Has The Human Species Become A Cancer On The Planet?: A Theoretical View Of Population Growth As A Sign of Pathology

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As the 20th century draws to a close, we find that we are being overwhelmed by our success as species. The human population grows without restraint, our activities are steadily destroying the global ecosystem in which we evolved, and we occupy and dominate all major ecosystems. We are no longer a few bands of inconsequential primates roving the grasslands of East Africa as we were three million years ago. The human species, through the instrument of culture, has become the dominant force of planetary ecological change. Our adaptations have become maladaptive. Moreover, the human species as a whole now displays all four major characteristics of a malignant process: rapid, uncontrolled growth; invasion and destruction of adjacent normal tissues (ecosystems); metastasis (distant colonization); and dedifferentiation (loss of distinctiveness in individual components). We have become a malignant ecopathologic process. If this diagnosis is true, what is the prognosis? The difference between us and most forms of cancer is that we can think, and we can decide not to be a cancer. Is this possible?

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Statement of the Problem

As we approach the end of the century, we can plainly see that the overwhelming problem facing all of human society is the sheer numbers of people on the planet and the fact that the most severe challenges we face can be traced to the increase in these numbers. The most stunning feature of the human population in the 20th century is its rapid and even explosive growth. Yet this phenomenon is not new. Several spurts in human population growth have occurred. One began with the end of the Paleolithic and at the beginning of the agricultural revolution; another occurred at the beginning of the Industrial Revolution (Deevey 1960; Hassan 1981). As of 1993, we have added more humans to the total human population of the world in the past 40 years than we added in the previous three million years (Keyfitz 1989; United Nations 1992). The human population has quadrupled in the last century. Between seven and 8% of all human beings ever born are alive today (Weeks 1992, 53). Until recently, the rate of growth of the human population has been increasing, which means that it exceeds even exponential growth (Demeny 1986; Bartlett 1978). There is wide disagreement about the prospects for future growth of the human population and whether, as well as under what circumstances and when, it will stop growing. The current world population reached 5.5 billion in 1992, well ahead of previous official projections, with an estimated 1.7% rate of growth per year, which means that approximately 93.5 million persons are added to the world population each year at the current rate of increase. But it should be remembered

that this is “interest” compounded, not annually, but minute-to-minute, second-to-second, meaning that 178 persons are added each *minute*, three per second. That is *net increase* after deaths are subtracted from births.

It should also be remembered that the estimates of total population and growth rates are based on official numbers that often do not include large numbers of people, especially in the Third World countries, who are not counted because they are out of the official enumeration system. In some cases, these are the groups with the highest fertility. From my work in South America, I estimate that official census counts in rural areas may be as much as 10-25% too low, and that published growth rates may be low by the same degree. Also, it should be remembered that official population growth rates assume a constant doubling time. But calculations by Bartlett (1993) show clearly that growth rates based on official counts have continued to increase until recently and have declined (officially) only slightly since the decade of the 1970s.

In 1960, Heinz von Foerster and coworkers published a paper in *Science* that provided evidence that human population doubling times have declined steadily since A.D. 0, when the estimated world population was 250 (von Foerster et al. 1960). Von Foerster’s mathematics indicated that the date at which, with current trends, the population doubling time would approach zero, and at which the time the population would be expanding at the speed of light, would occur in 2027 A.D. Von Foerster’s conclusions were highly controversial, but Umpleby (1990) showed that population projections made in 1960 on the basis of von Foerster’s equations have proven to be lower in every case than the best population estimates made by the United Nations, *even though UN estimates revised after the year in question.* For example, the 1951 UN estimate for projected 1980 world population was 3.277 billion. The 1982 UN estimate for the actual 1980 population was 4.453 billion (1.176 billion more than the 1951 estimate), whereas the population predicted by von Foerster’s equations was 3.969 billion, nearly .5 billion less than actually observed. The 1963 UN projection for the 1990 world population was 5.188 billion, whereas von Foerster’s equations predicted 5.033 billion. The actual 1990 world population has now been estimated at 5.3 billion, more than 100 million more than the 1963 estimate and nearly 300 million more than von Foerster’s. The 1988 UN estimate for 1995 has been revised upward since 1963 from 5.648 billion to 5.766 billion; the von Foerster calculations project 5.814 billion, which we are likely to reach. Using current population figures, the von Foerster formulas project a population of 7.159 billion in the year 2000 (1988 UN estimate: 6.251) and 10 billion in the year 2007. In 1962, von Foerster et al. (1962) projected a population of 6.91 billion for the year 2000, whereas the 1958 median UN projections for 2000 were 5.70 billion. We will reach 5.70 billion in 1994.

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Accompanying this exponential population growth has been the increasing pace of human destruction of the global ecosystem. Small scale human assaults on the environment had little or no lasting impact during the early Pleistocene, but local and

regional impacts began to be seen in the late Pleistocene and Neolithic (Martin 1973 and 1984; Angel 1975; Darby 1956. Beginning with the Industrial Age, large areas of previously intact ecosystems that had formerly experienced little or no human perturbation have been destroyed. As the 20th century draws to a close, human activities are seriously and perhaps irreversibly disrupting features of the global ecosystem that are necessary in the preservation of the human species and other life forms. Global atmospheric carbon dioxide levels, for example, have increased 25% during the last century (Money 1988, 64). Several of the warmest years on record occurred in the 1980s (Schneider 1989). Severe seasonal reductions in the ozone layers over Antarctica, and perhaps even the Arctic, are matters of concern. The ozone layers over Antarctica and perhaps over the Arctic are beginning to disappear (Solomon et al. 1986; Graedel and Crutzen 1989). Photochemical smog has become a permanent problem in most of the major cities of the world, and “megacities” are beginning to contain most of the earth’s human inhabitants (Dogon and Kasarda 1988; Rohter 1990).

