquiring claims on future dividends from the business in which they acquire shares, but for the purpose of profiting from the expected escalation in their stock's resale value. When nearly all buyers are speculators, then virtually the only value of their shares is the resale value. Stock prices continue to escalate under such circumstances only as long as virtually everyone expects resale values to continue rising, and are thus willing to buy. The fact that prices may already grossly exaggerate a stock's intrinsic (dividend-paying) worth simply ceases to concern the speculator during the time when price escalation is confidently expected to continue. Breakdown of that faith, however, turns the process around. Anticipation of inexorable enrichment gives way to fear of ruin as self-induced price escalation turns into self-induced price decline. Panic, in the stock market sense, means the competitive drive to sell before falling prices fall farther—which drives prices down.

What connected the 1929 Wall Street crash to Liebig's law was the fact that so much speculative buying had been done with borrowed money. Collapse in the "value" of stocks thus led to an epidemic of bank failures, because the banks were unable to retrieve the funds they had lent to the speculators. Stock certificates taken in by the banks as security from borrowers were worth much less money after the crash than the number of dollars borrowed on them before the crash. When banks failed, depositors with accounts in those banks suddenly found themselves shorn of the purchasing power formerly signified by their bankbook entries. As depositors went broke, they ceased being able to buy goods or hire employees. Sellers of whatever they would have bought, or workers they would have employed, were therefore also suddenly bereft of revenue sources. In a society with elaborate division of labor and a money economy, a "revenue source" is the magic key that provides access to carrying capacity. Collapse of fiscal webs thus confronted millions of people with loss of access to carrying capacity, as truly as if purchasable resources had actually ceased to exist. Nations whose citizens had increasingly become masters of one trade apiece and jacks of few others found themselves suddenly unable to rely on composite carrying capacity drawn from a nonlocal environment. What I have called the "medium of mutualism" was no longer functioning, so the scope of application of Liebig's law of the minimum was being constricted once again to local (or personal) resources.

There was not in those days any Federal Deposit Insurance Corporation to back up the solvency of an individual bank when it suffered a "run" by its depositors. The failure of bank after bank in a time when banks had no institutionalized way of pooling their assets for mutual protection can thus be seen as a fiscal instance of the hazards of scope reduction. Had bankers understood that an ecological principle formulated by an agricultural chemist could apply to the world of finance, perhaps something like the FDIC would have been invented sooner.

The fiscal collapse had an even more important implication than this for our ecological understanding of the human predicament. That implication appears in the generalized Depression that followed. Consider the farm population in America. Like almost everyone else, farm families were compelled, by the repercussions of bank failures and the ramifications of general panic, to cut their consumer expenditures. Farmers also often had to allow their land, their buildings, and their equipment to deteriorate for lack of money to pay for maintenance and repairs. Many farms were encumbered by mortgages—mortgages which were foreclosed by banks that now desperately needed the payments farmers could not afford to make. (Bank failures were even more common in rural regions than in major cities.) In spite of all these difficulties, however, the farm population in America ceased declining (as it had been doing) and increased between 1929 and 1933 by more than a million. The long-term trend of movement out of farm niches and into urban niches was reversed during the Great Depression. [6]

Niches everywhere were being constricted by the Depression. However, the urbanizing trend that had been occurring as a result of industrial growth in the cities and from elimination of farm niches by mechanization of agriculture was disrupted by this economic breakdown. At the heart of the reversal was a simple fact: the nature of farming in the 1930s was still such that, whatever else they had to give up, there was still truth in the cliché that "the farm family can always eat." Other (non-food-producing) occupational groups that now had to fall back (like the farmers) on carrying capacities of reduced scope could find themselves in much more dire straits.

If we read it rightly, then, we can see the differential impact of the Depression upon farm versus non-farm populations as a cogent indicator of the dependence of the total population on previously achieved enlargements of the scope of application of Liebig's law. With breakdown of the mechanisms of exchange, various segments of a modern nation had to revert as best they could to living on carrying capacities again limited by locally least abundant resources, rather than extended by access to less scarce resources from elsewhere. Although scope reduction hurt everyone, rural folk had local resources to fall back upon; urban people, in contrast, had so detached themselves as to have almost ceased to recognize the indispensability of those resources. For reasons we shall examine in a moment, economic hard times hit the farms sooner than they hit the cities, but in the final scope-reducing crunch the farmers turned out to have an advantage sufficient to interrupt a clear trend of urbanization.

## No Fairy Godmother

The Depression also interrupted the advance of industrialization and its attendant occupational diversification of the population. With hindsight, that interruption becomes an opportunity to bring the previous diversification into ecological focus.

