

FERTILITY, MORTALITY AND DISEASE

By
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The Population Explosion

During my lifetime, the world's population has doubled from some 3 billion to over 6 billion today. This is a startling and a quite unsustainable rate of increase, and contemporary commentators are almost unanimous in expressing their anxiety at the prospects for the coming century.

Demographers and others have not always been so concerned. In the 1930's many commentators were anxious at the prospect of a declining European population; and some were recommending that their governments should take steps to sustain the numbers. In countries that were governed by fascist or totalitarian regimes, and in those that were motivated by a militant nationalism, various fiscal incentives were aimed at sustaining and enhancing the birth rate. In the USSR, the title of *Hero Mother of the Soviet Union* was conferred on highly fertile women, and similar accolades were given to mothers in Nazi Germany.

The decline in fertility that was experienced in Europe in the inter-war period was a consequence, in part, of the great economic depression of the 1930's. When the Second World War ended in 1945, there was a vigorous resurgence of the birth rate in Europe, which resulted in what came to be known as the baby boom. At the time, attention was also attracted by what was happening in the European colonies in Africa and in the East, where populations were surging upwards.

By the 1960's, people were sounding the alarm. The United Nations, via the agency of UNESCO, and the Organisation of Economic Co-operation and Development pursued this issue vigorously, and the governments of India and China were taking note. In India, the awareness of a population crisis led to a policy of compulsory male sterilisation, which eventually proved to be highly counter productive. In China, it led to the one child-policy, which, seems in retrospect, to have been honoured more by its neglect than by its observance.

Recent Inattention

Thereafter, these anxieties lessened in a way that is both curious and hard to explain. The population crisis was increasingly ignored throughout the 1970's and 1980's. People turned their attention elsewhere and the issue was sidelined. Two reasons may be offered for this.

The first reason was the disengagement of Europe from its colonies. Western politicians and diplomats were unwilling to affront the leaders of recently independent nations by urging upon them policies of population control. It was felt that such advocacy was liable to be regarded as a neo-colonial interference with racist overtones.

A second reason may have been the optimism occasioned by economic growth. Many economists believed that the population problem would be solved partly by the increased wealth that would be available to sustain the increased numbers, and partly by the demographic reaction of family limitation that would also be occasioned by increased prosperity.

Few people retain this optimism today. It seems that, in consequence of the burden of population, the planet is facing a crisis of over exploitation. This threatens to lead to the collapse of the ecosystems that replenish and restore the natural resources on which we ultimately depend. The consequence of a widespread collapse would be disease and famine amongst the human population on an unprecedented scale. The impetus of industrial development would be halted and the social and economic developments of the past two hundred and fifty years would be reversed.

Reproductive Strategies

To understand what is happening in the modern world and to make reasonable predictions of where we are heading, we need to look over a much longer time span than that of the recent period of industrialisation. We can derive some significant insights by looking over the entire expanse of human history, beginning with the very inception of the species. By looking at the origins of the human species, we can understand why it is burdened by such excessive fertility.

In analysing the reproduction strategies of animals, population ecologists have described a trade-off between the investment in individual survival and the expenditure of effort in reproduction. This trade-off defines the so-called r/K continuum.

Some species, which follow the r -strategy, are adapted to live in ephemeral environments from which they must emigrate in large numbers at birth or shortly afterwards. (In mathematical models of population, r commonly denotes the natural rate of reproduction, undiminished by the effects of overcrowding.) Such species are likely to have a high inherent growth rate which should enable them rapidly to colonise favourable environments as well as to sustain the high rates of mortality to which they are subject whilst migrating to new habitats.

The r -strategy is followed by many fish and insect species that produce prodigious numbers of offspring, of which few survive to adulthood. Such species are liable, under certain circumstances, to swarm. This can happen when circumstances arise that favour the survival of the offspring such as the removal of a natural predator or the temporary abundance of food.

An example of the phenomenon of swarming is provided by the locusts that have afflicted agriculture in African and in the Middle East, probably since its very inception. Locusts change their behaviour radically whenever they swarm. They change from harmless grasshoppers into destructive consumers of every

piece of vegetation that lies in their path. A dramatic account of swarming locusts is to be found in the book of Joel in the old testament of the bible.

Other species, which follow the K -strategy, are adapted to live in stable and specialised environments where territories can be found which individuals or groups can demarcate. (The carrying capacity of the environment, which is the maximum sustainable population, is commonly denoted by K .) Such species are liable to be longer-lived than others; and their reproductive rates are liable to be lower. A good example is provided by the forest-dwelling gorillas whose low reproductive rates now pose a threat to their survival as the extent of their natural habitat is reduced by the incursions of man.