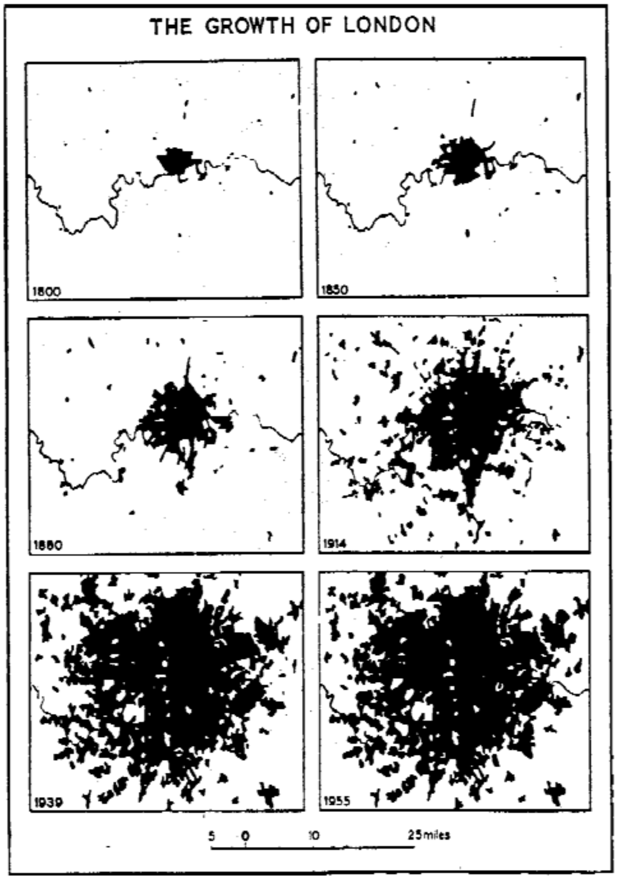
Enormous areas of the world’s rainforests are disappearing forever at a breathtaking rate, and this is accompanied by layers of smoke haze that cover tens of thousands of square kilometers in every direction, adding significantly to the fossil fuel-induced changes in the Earth’s atmosphere (Crutzen and Andreae 1990). Innumerable species have become extinct as the direct result of human activity, and the rate of extinctions is increasing (Ziswiler 1967; Hoage 1985; Wilson 1988). Wilson (1990) estimates that, at the present rate of ecosystem destruction, as many as 25% of all living species will become extinct within the next 50 years. Today, one oil tanker disaster can wipe out a whole ecosystem (Jackson et al. 1989), and such incidents fill the daily headlines. At the same time, there is growing consciousness of a global ecosystem and the need to preserve it (Cole 1964; Rambler et al. 1989; Study of Critical Environmental Problems 1970; Boulding 1978; Sahtouris 1989; Russell 1983; Ehrlich et al. 1977; Lovelock 1979; Myers 1984; Daly and Cobb 1990).

Numerous observations that humans are threatening the global ecosystem have appeared over the past few decades. The human species has often been characterized as, or compared to, some kind of planetary disease (Gregg 1955; Eisley 1961; Russell 1983; Odum 1989). Geologist Peter Flawn speaking to students at Northwestern University in 1970, said that the earth’s crust has a skin disease, a case of microbes infecting its crust, and that the sickness is man (Flawn 1970). Flawn’s and other observations stimulate a search for other pathologic models. Lewis Mumford’s (1961) book, *The City In History*, is replete with references to large cities as pathologic processes, in which “…the complex structure of the city [is replaced] with gray masses of ‘urbanoid’ tissue. This formless urbanization, which is both dynamic and destructive, has become almost universal…cities, villages and countryside, once distinct entities with individuality and identity, have become homogenized masses” (Mumford 1968). Geddes (1915) proposed a scheme of cities that included “patholopolis,” and McHarg, writing of the human assault on natural ecosystems in *Design With Nature* (1969), described the city as “the heart of pathology.” Because spectacular growth and invasiveness are outstanding characteristics of the human population, the similarity of the human species to a cancerous process comes readily to mind, especially to a physician. A schematic view of the growth of London from 1800 to 1955 looks like nothing so much as an expanding, invasive, metastatic, malignant tumor (Johnson 1972, Figure 1). Nearly identical patterns are seen in the growth of other communities such as Baltimore from

1800 to 1950 (Gist and Fava 1964; Hoover 1948), and in the appearance and structure of all major urban settlements throughout the world.

The universality of these disparate phenomena, taken together, the speed at which they are happening in terms of the total length of human evolutionary experience, and the severity of their cumulative effects demands that we devise a hypothesis or theory that explains and makes sense of them. Until recently, there has been no such satisfactory overall theory or hypothesis that provides and explanation for these various phenomena, all of which are well documented.

Figure 1
The growth of London, 1800 - 1955



Source: Johnson 1972

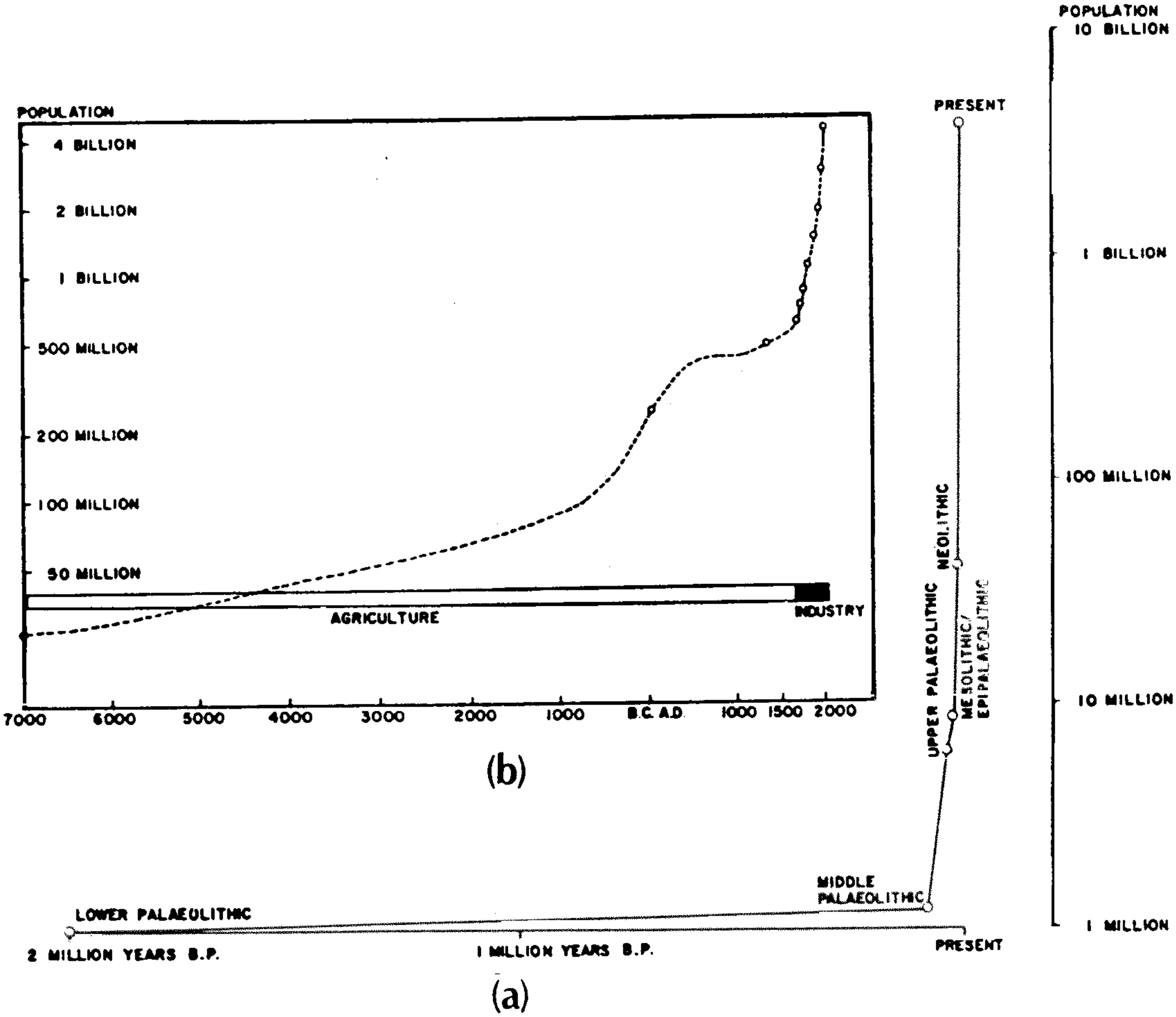
Characteristics of Human Populations and Communities