An ecological perspective enables us to see pressure toward niche diversification as the natural result of the overfilling of existing niches. Among non-human organisms, this pressure leads eventually to the emergence of new species. Among humans it leads through sociocultural processes to the emergence of new occupations (quasispecies), which, as we noted in Chapter 6, had been made clear by Emile Durkheim as long ago as 1893. To bring Durkheim's analysis and the ecological perspective to bear upon the Great Depression, however, we must take into account the fact that nature is no Fairy Godmother and provides no guarantee that new niches will automatically be already available at the right time and in the right quantity to absorb immediately the surplus population from overfilled previous niches. Nor does nature guarantee pre-adaptation of the surplus individuals to whatever new niches do become available.

In nature, overfilling of old niches can result in massive death. Many organisms fall by the wayside in the march of speciation. Among *human* organisms the principles hold, but the process is moderated because humans are occupationally differentiated by social processes rather than by biological processes. Ostensibly, when old niches become obsolete, we can retrain ourselves for new roles. So, for *Homo sapiens*, overpopulation and death are avoidable results of niche saturation. The avoidance is not easy, however, and retraining for new niches can be traumatic.

An ecological perspective thus heightens the significance of a classic sociological study that clearly showed how unlikely it is, even among members of the relatively flexible and plastic human species, that re-adaptation to new niches (as old ones close up) will occur easily or automatically. Between 1908 and 1918, W. I. Thomas at the University of Chicago analyzed mountains of documentary data on the experience of Polish immigrants in America. [7] The people he studied had come to the New World after absorbing the folkways of their native Poland. In America they were faced with the necessity of adapting to unfamiliar circumstances. Thomas found that old ways of behaving and thinking were not easily abandoned or changed. New ways were learned only with difficulty when they contradicted the migrants' old-country upbringing. Thomas generalized from the immigrants' situation to say something about social change in broader contexts. He concluded that an accustomed way of behaving tends to persist as long as circumstances

allow. When circumstances change, making familiar and comfortable ways unworkable (or unacceptable), a degree of crisis is inevitable. Re-adaptation hurts. It is resisted. [8]

We know now that the change that makes re-adaptation necessary need not be relocation. Any event that makes old ways unworkable and new ways mandatory can provoke the trauma of reorientation. Conflict and tension are natural accompaniments of change; they tend to continue until some new *modus vivendi* is worked out. The new form of adaptation will typically combine some elements of the old with some features imposed by the changed circumstances.

"Culture shock" became a familiar term for denoting the enervating disorientation and bewilderment associated with movement into unfamiliar societal contexts. Even a casual tourist can feel it when he travels abroad. Half a century after the phenomenon was studied by W. I. Thomas among Polish peasants resettled in America, Alvin Toffler coined and popularized another phrase that extended the concept. "Future shock" was his apt new term; forced adjustment to *new* ways can be as traumatic as forced adjustment to *foreign* ways. [9]

People in a post-exuberant world found themselves surrounded by alien conditions. They underwent a great deal of future shock, years before they got that name for it. By mechanization of agriculture in the nineteenth and early twentieth century, the Western world greatly reduced the number of farm workers needed to provide sustenance for themselves and for urban dwellers. Displaced from agricultural occupations, ex-farmers naturally migrated into cities in search of alternative employment, employment for which their farming experience or upbringing had not prepared them. Industrial expansion connected with World War I took up the slack temporarily, making employable on an emergency basis many persons who would otherwise have been passed over as unprepared for a given job. The war also helped hasten the mechanization of agriculture that was creating the displaced farm-worker surplus. After the war, urbanization and the proliferation of industrial occupations could not altogether keep pace with the continuing displacement of workers from the farming sector. There continued to be more farmers than were needed, so the agricultural portion of the economy was beset with "overproduction." This depressed farm prices—several years before the Wall Street crash provided the impetus that depressed prices for everyone. The resulting loss of purchasing power by the farming population helped depress, in turn, the urban-industrial sectors of the world's economy.

Ecological difficulties were aggravated, of course, by human errors—the glibly confident indulgence in speculation in 1928 being one example. But the causal importance of some human errors was easily overestimated. Amid the economic and political events of 1929-32 it was plausible for Americans, unaware of the ecological basis for what was happening, to see all the difficulties of that difficult time as products merely of the failures of the Hoover administration. This attractive oversimplification neglected one fact that should have been obvious: many other nations, over which Mr. Hoover did not preside, were undergoing the same calamity.

For those of radical inclination, it seemed plausible (in the absence of an ecological paradigm) to attribute the dire situation to a failure of "the capitalist system." But socialists believed as ardently as capitalists in the myth of limitlessness. In spite of socialists' commitment to production for use rather than for profit, they were not then (and have not been since) any more cautious than capitalists about adopting the drawdown method.

They assumed that socialist-sponsored versions of drawdown could somehow eliminate such "capitalist contradictions" as simultaneous overproduction and abject poverty. They remained just as unconcerned as the capitalists about overshoot. [10]

Conservatives, on the other hand, who were not necessarily misanthropes, found it plausible to whistle in the dark, insisting that prosperity would automatically return if we just waited for the system to adjust itself. They were the Ostriches of their time, holders of the Type V attitude (delineated in Chapter 4). They believed nothing essential had changed from the Age of Exuberance.