Speaking figuratively, we might say that the human population is now in the process of swarming. The swarming of the locusts ends when their food supply is exhausted and when their physical energies are spent. At that stage, they are subject to massive mortality. By extending the analogy to mankind, we may wonder whether the growth in the human population will be halted, likewise, by widespread mortality.

Mankind's Natural Fertility

The case can be made that the natural fertility of mankind represents an adaptation to circumstances that no longer characterise our lives. Our fertility rates may have been established at a time when man's hominid forebears were in the process of dispersing over much wider areas than those inhabited by their ancestors. The ancestral habitats may have resembled those of the modern gorilla and the chimpanzee.

According to this supposition, the high fertility rates, which were established at the time of the dispersal, are the feature that has caused the populations of mankind, since time immemorial, to press relentlessly against the limits of the available resources.

Primate Apes and Australopithecines

The events that gave rise to the human species occurred, we suppose, some five or six million years ago in the late Pleistocene. At that time, the verdant African environments began to suffer the effects of aridification. The great Miocene rain forests that had blanketed the continent virtually from coast to coast over a 15 million year period began retreating. At the same time, the continents of the Northern hemisphere froze over under the grip of an ice age that locked away large quantities of water.

The primate apes of Africa would have been divided into two groups, separated from each other by the Africa's rift valley. The rift valley is a 1,860-mile-long gash in the African continent that is a testimony to the violent tectonic activity that virtually tore it apart some 20 million years ago. It stretches like a great scar up the eastern half of Africa, snaking northward from Mozambique

through Malawi, Zambia, Tanzania, Burundi, Rwanda, Uganda and Kenya and into Ethiopia and Northern Somalia.

With the aridification of the continent, two quite distinct habitats were created. On the eastern side of the rift, there appeared open savannas and grasslands of an increasing extent that became the habitat of herds of cloven-hoofed animals together with their feline predators and the associated scavengers, which were vultures and hyenas. In contrast, the highlands to the west of the rift retained much of their primordial forest cover.

The primates on the east side were forced to adapt to a new environment. One of their adaptations was bipedalism. Their upright posture enabled them to cover greater distances with increased speed and efficiency. It enabled the hominids to move through tracts of open savanna in search of food. It also gave them better chance of evading the predators.

The Variety of Hominids

A variety of hominids populated this environment. One of the hominid species, the robust australopithecines, settled on a diet that consisted largely of roots, tubers and berries, supplemented, we imagine, by a supply of insect grubs and termites. This low energy diet meant that they were perpetually chewing their food; and, to do so, they had to develop massive jaws and huge grinding molars.

Another species, which was the ancestor of mankind, pursued an alternative and a more generalised strategy of feeding, which included the scavenging of dead prey in competition with hyenas and vultures. Their high-protein diet, which included flesh and bone marrow, was necessary to sustain the hypertrophic development of the brain, which is the essential human characteristic.

The hominid apes of the savanna were themselves the victims of the predators; and they doubtless suffered a much higher mortality than the forest apes, of which the surviving African examples are the gorillas and the chimpanzees. The skeletal remains of the australopithecine hominids have been found mostly in ancient limestone caves that were the lairs of leopards, tigers and hyenas. Their bones bear the marks of the gnawing and chewing to which they were subject, and some of the skulls bear distinct impressions of the incisors of the predators.

The evidence of the fossilised bones was grossly misinterpreted in the mid 1950's by Raymond Dart, who was originally responsible for identifying and naming the australopithecines in the 1920's. Dart imagined that the australopithecines were responsible for accumulating the bones of other animals in the places where their own remains were discovered by the archaeologists; and he developed a theory about their culture.

He concluded that the hominids had smashed and butchered the animals whose remains were found beside with their own bones. He also believed that the australopithecines were cannibals who treated their own kind in a similar

manner. Dart saw humanity as inherently aggressive and blood thirsty; and his view was probably influenced by his own experiences as a medical orderly in the first world war and as a spectator of the second world war. It is now clear to us that the australopithecines were the victims rather than the predators. They were the hunted rather than the hunters.

The adaptation to these circumstances, which was necessary to ensure survival, was a heightened rate of fertility. That fertility continues to be a characteristic of the present-day humans, who are the descendants of the australopithecines.

Homo Sapiens

As these hominids gradually transformed into human beings, they ceased to be victims of predators and they became predators themselves. They developed the lifestyle of hunter-gatherers that has characterised human beings for most of their career. It was probably the very success of the proto-humans as predators that led, eventually, to the demise of the other hominid species and to the unique survival of *Homo sapiens*.

Nevertheless, it is clear that, as recently as 150 thousand years ago, humans themselves were threatened with extinction. This fact is evident in the very limited genetic variation of the modern human population. It has been said that there is a liability to be a greater genetic distance separating two tribes of chimpanzees in adjacent valleys than is to be found in any comparison that might be made within the entire human population.