Humans can be studied in the manner that we study other species and organisms. Within certain limits, humans appear to be subject to the same characteristics and biological laws as other species.

Survival curves of humans, for example, can be compared with species as different as black-tailed deer (Taber and Dasman 1957), and, as Deevey (1960) has noted, fruit flies and oysters. Population pyramids can reflect the relative age distributions of human or other populations (Odum 1971). There are, in fact, several kinds of age distributions among human societies. One of the most common found around the globe at this time is that of a young and rapidly reproducing population with as much as 50% of the

population under the reproductive age (Hern 1977, 1992a). Growth curves in the populations of various species tend to level off (Odum 1971), but some phases of population growth may be extremely rapid. The human species has shown this patter since its origin with a markedly increased rate of growth in recent centuries (Hassan 1981, Figure 2).

Figure 2
The growth of the human population over the past two million years (a) and 9,000 years (b)



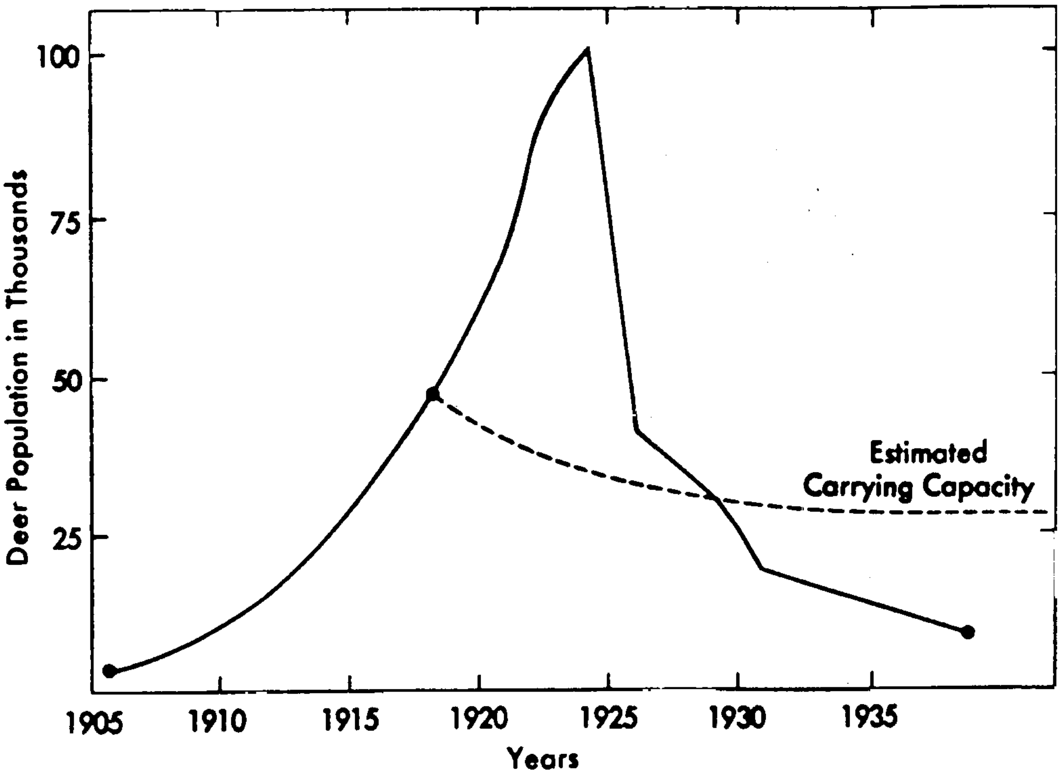
Source: Hassan 1980

Shown clearly are the remarkable acceleration in population growth rate and the dramatic increase in world population size over the last few centuries (data from Hassan 1978 and Thomlinson 1965

Studies from population biology repeatedly show that species populations increasing rapidly are subject to important fluctuations in population size and viability as found in, for example, Kaibab Plateau deer (Rasmussen 1941; Leopold 143, Figure 3), adult thrips (Davidson and Adrewartha 1948, and *cardia spina albitextura* feeding on eucalyptus trees (Clark 1964). Population crashes are often described in rapidly growing populations that exceed carrying capacities or local food supplies. Some population crashes may result in no recovery of the original population, or it may fluctuate around an average that

appears to be set by the carrying capacity of a given ecosystem (Boughey 1973, Figure 4). Predator-prey relationships can fluctuate in this manner in a series of linked oscillations, as in the classic case of the snowshoe hare and lynx populations (MacLulich 1937). A single predator-prey relationship leads to severe oscillations in populations, but more complex predator-prey relationships lead to damped oscillations that tend to be uniform around an average over time (Wilson and Bossert 1971).