Roosevelt was elected to replace Hoover, new approaches were put rapidly into practice, and a discouraged nation took heart. But full economic recovery continued to elude even the New Deal until preparation for World War II began to spur massive industrial activity—with even more than the usual disregard for long-range drawdown costs.

Economic recovery under the New Deal was not unique. Nazi Germany also overcame its depression, reducing unemployment in the first four years under Hitler from six million to one million. (People outside Germany did not automatically interpret this achievement as validation of Nazi tactics.) Under the Nazi method, millions of the unemployed could be employed as soldiers, and millions more could be *compulsorily* retrained and given niches as producers of military hardware. The war economy nurtured demand for consumer goods for the soldiers and for these re-employed makers of military materiel; furthermore, it provided "the correct psychological atmosphere," enabling the civilian sector to accept painful re-adaptation.

War psychology overcame natural human resistance to departure from custom. [11] The war also used elaborate technology and drew down the world's stocks of natural resources.

In the United States, wartime economic recovery supposedly proved that New Deal "pump priming" by fiscal deficits had been the right kind of response to a stagnant economy, except that it could not be done in adequate volume until the need to re-arm rapidly for all-out war made truly massive red-ink budgets politically acceptable. But American recovery from the depression of the 1930s did not unambiguously validate the Keynesian economic theory implicit in Roosevelt's approach.

In either the German or the American portion of the Great Depression, an economic interpretation (by minds unaccustomed to an ecological perspective) enabled us to miss the point. Very simply, the ecological paradigm enables these events to be read as follows: Expansion of the military establishment, at the cost of additional resource drawdown, suddenly provided new niches (in industry and in the armed forces) capable of absorbing the overflow from the whole array of saturated civilian occupations. And the wartime social climate provided the patriotic push that made the trauma of re-adaptation to new occupational roles endurable. The new or enlarged military-industrial niches had been previously either non-existent or under serious stigma. What was important, ecologically speaking, was the fact that previously existent and acceptable niches *had been saturated*; there were people to spare—in America because of technological progress and population growth; in Germany because of the debacle of World War I and its aftermath, which left the German economy, occupational structure, and national morale in a shambles. Moreover, human redundancy throughout much of the world had become manifest when, in various

ways and in various places, the medium of mutualism came apart, leaving everyone to cope with carrying capacity limits set by local minimums.

In the American case, the fiscal deficits run up during World War II were merely the ledger-book picture of the change that eased the problem, not the cause of that change. Red ink didn't re-employ the unemployed. The growing national debt (expressed in money) was a fiction of accountancy, a fiction that enabled Americans to believe that wartime drawdown of the once-New World's resource reservoir only constituted "borrowing from ourselves," rather than stealing from the future. The reality of diachronic competition remained unacknowledged. Nevertheless, resources used up in World War II were made unavailable for use by posterity.

## Circular versus Linear Ecosystems

Whatever the origins of human redundancy, and whatever the sequel to it, we needed to see (but were not seeing) that what had happened to us between the wars, and especially what happened to us since World War II, had not resulted merely from politics or economics in the conventional sense. The events of this period had simply accelerated a fate that began to overtake us centuries ago. The population explosion after 1945 and the explosive increase of technology during and after the war were only the most recent means of that acceleration.

Human communities once relied almost entirely on organic sources of energy—plant fuels and animal musclepower—supplemented very modestly by the equally renewable energy of moving air and flowing water. All of these energy sources were derived from ongoing solar income. As long as man's activities were based on them, this was, as church men said, "world without end." That phrase should never have been construed to mean "world without limit," for supplies can be perpetual without being infinite.

Locally, green pastures might become overgrazed, and still waters might be overused. Local environmental changes through the centuries might compel human communities to migrate. As long as resources available *somewhere* were sufficient to sustain the human population then in existence, the implication of Liebig's law was that carrying capacity (globally) had not yet been overshot. If man was then living within the earth's current income, it was not from wisdom, but from ignorance of the buried treasure yet to be discovered.

Then the earth's savings, and new ways to use them, began to be discovered. Mankind became committed to the fatal error of supposing that life could thenceforth be lived on a scale and at a pace commensurate with the rate at which treasure was discovered and unearthed. Drawing down stocks of exhaustible resources would not have seemed significantly different from drawing upon carrying capacity imports, at a time when nobody yet knew Liebig's law, or the principle of scope enlargement, or the distinction between real and phantom carrying capacity, or the various categories of ghost acreage.