During most of their career, human beings have adopted the lifestyle of hunter-gatherers. They have pursued this occupation through territories of sizes that have depended upon the ability of the environment to satisfy their needs; and they have exercised the same territorial prerogatives as the forest apes do, by fiercely defending their domains against the incursions of others of their species.

Hunter-Gatherers

The hunter-gathering lifestyle imposes a limit on the fertility of those who pursue it. They must be constantly on the move. A woman on the move can afford to have one small child in her arms or on her back and another clutching at her ankles. The child at her ankles must make its own way, for which it needs to be of more than a certain age. This consideration imposes a minimum spacing in the ages of the offspring. If children are more closely spaced, then their survival is threatened.

Whether, in the main, the limitations on the population of hunter-gatherers have been imposed by the active self-restraint of adults or, more brutally, via the mortality of infants, is a topic that bears some investigation. However, the net effect will be much the same, whichever the agency.

The need of humans to restrain their natural fertility becomes acute only when the human population becomes sedentary or immobile, as happened with the advent of agriculture at the end of the last ice age, which ended as recently as 10 thousand years ago.

Creation Myths

The modern science of paleoanthropology, which we have been discussing briefly, has become a subject of intense popular interest. Nowhere is there a more active interest than in the United States, where fundamentalist Christians oppose the theories of Charles Darwin, concerning the origins of the species, and adhere to the creation myths of the bible.

Amongst these myths is the story of Adam and Eve and of their expulsion from the Garden of Eden, which is depicted as an earthly paradise. The sin that led to the expulsion was that of sex and procreation. The wages of sins were hard labour, devoted to tilling the soil.

Lord said to Adam

“Because you have listened to the voice of your wife
and have eaten of the tree of which I commanded you
‘You shall not eat it,’
cursed is the ground because of you;
in toil you shall eat of it all the days of your life;
thorns and thistles it shall bring forth to you
and you shall eat the plants of the field.
In the sweat of your face you shall eat bread
till you return to the ground
from out of which you were taken;
You are dust, and to dust you shall return.”

For our own point of view, it seems clear that the expulsion from Eden represents an ancient memory of the transition of a human population from the status of hunter-gathers to the status of agriculturalists. It is uncertain which date we should put upon these events, nor it is clear where we should place the Garden of Eden.

If we date the start of the agricultural revolution in the Middle East at 8 thousand years ago, then we are talking of a time when much of the Persian Gulf was still above the sea, since, at that time, much of the ice that covered the northern hemisphere had yet to melt. With the end of the ice age, the process of aridification that has created the deserts of the Middle East was just beginning, and the sea levels were rising. The reduction of the available land and the thinning of the forest cover would have forced the population to resort increasingly to the arts of cultivation.

The Curses of Agriculture

It is unnecessary to assume that these arts were invented for the occasion. Many of them must have been known to mankind since time immemorial. But they began, at this time, to be used to an increasing extent. One of the conceits of late 19th century and early 20th century scholars was that the advent of agriculture represented a milestone in human progress; and that once its potential had been demonstrated to them, human populations were invariably eager to exploit its bounty. Modern opinion is quite to the contrary.

It now seems that, whenever people have had to resort to it, agriculture has been accompanied by toil and misery. This reality is clearly represented in the Lord's curse on Adam, which we have quoted above. The laborious nature of agriculture would have been clear to the European ancestors of some of us, who lived before the age of mechanised agriculture, and it is only in modern western societies that we fail to recognise it.

Amongst the curses of agriculture are the diseases that accompany it. There are two evident sources of disease. Agriculture sustains a much higher population density than does the hunter-gathering way of life. Hunter-gatherers leave behind their waste as they move from place to place. By contrast, sedentary agriculturalists are surrounded by their own effluent, which keeps them in permanent contact with pathogenic microbes and parasites. Unless they take active precautions, they are liable to pollute their supplies of drinking water, which is a fertile source of infection.

Agriculturalists also keep close company with other animals. There are dozens of diseases that have been passed from animals to humans on account of this proximity. To mention just a few, there are measles, tuberculosis and small-pox, which come from cattle. Influenza comes from pigs and ducks, whooping cough comes from pigs and dogs. The common cold comes from horses. Malaria infects birds, including chickens and ducks. In tropical and semi-tropical environments, the larvae of the malarial mosquito are liable to hatch in any puddle or expanse of stagnant water that has been created by agricultural activities.

Cities

It is probable that most of us who are present here are unfamiliar with these facts of life, because we live in clean urban environments, quite separated from the odours and the contamination of agriculture; but herein lies an irony. Only in the twentieth century did the cities of the western world become the sanitary places that we expect. In former times, they were breeding grounds of disease, as they continue to be in other parts of the world.