Figure 3
Population growth and crash of Kaibab Plateau deer

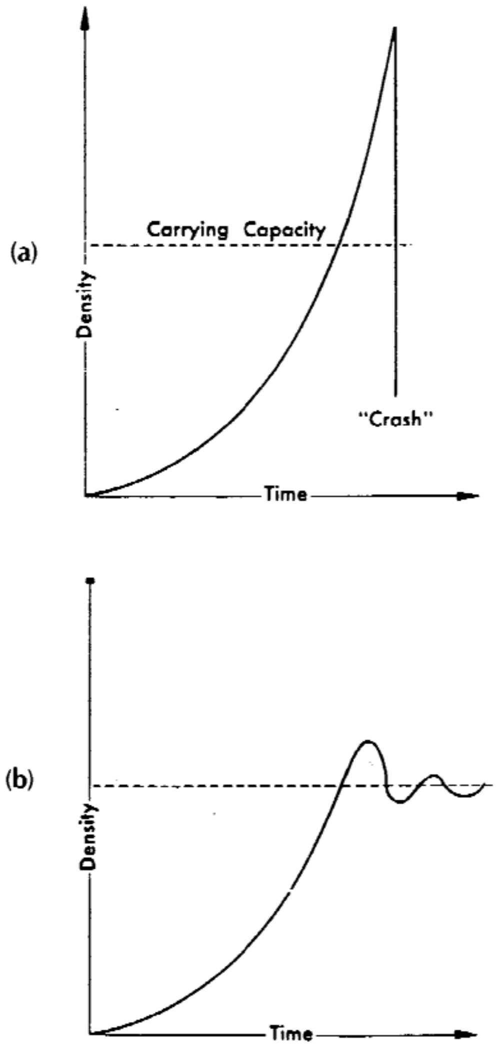


Source: Boughey 1973

An important concept in population biology is that populations tend to maintain themselves in a series of damped oscillations (Margalef 1968). Digression from this pattern results in severe instability and even extinction.

Part of the instability and vulnerability to extinction appears to be related to stresses that develop under conditions of high density and severe crowding as shown by the well-known experiments of John Calhoun (1962) and John Christian (1980). Crowding leads to social and biological pathology that results in turn in high mortality and diminished group survivability (Cassel 1971; Ashby et al. 1983)

Figure 4
Population increase, overshoot, crash, or return to carrying capacity level with damped oscillations



Source: Boughey 1973

a) A theoretical example of population increase that has overshot the carrying capacity, with a resultant crash

b) A theoretical example of population increase having a curve of a J form that has slightly overshot and its oscillating about the carrying capacity level.

An important characteristic of historic human populations has been the ability to circumvent these stresses through group fission, emigration, and settlement of unexploited new territories. As a result, thousands of years of intercontinental migration have resulted in the permanent colonization of virtually every part of the terrestrial global ecosystem by humans and the development of colossal and rapidly growing human settlements that envelop and engulf adjacent ecosystems. Surrounding colonies, or suburbs, become indistinguishable parts of the urban sprawl.

While migration and colonization strategies were available during the last 10,000 years of history, when rapid population growth began occurring, they are no longer available. Population migration and concentration is in the direction of large cities where the stresses of high density develop new urgency and intensity for individuals.

Human populations have responded to population pressures with a variety of strategies other than migration, including predation and agricultural intensification (Abernethy 1979; Sahlins 1961; Cohen 1977).

Human Communities

A striking feature of human communities is that they are becoming indistinguishable in appearance. Ancient human communities frequently exhibited unique architecture and residence patterns that were characteristic and specific to that culture or area (Jordan and Rowntree 1986). The boundaries of cities were carefully delimited by having city walls. Cities were sometimes located for defensive reasons at sites where the physical topography either required this practice or provided the means by which it was accomplished (Carver 1979). In more recent times, the boundaries of communities everywhere have become indistinct while they are becoming extensive.

Urban planners and students of human communities have for many years referred to their subjects in aggregate terms. Gruen's (1973) depiction of "the urban organism" is shown in Figure 5. Lewis Mumford (1956) wrote that ancient cities, almost like tree-rings, could be dated in their new growth by the steady expansion of their outer walls. Now, with the phenomenon of "conurbation," as it was called by Patrick Geddes (1915), the new "…urban tissue was less differentiated than the old. It presented an impoverished institutional life; it showed fewer signs of social nucleation; and it tended to increase in size, block by block, avenue by avenue, 'development by development,' without any individuality of form and, most remarkably of all, without any quantitative limits" (Mumford 1956).

In discussing ecosystem changes, including atmospheric and local environmental changes, brought by large urban settlements, Wolman (1965) refers to the "metabolism of the city." The phenomenon of the "urban heat island" is well known and may contribute significantly to the process of global warming (Jordan and Rowntree 1986).

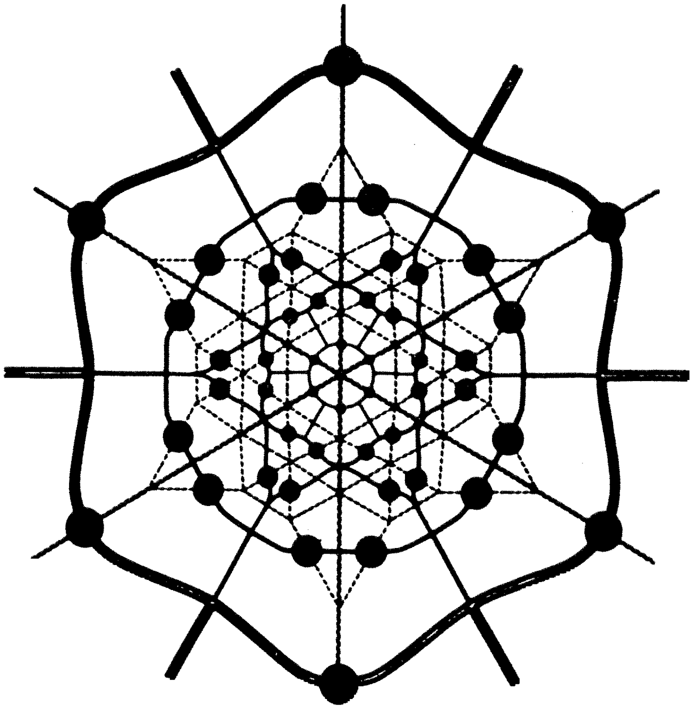
Cities everywhere developed a process of "de-differentiation," becoming superorganisms without form, invading and destroying the natural environment and expanding at a rapid rate. Gruen (1973), in his *Centers for the Urban Environment*, gives a phantasmagoric illustration of this idea, with the illustration's title being "The City Devours The Countryside." In the view of Ian McHarg (1969, the modern city is an ecological desert, hostile to human and other forms of life.