*Homo sapiens* mistook the rate of withdrawal of savings deposits for a rise in income. No regard for the total size of the legacy, or for the rate at which nature might still be storing carbon away, seemed necessary. *Homo sapiens* set about becoming *Homo colossus* without wondering if the transformation would have to be quite temporary. (Later, our pre-ecological misunderstanding of what was being done to our future was epitomized by that venerable loophole in the corporate tax laws of the United States, the oil depletion



allowance. This measure permitted oil "producers" to offset their taxable revenues by a generous percentage, on the pretext that their earnings reflected depletion of "their" crude oil reserves. Even though nature, not the oil companies, had put the oil into the earth, this tax write-off was rationalized as an incentive to "production." Since "production" really meant *extraction*, this was like running a bank with rules that called for paying interest on each withdrawal of savings, rather than on the principal left in the bank. It was, in short, a government subsidy for stealing from the future.)

The essence of the drawdown method is this: man began to spend nature's legacy as if it were income. Temporarily this made possible a dramatic increase in the quantity of energy per capita per year by which *Homo colossus* could do the things he wanted to do. This increase led, among other things, to reduced manpower requirements in agriculture. It also led to the development of many new occupational niches for increasingly diversified human beings. (Expansion of niches in Germany, America, and elsewhere from 1933 to 1945 was, it now appears, just a brief episode in this long-run development.) Because the new niches depended on spending the withdrawn savings, they were niches in what amounted to a "detritus ecosystem." Detritus, or an accumulation of dead organic matter, is nature's own version of ghost acreage. [12]

Detritus ecosystems are not uncommon. When nutrients from decaying autumn leaves on land are carried by runoff from melting snows into a pond, their consumption by algae in the pond may be checked until springtime by the low winter temperatures that keep the algae from growing. When warm weather arrives, the inflow of nutrients may already be largely complete for the year. The algal population, unable to plan ahead, explodes in the halcyon days of spring in an irruption or bloom that soon exhausts the finite legacy of sustenance materials. This algal Age of Exuberance lasts only a few weeks. Long before the seasonal cycle can bring in more detritus, there is a massive die-off of these innocently incautious and exuberant organisms. Their "age of overpopulation" is very brief, and its sequel is swift and inescapable.

When the fossil fuel legacy upon which *Homo colossus* was going to thrive for a time became seriously depleted, the human niches based on burning that legacy would collapse, just as detritivore niches collapse when the detritus is exhausted. For humans, the social ramifications of that collapse were unpleasant to contemplate. The Great Depression was, as we have seen, a mild preview. Detritus ecosystems flourish and collapse because they lack the life-sustaining biogeochemical circularity of other kinds of ecosystems. They are nature's own version of communities that prosper briefly by the drawdown method.

The phrase "detritus ecosystem" was, of course, not widely familiar. The fact that "bloom" and "crash" cycles were common among organisms that depend on exhaustible accumulations of dead organic matter for their sustenance was not widely known. It is therefore understandable that people welcomed ways of becoming colossal, not recognizing as a kind of detritus the transformed organic remains called "fossil fuels," and not noticing that *Homo colossus* was in fact a detritivore, subject to the risk of crashing as a consequence of blooming.

Bloom and crash constitute a special kind of sere; certain kinds of populations in certain kinds of circumstances typically experience these two seral stages—irruption followed by die-off. Crash can be thought of as an abrupt instance of "succession with no apparent successor." As in ordinary succession, the biotic community has changed its habitat by

using it, and has become (much) less viable in the changed environment. If, after the crash, the environment can recover from the resource depletion inflicted by an irrupting species, then a new increase of numbers may occur and make that species "its own successor." Hence there are cycles of irruption and die-off (among species as different as rodents, insects, algae). Our own species' uniqueness cannot be counted upon as protection. Moreover, some of the resources we use cannot recover. [13]

When yeast cells are introduced into a wine vat, as noted in Chapter 6, they find their "New World" (the moist, sugar-laden fruit mash) abundantly endowed with the resources they need for exuberant growth. But as their population responds explosively to this magnificent circumstance, the accumulation of their own fermentation products makes life increasingly difficult—and, if we indulge in a little anthropomorphic thinking about their plight, miserable. Eventually, the microscopic inhabitants of this artificially prepared detritus ecosystem all die. To be anthropomorphic again, the coroner's reports would have to say that they died of self-inflicted pollution: the fermentation products.

Nature treated human beings as winemakers treat the yeast cells, by endowing our world (especially Europe's New World) with abundant but exhaustible resources. People promptly responded to this circumstance as the yeast cells respond to the conditions they find when put into the wine vat.

When the earth's deposits of fossil fuels and mineral resources were being laid down, *Homo sapiens* had not yet been prepared by evolution to take advantage of them. As soon as technology made it possible for mankind to do so, people eagerly (and without foreseeing the ultimate consequences) shifted to a high-energy way of life. Man became, in effect, a detritovore, *Homo colossus*. Our species bloomed, and now we must expect crash (of some sort) as the natural sequel. What form our crash may take remains to be considered in the concluding section.