Models of Pathologic Processes

If we perceive the human species as one that is destructive to others and even to the environment in which we live, and if we begin to look for comparisons with other organisms, systems, or pathologic processes to help us understand the process we are both witnessing and causing to happen, we must begin with the framework of devising a hypothesis that explains reality and predicts events; that is the purpose of a hypothesis. Our hypothesis must be one that, within reasonable limits, permits us to explain a set of

events and observations that have hitherto appeared to be unrelated or to be related in a way that is not yet clear to us. In this case, it must be a hypothesis that includes aspects of human behavior and biology as well as anthropogenic changes in the ecosystem (Cassel 1964). We must be prepared to explore any possibility.

Figure 5
The "urban organism"



Source: Gruen 1973

Linear mathematical models such as those used in a General Circulation Model (GCM) (Stern et al. 1992) or in systems dynamics models (Meadows, et al. 1992) have important limitations in describing large systems for which we have partial or unreliable information, and they are especially deficient in describing biological systems. For example, the GCM is a highly sophisticated mathematical model that describes the global climate changes resulting from the accumulation of greenhouse gases, but such models do not explain the wide variety of biological or other geomorphologic phenomena that accompany or result from human activities (Sagan et al. 1979). The GCM may be explanatory for such phenomena as climatologic changes, but not for most kinds of global change, and it does not help us with causal inference to determine why it is happening except in a very limited sense. Linear models in general are inadequate to describe complex ecological relationships, particularly when they include biological and human sociocultural and political systems. A *biocultural* model that includes these factors is needed.

The difficulty of comparing humans to other species is that humans have culture, which permits the transmission of knowledge from one generation to others, sometimes over spans of thousands of years and tens of thousands of generations. Human culture gives us the capacity to adapt to inhospitable circumstances and environments in ways not available to other species. We are not, in fact, subject to some of the same biological limits and constraints that limit the actions and growth of other species' populations.

Comparing the human species to some pathologic process is fraught with hazard. If we make the comparison of human species to pathologic process as did Professor Flawn, we take the risk that it will be inappropriate because of the differences in scale as well as differences in process. How can one compare the human species to dermatitis? Dermatitis can be caused by a variety of factors including microbes (bacteria or fungi), autoimmune or allergic processes, toxic substances or other physical agents, or by psychogenic disturbances. Dermatitis does not often become pervasive and it usually doesn't threaten its host. The consequences of human activities neither fit into such neat categories nor are they that benign. If human activities appear to be pathological for the global ecosystem, we must find a more comprehensive model. Among the possibilities are the pathologic categories of parasitism, neoplasia or disturbances of growth, infectious disease and inflammatory processes, and autoimmune disorders (Perez-Tamayo 1961).

In reviewing these alternatives, the model including "disturbances in growth" is immediately appealing since growth is the single most dramatic and obvious characteristic of the human population. Growth of the global human population can only be characterized at this time as unregulated and increasing rapidly. It is slower and moderately regulated in some localities and even in some regions, but it is nonetheless inexorable in the global perspective. In the early Pleistocene, the annual human population growth probably did not exceed 0.001% including minor and temporary local fluctuations (Hassan 1981). The human population doubled every 100,000 years or so. In the Neolithic, population growth increased at a rate of 0.1% per year, doubling every 700 years (Saucier 1972). By A.D. 0, the total human population was approximately 250,000,000, but it doubled to 500 million by about 1650. The Black Death in the 14th century removed one-third of the human population, resulting in a temporary reduction in growth, but the population then doubled again to 1.1 billion by 1850, only 200 years later. World population reached two billion some time in the early 1930s, it reached 2.5 billion in 1950, and it reached 5.0 billion in 1987. Doubling times have dropped by almost 50% with each doubling since 1650 A.D. Von Foerster (1966) shows that reported "growth rtes" are, in fact, tangents to a hyperbolic log-linear curve showing *increasing rates of growth* over time; assurances that population growth rates are "dropping" do not accurately reflect this fact.

The human population is now doubling every 39 years or less (37 years, in the case of the most recent doubling). We are adding approximately 94 million people to the world's population each year. Depicting this extremely rapid growth on an arithmetic scale that includes the Pleistocene or even the past few thousand years shows a growth curve that is similar to those seen in other populations just before they collapse (Ehrlich et al. 1977). Yet humans have shown an extraordinary resistance to forces that cause other species to collapse.

Rapid, uncontrolled growth is a principal characteristic of one kind of neoplasm (new growth), that of a malignant neoplasm. Malignant neoplasms display four main characteristics:

- **Rapid, uncontrolled growth;**
- **Invasion and destruction of adjacent normal tissues;**
- **De-differentiation (loss of distinctiveness of individual components); and**
- **Metastasis to different sites (Anderson 1961; Perez-Tamayo 1961).**

Cancers also show what cancer biologists call progression, or an evolution toward greater malignancy, with less differentiation of cells, faster growth, and more metastatically aggressive cells (Prescott 1990; Ruddon 1987).

Malignant Characteristics of the Human Species

We may now examine those characteristics of the human species as a whole that suggest the comparison with a malignant process. Recognition of a malignancy depends on a “group of morphologic changes” as well as behaviors. A *malignant neoplasm* is defined as “…an uncontrolled new growth of tissue composed of components which have the power of growth and multiplication relatively free from the usual restraints” (Anderson 1961).

Rapid, Uncontrolled Growth

There is no evidence that overall growth of the human species is regulated at this time or has been for at least 10,000 years. There is no indication that growth of the human population will be regulated in the foreseeable future. This is not to say that humans do not have the capacity to regulate their population growth. On the contrary, the efforts of humans to control their fertility are widespread, legendary, and heavily documented (Devereaux 1955; Birdsell 1957, 1968; Himes 1970; Nag 1962; Polgar 1968; Dumond 1975; Tinker et al. 1976; Hern 1976). Humans have regulated their fertility in early human existence and even among contemporary preindustrial populations. Much of our prehistoric and modern population growth is not the result of better medical care and declining mortality but disruptions of ancient controls on fertility and natality that have previously kept population growth at lower rates (Armelagos et al. 1991; Hern 1992a, 1992b).

In spite of efforts to control fertility, the global human population has not recently succeeded as a species in doing so.

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There are numerous instances of powerful forces that block attempts to control human fertility and even encourage fertility. These range from heads of state and heads of religious hierarchies to private interest groups. A recent president of the United States, George Bush, judged correctly that he could gain votes and enhance his prospects for being elected by advocating the imprisonment of doctors who perform abortions (Boyd 1988). He received no effective criticism and paid no immediate political price for this position. The current Pope is famous for going to places where members of the rapidly growing local population have stripped the original vegetation from the landscape in a desperate attempt to feed themselves and, upon arriving, exhorting them to reproduce themselves as much as possible. Pronatalist forces are, for the most part, in control of human institutions. A recent and dramatic reversal of this tendency was the overthrow

of Ceaucescu in Romania. The first act of the new revolutionary government was to lift Ceaucescu's ban on abortion and contraception.

The U.S. government, which has a powerful influence on world population policies and programs, announced at the 1984 International Conference on Population at Mexico City that population growth is "neutral," that localized population growth crises are evidence of "too much government control and planning;" population growth should be slowed by "natural mechanisms" that will follow from "development" (Menken 1986). The policy of the U.S. government from 1981 until the beginning of 1993 was to withdraw support for the UN Population Fund and to limit other fertility control programs. This policy, however, was dramatically reversed shortly after the inauguration of President Clinton, who immediately announced withdrawal of the Mexico City Policy, restrictions on abortion information, and other measures that restricted access to fertility control.

One of the main characteristics of a cancerous growth is that it resists regulation. *A cancer cell is a cell that reproduces without limit* (Prescott and Flexer 1986). The regulatory mechanisms that determine the rate of cellular multiplication and increase in total mass are disturbed to the point that growth is not controlled. Regulatory mechanisms may be present, but they are not present in sufficient quantities to be effective, and they are ultimately destroyed by the unregulated tissue (Anderson 1961).

The fact that some humans limit their fertility effectively, do not reproduce, or advocate the widespread availability of methods of fertility limitation does not change the corollary fact that the human species as a whole does not operate at this time under any constraint on the growth of its numbers.

Invasion and Destruction of Adjacent Normal Tissues

We have from the beginning of recorded history seen examples of human destruction of the global environment beginning with the deforestation of the Mediterranean (Darby 1956; Angel 1975). The forests of the cedars of Lebanon were destroyed forever to build the ships of the Phoenicians and the Temple of Solomon. Examples of local ecosystem destruction are innumerable.

Cancers spread by two means: extensive invasion and by metastasis, or distant colonization. Human communities, once established, tend to invade and destroy all adjacent ecosystems without limits. Because of prior limitations of technology and sheer population size, and because of cultural traditions that respected natural ecosystems, this was not always so, but it appears now to be occurring routinely. There is no ecosystem on the planet that is not already destroyed, invaded, or immediately threatened in some manner by the human species, including some thought until recently to have been left in pristine condition by aboriginal populations (Denevan 1992; Williams 1989). In fact, the global ecosystem is itself under considerable stress from human activities, and this process is expected to accelerate (Gentry and Lopez-Parodi 1980; Sagan et al 1979; Fyle 1981; Gomez-Pampa et al. 1973; Moriarty 1988; Study of Critical Environmental Problems 1970; Goudie 1982; Hafele 1980; Mooney 1988; Repetto 1989; Birdsall 1992; Allen and Flecker 1993). Recent specific examples of severe ecosystem stress range from the Amazon (Skole and Tucker 1993; Macedo and Anderson 1993) to Chesapeake Bay (Brush 1993) to the Nile Delta (Stanley and Warne 1993) to the Philippines (Eder 1990) and points in between.

De-differentiation

To the pathologist or oncologist, the term "de-differentiation" has a variety of meanings but it principally refers to individual cell type. A normal cell has a characteristic appearance that identifies the kind of tissue and even the organ from which it derives. Heart tissue has the appearance of muscle tissue and it can be identified as being from the heart. Columnar cells that line the bowel or cervix have typical appearances. Cancer cells tend to lose this differentiated appearance. The pathologist may be able to determine that a certain cancer cell is from adenomatous tissue but may not be able to tell whether it was originally from the breast, bowel, or parotid gland, or that a squamous cell cancer originated in the lung or somewhere else. Sometimes cancer cells just look like cancer cells but the general origin is not apparent. The less a cell appears to be from a specific kind of tissue, the more likely it is to be malignant; the more unidentifiable it is, the more likely it is to be part of a highly malignant and aggressive tumor.

A mass of cancer tissue can also appear to be undifferentiated in the sense that no specific structure is visible. There is no way to determine the cell origin from either the appearance of individual cells or the gross appearance of the lesion. Sometimes, to be sure, particular malignancies have characteristic appearances, but even these have lost the original relationships of cells and structures that give it a normal appearance and function.

On an individual basis, human beings are remarkably similar in anatomy, physiology, and appearance worldwide. There are minor intraspecific differences that include skin color, stature, facial configuration, and adaptations to heat or cold, or even adaptations to specific disease problems such as sickle-cell trait that protects against *falciparum* malaria, but the differences that are present with other species adapted to different ecosystems are absent. Cultural adaptations, instead of physical adaptations, bridge the gap between the !Kung Bushman in the Kalahari Desert and his brother Nunamiut Eskimo hunting seal in the frozen Arctic. They are of the same species even if they cannot understand each others' language, behavior, diet, or manner of spouse selection. Human beings are "anaplastic" in the sense that they are not highly differentiated, and increasing contact between all groups accelerates the loss of differences between individual members of the species.

In a broader sense, however, the critical factor in human "anaplasia" is found in the capacity of culture to eliminate the importance of differences in physical adaptations or even specialized subcultural adaptations to local ecosystems that were previously necessary for survival (Frisancho 1981). The Eskimo may now use a snowmobile instead of a dogsled or kayak to reach a hunting site on the other side of the bay. Western technological adaptations permit non-Eskimos to live on the North Slope of Alaska with reasonable comfort in a climate and setting only survivable previously by those steeped in a highly specialized culture highly adapted to that rigorous environment. I go to live with my Shipibo Indian friends in the upper Peruvian Amazon without having to know a thing about hunting *arapaima gigas* with a harpoon or collared peccary with a bow and arrow. My own cultural adaptations, which I take with me, and my ability to use language and medical skills to exchange types of assistance with the Shipibo, permit me to go live with them comfortably for long periods of time. Put me in the jungle by myself without equipment and I would probably not last long. Conversely, my Shipibo friends would not last long in the Colorado winter without the local cultural adaptations that I could provide or teach them to use. Negotiated exchanges of specific cultural adaptations, which

diminish differences in local adaptations, minimize human difficulties in surviving widely different environments.