One thing that kept us from seeing all this, and enabled us to rush exuberantly into niches that had to be temporary, was our ability to give ideological legitimation to occupations that made no sense ecologically. When General Eisenhower, as retiring president, warned the American people to beware of unwarranted influence wielded by the military-industrial complex, [14] it was presumably political and economic influence that he had in mind. But the military-industrial complex was a vast conglomeration of occupational niches. As such, it wielded an altogether different (and even more insidious) kind of influence. The military-industrial complex helped perpetuate the illusion that we still had a carrying capacity surplus; it made it profitable for the living generation to extract and use up natural resources that might otherwise have been left for posterity. It absorbed for a while most of the excess labor force displaced by technological progress from older occupational niches that had been less dependent on drawing down reservoirs of exhaustible resources. It thus helped us believe that the Age of Exuberance could go on.

Nor was General Eisenhower alone in missing the ecological significance and over-emphasizing the political elements in the trends of his time. His young, articulate, and sophisticated Bostonian successor launched a new administration with an inaugural address whose inspirational quality lay partly in its eloquent resolution of American ambivalence. If we wanted to maintain full employment, we dreaded achieving it by means of an arms race. Subtly, and with the gloss of high idealism, John F. Kennedy reassured the nationwide television audience on that crisp, brilliant January day in 1961 that the temporary occupational niches of the military-industrial complex could be long-lasting and

could be made more honorable than horrible. There was to be a "new Alliance for Progress," and we were to hope for emancipation from the "uncertain balance of terror that stays the hand of' mankind's final war." But the conflict-bred niches would last, for "the trumpet summons us again . . . to bear the burden of a long twilight struggle year in and year out . . . against the common enemies of man: tyranny, poverty, disease and war itself." [15] Under both parties, the military-industrial complex enabled us to be preoccupied with matters that helped us ignore resource limits. It helped thereby to obscure the fact that population was expanding to fill niches that could not be permanent because they were founded upon drawing down prehistoric savings, exhaustible fossil energy stocks.

The human family, even if it were soon to stop growing, had committed itself to living beyond its means. *Homo sapiens*, as we saw in Chapter 9, was capable of transforming himself into new "quasi-species." By the Industrial Revolution humans had turned themselves into "detritovores," dependent on ravenous consumption of long-since accumulated organic remains, especially petroleum.

If we were to understand what was now happening to us and to our world, we had to learn to see recent history as a crescendo of human prodigality. When American birth rates declined as the 1960s gave way to the 1970s, this did not mean we were escaping the predicament of the algae any more than the ringing words of President Kennedy's inaugural address had really meant that we could eat our cake and still have it. Rather, something had happened that was fundamental, and that could not be undone by brilliant rhetoric: there had been a marked acceleration in our previously begun shift from a self-perpetuating way of life that relied on the circularity of natural biogeochemical processes, to a way of life that was ultimately self-terminating because it relied on linear chemical transformations. They were linear (and one way) because man was using (with the aid of his prosthetic equipment) so many non-crop substances. Man was no longer engaged in a balanced system of symbiotic relations with other species. When man degraded the habitat, it tended to stay degraded; it was not being rehabilitated by other organisms with different biochemical needs.

## **Perils of Prodigality: The Coming Crash**

Man does not live on detritus alone. Misled by our prodigal expenditures of savings, we allowed the human family to multiply so much that by the 1970s mankind had taken over for human use about *one eighth* of the annual total net production of organic matter by *contemporary* photosynthesis in all the vegetation on all the earth's land. That much was being used by man and his domestic animals. [16] It would require taking over more than the other seven-eighths to provide from organic sources the vast quantities of energy we were deriving from fossil fuels to run our mechanized civilization, even if economic growth and human increase were halted by the year 2000. Thus, as we began to see in Chapter 3, we were already well beyond the size that would permit us to re-adapt (without severe depopulation) to a sustained yield way of life when our access to savings gave out. On the other hand, just three more doublings of population (scarcely more than Britain had already experienced in the short time since Malthus) would mean that *all* the net photosynthetic production on all the continents and all the islands on earth would have to be used for supporting the human community. Then our descendants would be condemned to living at an abjectly "underdeveloped" level, if no fossil acreage remained available to sustain modern industry.

Such total exploitation of an ecosystem by one dominant species has seldom happened, except among species which bloom and crash. Detritivores provide clear examples, but there are others, and we shall take a close look at some of them in the final chapter. For *Homo sapiens*, it was unlikely that we could even divert much more than the already unprecedented fraction of the total photosynthesis to our uses.

It was thus becoming apparent that nature must, in the not far distant future, institute bankruptcy proceedings against industrial civilization, and perhaps against the standing crop of human flesh, just as nature had done many times to other detritus-consuming species following their exuberant expansion in response to the savings deposits their ecosystems had accumulated before they got the opportunity to begin the drawdown.