Because of their mobility and capacity for cultural adaptations, humans can exploit and survive in widely scattered and different ecosystems (Moran 1982). In that respect, humans are different from most other vertebrate species that are highly adapted to narrow and specific ecological niches. Anthropologist Joseph Birdsell (1968) observed that man has "given up density for plasticity" (p. 248). Anthropologist William S. Laughlin (1968) noted that, upon finding a horse, a man can run it down in two or three days, then "decide whether to eat it, ride it, pull a load with it, wear it, or worship it" (p. 313). Humans are ecologically more versatile than any other vertebrate species.

De-differentiation at the Community Level

While the argument can be made that individual human beings are "de-differentiated" members of a single ubiquitous species, the expression of "de-differentiation" in human populations can be illustrated at another level of analysis, namely, the community level. A visitor from space might see, not individual human beings, but lesions on the earth's landscape, some with interconnecting links. The lesions glow in the dark. (See the *Scientific American* cover of September 1989). A space observer watching the planet for the past three thousand years would see, first, a wide variety of these lesions with very discrete borders, layouts, and permanent structures with unique forms. The architecture of permanent structures would be specific, in many cases, to discrete locations on the globe. The Yanomamö oval community house would be distinctly different from the Kayapo or Waorani longhouse and these different still from the architecture and residence patterns of the Dogon in West Africa and the conical trulli houses of southern Italy (Carver 1979, 145). Now the international traveler finds rows of identically appearing cottages or apartment houses in Zagreb, São Paulo, Levittown, and Houston. The skylines of Chicago, São Paulo, Denver, and Tokyo are more similar than they are different. Gross appearances of human communities at the large-scale level, particularly in urban centers, are quickly disappearing. In fact, scalar differences aside, in their morphology settlement patterns of large human communities are not only becoming indistinguishable from each other and undifferentiated in appearance, but they are also becoming indistinguishable from the morphology of malignant lesions found in nature.

Malignant tumors, whether primary site or metastatic, are characterized by highly irregular and invasive borders that are indistinct in proportion to the virulence or aggressiveness of the tumor. Benign tumors tend to have distinct and even encapsulated borders and are not invasive. When images of malignant lesions are compared with images of human communities, especially modern urban conglomerates, and scalar-tonal differences are eliminated, as in Figures 6-8, the lesions and communities are highly similar, even indistinguishable, in their appearances. These two widely different phenomena have the same morphology. In function, each aggressively invades adjacent space and replaces the previous tissue or environment with its own. As malignant neoplasms establish local metastases, so do cities develop satellite communities that ultimately become part of the larger process. Aerial photos, satellite images, or other abstracted images of human communities and other corporate human activities over time anywhere on the planet illustrate this principle.

Odum (1989) notes that cities are highly heterotrophic ecosystems in that they consume much more energy than they produce. As the megacities of the late 20th and early 21st

century develop, with numerous urban centers containing tens of millions of inhabitants, the world's large cities become concentrated heterotrophic systems drawing energy from distant parts of the planet and creating a quantum increase in entropy (Polgar 1961; Brooks and Wiley, 1986).

Figure 6
Pulmonary adenocarcinoma, human lung

Figure 7
Baltimore, 1950

Source: McHarg 1969

Figure 8
Five cities cluster, North Carolina

Source: Chapin and Weiss 1962

Metastasis

Metastasis, or dissemination to distant sites, is a primary feature of malignant neoplasms. By this means malignant neoplasms become established in different organ systems far from the tissue or organ of origin. It is the process by which cancer most quickly and lethally spreads to kill the host organism.

The corollary of metastasis in the human population is the establishment of new human colonies in sites distant from the origins of their members. The migratory abilities of human beings are astounding. Even more astounding is the ability of human beings to find a new environment and climate, identify the beneficial and harmful components of the environment, and adapt their culture to meet the needs for survival in the new environment. The Amazon rainforest, for example, is an exceedingly complex environment, but native Amazonians have successfully lived there for at least 10,000 years (Lathrap 1970; Roosevelt 1980; Posey 1983). They were doing well until contacted by European explorers (Denevan 1976; Myers 1988; Hecht and Cockburn 1989; Hern 1991). Crosby (1986) has documented the expansion of European culture through colonies and the destruction that it brought to New World ecosystems. Along with these contacts came devastating epidemics and loss of up to 95% of indigenous populations. Even Malthus (1798) commented on the rapid growth of populations in the American colonies. The consequences of colonial expansion are similar in many ways to highly aggressive metastatic cancer.

Criteria for Diagnosis

Of the four characteristics of malignant tumors, pathologists generally require that a tumor display two in order to be categorized as malignant. Also, behavior of a tumor is more important than its histogenesis (Perez-Tamayo 1961). It is my hypothesis that the human species has all four characteristics of a malignant process, and that its behavior in at least three of the four categories is clearly malignant (Hern 1990).

Description and Diagnosis

The human species is a rapacious, predatory, *omniecophagic* species engaged in a global pattern of converting all available plant, animal, organic, and inorganic matter into either human biomass or into adaptive adjuncts of human biomass. This is an *epiecopathological* process that is both immediately and ultimately *ecocidal*.

In this respect, the human species is an example of a malignant *ecotumor*, an uncontrolled proliferation of a single species that threatens the existence of other species in their habitats. A giant flock of starlings or blackbirds may be an example of a *benign ecotumor* that is obnoxious to humans, but it is unlikely to leave any lasting damage. An example of another malignant *ecotumor*, however, is the crown of thorns starfish species that is destroying the Great Barrier Reef in the South Pacific (Yonge, 1963). Yet another is the lamprey eel, which gained access to the Great Lakes via St. Lawrence Seaway and destroyed the native fish in the Great Lakes (Benard, 1989). Both are the result of disturbed regulatory mechanisms or anthropogenic disruptions within the ecosystem (Moriarty, 1988). In the case of the lamprey eel, humans have begun to reverse the ecological damage by the application of sophisticated technology.

Discussion

A highly malignant form of cancer resists all efforts at effective regulation until the host has died. Cancerous tumors continue to grow even in the face of starvation of the host (Ruddon, 1987).

In the case of the human species, this hypothesis predicts that the global ecosystem, the supporting substrate, would have to be destroyed before the malignancy is halted, if, indeed, it ever halts. A peculiar property of the human species is that it is ingenious in its cultural adaptations to difficult survival problems. It is now even moving beyond the earth's atmosphere to space, an environment that is hostile to all forms of life. In this respect, we can see the first moon landing as an anticipatory metastasis.