It was not widely recognized, of course, but the imminence of that kind of culmination really was why the United Nations had to convene its 1972 Conference on the Human Environment. The conference in Stockholm was meant to begin the process of preventing our only earth from being rendered less and less usable by humans. In short, its purpose was to arrest global succession. Persons who had struggled valiantly to bring about this conference had been engaged (in an important sense) in a global counterpart of the efforts of Dr. Goodwin in Williamsburg. But whereas he sought to undo succession in order to preserve history, they sought to preserve a world ecosystem in which *Homo sapiens* might remain the dominant species—and might remain human.

Until the extent of the transformation of *Homo sapiens* into *Homo colossus* was seen and the full ecological ramifications of that transformation were more nearly understood, however, it would hardly be recognized that the kind of world ecosystem the United Nations was seeking to perpetuate was already being superseded—by an ecosystem that, by its very nature, compelled the dominant species to go on sawing off the limb on which it was sitting. Having become a species of superdetritivores, mankind was destined not merely for succession, but for crash.

Unfortunately but inevitably, the Stockholm deliberations were confused by the fact that the luckier nations which happened to achieve industrial prodigality before the earth's savings became depleted had already infected the other nations with an insatiable desire to emulate that prodigality. The infection preceded recognition of the depletion. The result of this sad historical sequence was the pathetic quarrel over whether the luxury we cannot afford is economic growth or environmental preservation. Neither was a luxury; worse, neither was possible on a global scale.

Excess numbers and ravenous technology had already brought *Homo colossus* to an ecological impasse. The laudable ability of delegations from 114 diverse nations to hammer out compromise resolutions favoring both environmental protection *and* economic development for all nations did not extricate us from our predicament. Deft avoidance of political deadlock once again preserved the illusion that cake could be both eaten and saved. But illusion preserved was still illusion.

Man needed to realize how commonly populations of other species have undergone the experience of resource bankruptcy. But we humans have been experiencing a double irruption, confronting us with an intensified version of the plight of such species. As a biological type, *Homo sapiens* has been irrupting for 10,000 years, and especially the last 400. In addition, our detritus-consuming tools have been irrupting for the last 200 years. It is conceivable that the inevitable die-off necessitated by overshoot could apply more to

*Homo colossus* than to *Homo sapiens*. That is, resource demand might be brought back within the limits of permanent carrying capacity by shrinking ourselves to less colossal stature—by giving up a lot of our prosthetic apparatus and the high style of living it has made possible. This might seem, in principle, an alternative to the more literal form of die-off, an abrupt increase in human mortality. In practice, it runs afoul of several implications of W. I. Thomas's finding about resistance to change. Accustomed ways of behaving and thinking tend to persist; this is probably as true of the detritivorous habits of *Homo colossus* as it was true of earlier human folkways. Outbreaks of violence among American motorists waiting in long queues to buy gasoline, sputtering in stubborn non-recognition of the onset of the twilight of the petroleum era, suggest that the people of industrial societies who have learned to live in colossal fashion will not easily relinquish their seven-league boots, their heated homes, and their habit of living high on the food chain. As we said, re-adaptation hurts. It will be resisted.

Moreover, habits of *thought* persist. As we shall see in Chapter 11, people continue to advocate further technological breakthroughs as the supposedly sure cure for carrying capacity deficits. The very idea that technology caused overshoot, and that it made us too colossal to endure, remains alien to too many minds for "de-colossalization" to be a really feasible alternative to literal die-off. There is a persistent drive to apply remedies that aggravate the problem.

If any substantial fraction of the more colossal segments of humanity *did* conscientiously give up part of their resource-devouring extensions out of humane concern for their less colossal brethren, there is no guarantee that this would avert die-off. It might only postpone it, permitting human numbers to continue increasing a bit longer, or less colossal peoples to become a bit more colossal, before we crash all the more resoundingly.

All this tends to be disregarded by advocates of a "return to the simple life" as a gentle way out of the human predicament. Blessed are the less prosthetic, for they shall inherit the ravaged earth. Probably so, in the long run. But some view the dark cloud of fuel depletion and purport to see a silver lining already: individuals forced to abandon much of their modern technology will then get by on smaller per capita shares of the phantom carrying capacity upon which prosthetic man has become so dependent. However, insofar as the high agricultural yields upon which our irrupted population's life depends can be attained only by means of energy subsidies—by lavish application of synthetic fertilizers, and by large-scale use of petroleum-powered machinery—the dwindling fossil acreage will probably lower the output of visible acreage. As we asked before, what happens when it becomes necessary again to pull the plow with a team of horses instead of a tractor, and a substantial fraction of the crop acreage that now feeds humans has to be allocated again to growing feed for draft animals (or biomass to produce tractor fuel when the Carboniferous legacy is no longer cheaply available)? So much for *that* silver lining.

It will spare us no grief to deny that *Homo sapiens* has been irrupting. It will in no way ease the impact to deny that crash must follow. We must seek our rays of hope in another way altogether (as we shall do in Chapter 15).

## **Not Cleared for Takeoff**

The "developed" nations have been widely regarded as previews of the future condition of the "underdeveloped" countries. It would have been more accurate to reverse the picture,

as perhaps the Stockholm Conference began to do for its most perceptive participants and observers.

It was one thing to be an underdeveloped nation in the eighteenth century, when the world had no highly developed nations. It is quite another thing today. When today's developed nations were not yet industrialized and were just approaching their takeoff point, the *World* had only recently entered an exuberant phase which made takeoff possible. European technology was just starting to harness (for a few brilliant centuries) the energy stored in the earth during the past several hundred million years, and the sparsely populated New World had only recently become available for exuberant settlement and exploitation. These conditions of exuberance no longer prevail. The underdeveloped countries of Asia, Africa, and Latin America in the twentieth century cannot realistically expect to follow in the footsteps of the undeveloped nations of eighteenth-century Europe. *Most of today's underdeveloped nations are destined never to become developed.* Egalitarian traditions will be forced to adjust to permanent inequality.

Hard as it might be for the people and leaders of underdeveloped countries to face the fact, they are not alone in finding it repugnant. The people and leaders of the affluent societies have also resisted seeing it. Recognition that most of the world's poor would necessarily stay poor would destroy the comforting conviction of the world's privileged that their good fortune ought to inspire the world's poor to emulate them, not resent them.

Nature's limiting factors would not clear most underdeveloped countries for takeoff. But now that people are so numerous, it would be even worse if many did somehow take off. Most men of good will have been unable so far to accept this implication of the ecological facts. Some will no doubt righteously denounce this book for analyzing the situation in this unpalatable way, as if no fact could hurt us if we refused to acknowledge its truth. But not only are there not enough of the substances a developed human community must take from its environment in the process of living to permit a world of four billion people to be all developed; the capacity of the world's oceans, continents, and atmosphere to absorb the substances *Homo colossus* must *put* somewhere in the process of living is limited. Even as a waste disposal site, the world is finite.

Right into the 1970s we were misled by so bland a word as "pollution" for this part of our predicament. We were already suffering the plight of the yeast cells in the wine vat. Accumulation of the noxious and toxic extrametabolites of high-energy industrial civilization had become a world problem, but no government could admit that it would turn into a world disaster if the benefits of modern technology were bestowed as abundantly upon everyone in the underdeveloped countries as they already had been upon the average inhabitant of the overdeveloped ones. Leaders everywhere had to pretend full development of the whole world was their ultimate aim and was still on the agenda. By such pretensions mankind remained locked into stealing from the future.

## **Learning to Read the News**

Viewing contemporary events from a pre-ecological paradigm, we missed their significance. From an ecological paradigm we can see that fewer members of the species *Homo colossus* than of the species *Homo sapiens* can be supported by a finite world. The more colossal we become, the greater the difference. What we called "pollution," and regarded at first as either a mere nuisance or an indication of the insensitivity of industrial people to esthetic values, can now be recognized as a signal from the ecosystem. If we

had learned to call it "habitat damage," we might have read it as a sign of the danger inherent in becoming colossal. Even if the world were not already overloaded by four billion members of the species *Homo sapiens*, it does not have room for that many consumers of resources and exuders of extrametabolites on the scale of modern *Homo colossus*. In short, on a planet no larger than ours, four billion human beings simply cannot all turn into prosthetic giants.

As we move deeper into the post-exuberant age, one of the keen insights of a passionately concerned and unusually popular sociologist, C. Wright Mills, will become increasingly important to us all. It was an insight by which he tried to help his contemporaries read the news of their times perceptively. We will need to be at least as perceptive to avoid misconstruing events that will happen in the years to come.

Although the paradigm from which Mills wrote was pre-ecological, in one of his most earnest books he transcended archaic thoughtways enough to note that only sometimes and in some places do men make history; in other times and places, the minutiae of everyday life can add up to mere "fate." Mills gave us an unusually clear definition of this important word. Infinitesimal actions, if they are numerous and cumulative, can become enormously consequential. Fate, he explained, is shaping history when *what happens to us was intended by no one and was the summary outcome of innumerable small decisions about other matters by innumerable people*. [17]

In a world that will not accommodate four billion of us if we all become colossal, it is both futile and dangerous to indulge in resentment, as we shall be sorely tempted to do, blaming some person or group whom we suppose must have intended whatever is happening to happen. If we find ourselves beset with circumstances we wish were vastly different, we need to keep in mind that to a very large extent they have come about because of things that were hopefully and innocently done in the past by almost everyone in general, and not just by anyone in particular. If we single out supposed perpetrators of our predicament, resort to anger, and attempt to retaliate, the unforeseen outcomes of our indignant acts will compound fate.