Human beings have survived and prevailed not only by learning to exploit all ecosystems and their living components, but by learning to exploit other organic and inorganic resources such as oil, natural gas, and minerals. The human species is adept at finding ways to convert the most unlikely substances either to food for itself or to some highly adaptive adjunct of environments necessary for humans. There is a serious question whether elimination of the entire planetary nonhuman natural environment would prevent survival of the human species because of the species' ability to adapt or to convert resources to its use.

It is possible, of course, that the human species will recognize what it is doing to the planet in time to reverse the trend and restore the natural ecosystem to conditions that prevailed prior to human intervention. It is also possible that the human species will succeed in continued growth by converting all materials on the planet to human use. An important problem with this possibility is that the human species evolved in complex ecosystems. Are we smart enough to run an ecosystem complex enough to sustain us? "Trying to make nature stable gets you nowhere" (Schaffer, 1990).

A chief tendency of the human species is to simplify ecosystems everywhere. Simplified ecosystems are inherently unstable and tend to collapse. We have greatly simplified our prey-predator relationships; this increases the likelihood of experiencing sharp and

uncontrollable oscillations in both our life support systems and our own population levels. Human culture has permitted us to remove the constraints that result in damped oscillations characteristic of most species. We have not yet recognized or acknowledged any negative feedback loops that seriously endanger our survival as a species even though they loom before us (Keyfitz 1993). The result is unregulated growth and potentially lethal population instability that degenerates to figurative, literal, and mathematical chaos.

Chaos theory predicts that undamped oscillations proceed to extinction as a function of increasing rates of growth (May, 1974; May, 1976a; May, 1976b; May & Oster, 1976; Southwood, 1976; Schaffer 1984; Schaffer & Kot, 1985a). Small changes in initial conditions, especially in growth rates, may result in large, deterministic, but unpredictable oscillations in future population cycles. Our experience with other biological species and our own recent history should tell us that we are dangerously close to irretrievable chaos if we have not already long since established the pattern that will lead to that result. Is it possible that the increase in the human population growth from 0.001% per year to 0.1% per year at the end of the Paleolithic led us to enter a deterministic chaotic regime that spans thousands of years and which we cannot foresee? Is it likely that we will completely escape the ecological restraints experienced by other species (Woodwell, 1985)? Is it likely that, for humans, there is no limit to the "carrying capacity" of the earth's ecosystem? If there is a limit, how much longer will it take us to arrive at it (von Foerster et al, 1960)? What will happen when we do?

The purpose of any hypothesis is to explain reality and predict events. The hypothesis that the human species is a global malignant neoplasm, a ecopathological process, does provide a unitary explanation of a wide variety of events and phenomena including rapid human population growth, widespread human destruction of local, regional and continental environments as well as the global ecosystem, rapid urbanization, global atmospheric changes, widespread anthropogenic species extinctions, resistance to population regulation, and numerous other observations. It is a potentially reversible phenomenon and therefore a refutable hypothesis. The human species is capable of regulating its fertility and population growth, it is capable of restoring environments and saving other species from extinction, and it is capable of living in harmony with the rest of the ecosystem.

This hypothesis predicts that, while the human species is capable of all these non-cancerous activities and even occasionally displays them, it will continue to behave overall as a cancer on the planet. This will be true even if population growth stops but no other changes are made in the way that human beings relate to recover from the stress of human impact.

The authors believe that the current levels of human population cannot be sustained, and they are in agreement in this respect with many observers.

Choices for the Future

In a recent paper in *Population and Development Review*, Ehrlich et al. (1993), the authors doubt that a world population of 10 billion could be nourished “even

temporarily" without major improvements in agricultural efficiency and food distribution. The authors believe that the current levels of human population cannot be sustained, and they are in agreement in this respect with many other observers. It can be argued that chronic food shortages accompanying prolonged drought and other evidence of long-term ecosystem changes in places such as East Africa and northeast Brazil are current evidence that the human population has reached or passed the carrying capacity in those regions.

Vitousek et al. (1986) concluded that human used 40% of the Terrestrial Net Primary Production (TNPP) at the time of the study, with concerns that projected population increases may double that number of cause declines in TNPP by resource degradation (Daily and Ehrlich 1992). Even if population were to stop growing immediately, which is impossible, a continued increase in the proportion of TNPP used by humans could be expected to increase due to the disparity between adequate nutritional levels and subnutritional levels already being widely experienced in various regions.

Whether one accepts the calculations produced by von Foerster's formulas (which have consistently proven to be conservative), the arithmetic of growth alone, not to mention the facts of collapsing ecological systems, makes it clear that growth of the human species cannot continue on its current trajectory without important and, perhaps, dramatic changes in the foreseeable future. As pointed out by Bartlett (1993), the size or number of things (of any kind) "can never continue to grow indefinitely…"; "In all systems, growth is a short-term transient phenomenon."

One thing is clear: either the human population makes a collective conscious decision to stop growing by reducing the number of births, and exercises this decision through its social and political institutions, or growth will stop because of ecological limitations and resource degradation with the result of an increased number of deaths or declining fertility through social disorganization (warfare). There is nothing new in this observation (Ehrlich and Holdren 1971). It is not a technological problem to be fixed; it is a political problem to be confronted (Ludwig et al. 1993).

Another thing is clear: as long as the global human population is growing at all, i.e., has any measurable rate of growth, the diagnosis of a malignant epiecopathologic process must be assumed until disproven.

Fortunately, some modern populations have show declining fertility as the consequence of policy changes and program interventions. Bongaarts (1993) and Westhoff (1993) have shown that fertility declines and preferences for small families have been closely correlated with the availability of fertility limitation services. Also, U.S. Undersecretary of State for Global Affairs Tim Wirth has announced an important change in U.S. policy toward international assistance in family planning services (Wirth 1993). For the first time since 1981, the U.S. government will actively work toward helping other countries provide fertility limitation assistance to their citizens, and this change is reflected in U.S. domestic policies, as well. Internal U.S. controversies over various aspects of fertility control such as abortion, however, will make it difficult to fully implement these policy changes. Also, there is increased discussion of the need for conservation and recovery of damaged ecosystems (Allan and Flecker 1993).

Even with these encouraging facts, and even if the proposed policy changes are successfully implemented, the current momentum of world population growth will carry us to increasingly unsustainable levels of stress on the global ecosystem within the next 50 years. This is likely to mean increasing political and social instability and violent upheavals that reflect this instability (Homer-Dixon et al. 1993). Each moment of delay in helping the 400 million couples who need and want subsidized fertility control assistance means exacerbation of these trends. Each moment of delay also means increasing resistance to modification of the diagnosis I have described here of a malignant epiecopathologic process that will irreversibly derange the planetary ecosystem.

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