In precisely Mills's sense, the conversion of a marvelous carrying capacity surplus into a competition-aggravating and crash-inflicting deficit was a matter of fate. No compact group of leaders ever decided knowingly to take incautious advantage of enlargement of the scope of applicability of Liebig's law, or subsequently to reduce that scope and leave a swollen load inadequately supported. No one decided deliberately to terminate the Age of Exuberance. No group of leaders conspired knowingly to turn us into detritovores. Using the ecological paradigm to think about human history, we can see instead that the end of exuberance was the summary result of all our separate and innocent decisions to have a baby, to trade a horse for a tractor, to avoid illness by getting vaccinated, to move from a farm to a city, to live in a heated home, to buy a family automobile and not depend on public transit, to specialize, exchange, and thereby prosper.

## Notes

1. See the explanations offered by various analysts cited in Patterson 1965, pp. 227-245.
2. For the original formulation of this principle, see Liebig 1863, p.207. Also see the sharpened statement of it on p. 5 in the "Editor's Preface" to that volume. For indications that Liebig had the principle in mind even before he grasped its generality and fundamental significance, see his earlier work, *Chemistry in Its Application to Agriculture and Physiology* (London: Taylor & Walton, 1842), pp. 41, 43, 85, 127, 129, 130,

132, 139, 141-142, 159, 178. On the development of Liebig's thinking about this and other ecological principles, see Justus von Liebig, "An Autobiographical Sketch," trans. J. Campbell Brown *Chemical News* 63 (June 5 and 12, 1891): 265-267, 276-278; W. A. Shenstone, *Justus von Liebig: His Life and Work* (New York: Macmillan, 1895); and Forest Ray Moulton, ed., *Liebig and After Liebig: A Century of Progress in Agricultural Chemistry* (Washington: American Association for the Advancement of Science, 1942).

3. Cf. Fred Hirsch, *Social Limits to Growth* (Cambridge: Harvard University Press, 1976). Too often social limits are unwisely cited as if to afford some basis for disregarding environmental finiteness; social limits actually make finiteness all the more salient. They do not make carrying capacity less relevant to human affairs. The cliché which asserts "There are no real shortages, only maldistribution" inverts the significance of social limits. In comparison with biogeochemical limits, social limits to growth include all the ways in which human societies are prone to fall short of developing and maintaining the optimum organization that would allow Liebig's law to apply only on a thoroughly global scale, with carrying capacity thus never limited by local shortages. Social limits, in other words, tend to aggravate, not alleviate, the problems posed by biogeochemical limits.

4. See William L. Shirer, *The Rise and Fall of the Third Reich* (New York: Simon and Schuster, 1960), pp. 61-62. In thinking about the human implications of the law of the minimum and the social impediments to implementing the principle of scope enlargement, it is well to remember that, when the collapse occurred in Germany, one ramification was the opportunity it afforded for rise of the Nazi dictatorship, with grave consequences for many other nations.

5. See Galbraith 1955, especially the first five chapters.

6. See Ch. 4, "Farmers in the Depression," in Chandler 1970.

7. See Thomas and Znaniecki 1918-1920 *passim*.

8. Cf. Robert A. Nisbet, *Social Change and History* (New York: Oxford University Press, 1969), pp. 282-284.

9. Toffler 1970, pp. 4-5.

10. Cf. Ehrenfeld 1978 (listed among references for Ch. 1), pp. 249-254. For recent examples of socialist persistence in the myth of limitlessness, see Stanley Aronowitz, *Food, Shelter and the American Dream* (New York: Seabury Press, 1974); Hugh Stretton, *Capitalism, Socialism and the Environment* (New York: Cambridge University Press, 1976). Also see Irving Louis Horowitz, *Three Worlds of Development: The Theory and Practice of International Stratification*, 2nd ed. (New York: Oxford University Press, 1972), p. xvi, where "overdevelopment" is defined without any ecological reference as "an excess ratio of industrial capacity to social utility," i.e., to the ability of people with existing organization, skill levels, etc., to benefit from industrial output. In contrast, overdevelopment signifies to ecologists—e.g., Ehrlich and Ehrlich 1972 (listed among references for Ch. 12), pp. 418-420—a level of technological development that disregards physical and biological limitations and requires "far too large a slice of the world's resources to maintain our way of life."

11. Michael Tanzer, *The Sick Society* (New York: Holt, Rinehart and Winston, 1971).

12. See, for example, Odum and de la Cruz 1963; Darnell 1967.

13. This makes it unwise to have defined these substances as "resources."

14. For an interesting discussion of the political significance of Eisenhower's warning, see Fred Cook, *The Warfare State* (New York: Macmillan, 1962).

15. Quoted and discussed in Morison 1965 (listed among references for Ch. 5), p. 1110.

16. Odum 1971 (listed among references for Ch. 6), p. 55.

17. Mills 1958, pp. 10-14.

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To learn out about the coming energy crash and die off: **BEYOND OIL**, by Gever, et al., 1991, University Press of Colorado, 303-530-5337