Urbanisation and agriculture go hand in hand. For towns and cities to arise, there must be agricultural surpluses to sustain them. It follows that such settlements are liable to be heirs to all of the diseases that affect the agrarian environment. Nevertheless, they also breed their own specialised diseases. Some of these are water born diseases, such as cholera, typhoid and diphtheria, and,

more recently, polio. Other diseases that thrive in the urban environment are carried by rodent pests, including the bubonic and pneumonic plagues.

In northern Europe, the traditional recourse against urban water born diseases has been the resort to drinking beer instead of water. The hops and the alcohol in beer act as antiseptics, which destroy the bacterial contents of the water. It is notable that the patron saint of brewers is a certain monk named Adolphus who is reputed to have saved the citizens of Bruges in Belgium by recommending that, at the time of an epidemic of disease, which was probably caused by typhoid, they should drink nothing but beer.

The Plague

Until very recently, all cities have been net consumers of people, and the numbers of citizens have been sustained only by continual immigration from the countryside. The plague, in its various forms, was endemic in mediaeval cities. It is uncertain what the scale of mortality was in London during the black death of 1437, but it must have greatly exceeded the figure 30 percent, which represents a low estimate for death in the countryside. The plague began to disappear from Europe's cities during the 17th century. The last episode in London was in 1666, and the last occurrence anywhere in Europe was in Marseilles in 1720.

This relief from the plague was one of the factors in a curious hiatus of disease that occurred in Britain and elsewhere in Europe on the eve of the industrial revolution. This created a burgeoning rural population, which provided the recruits to the growing armies of industrial workers. The industrial workers survived some appalling conditions of urban overcrowding, which might have been expected to result in disease and death on an unprecedented scale.

The Urban Populations of the Industrial Revolution

The survival of the urban population of the industrial revolution is one of the great mysteries of epidemiology. The relative freedom from cholera and typhoid has been attributed by some to the habits of liquid consumption that arose at the time. The industrialisation of brewing provided ample quantities of beer to drink in place of water. A significant factor in Britain was the development of the habit of tea drinking. This involves the boiling of water, which tends to kill bacteria, followed by the infusion of an extremely powerful antiseptic, which is the tea itself.

The industrial revolution bred its own diseases. Most notable of these was tuberculosis, which is, nowadays, one of the world's leading causes of death. Polio was another emergent disease, but cholera and typhoid remained major scourges of European industrial cities until the middle and late 19th century. The water system of London began to be cleansed and the associated sewerage system established in the middle of the 19th century; and the work was virtually complete by the 1880's.

World Population

It is clear that the modern developments in medicine that cure and prevent disease came far too late to have a major effect upon the populations of the industrial revolution. Only in the latter half of the twentieth century did they begin to have a major effect upon populations worldwide.

The first major effect upon the mortality of populations outside Europe was in consequence of European colonisation. Transport systems were established in the colonies. These could be used to mitigate the effect of localised famines that would normally have resulted in high infant mortality. A major impact has been in consequence of twentieth century medicine. This was experienced first in the European colonies, but the effect has spread rapidly throughout the world.

Whereas, in the 19th century, the reductions in mortality were achieved mainly by advances in public sanitation, in the 20th century, they have been greatly influenced by medical science. In the latter half of the century, two of the most powerful agencies have been vaccinations and the use of antibiotics. Antibiotics can have a dramatic effect, even in the complete absence of proper sanitation. The lack of proper sanitation allied to the declining efficacy of antibiotics is one of the reasons why we should be fearful of a massive resurgence of mortality.

Transport and the Propagation Disease

Another reason to be fearful of death through infectious diseases is that the modern world is now in a state that greatly facilitates the propagation of disease. As we have seen recently, an emerging strain of avian flu is liable to be spread across the globe almost instantly by means of air travel. However, all forms of transport that carry people from one place to another are liable to be implicated in the spread of disease.

A dramatic instance of the effect of a transport system in propagating disease has occurred in the African rift valley and it concern the spread of AIDS. The rift valley, which contains some of the principal highways of Africa, is the spinal cord of the African economy. Along its roads travel trucks and lorries, and every other sort of motorised vehicle, which carry goods and people up and down its length.

The travellers include large numbers of male migrant workers who are forced to leave their native villages in pursuit of employment. They seek sexual relief wherever they can find it. As for the women who attend to them, once they have overcome any inhibitions they might have, they are able provide a simple and profitable service.

The consequences of these arrangements have been devastating. In some areas that are contiguous to the transport routes of the rift valley, the incidence of the HIV infection amongst the sexually active population exceeds 30 percent.

With such a degree of infection, it will take ages before the disease is overcome; and it may require a radical change in behaviour to achieve this.

There is one device that can effectively prevent the transmission of the HIV virus, and that is the condom. It could be made widely available at very little cost. However, many of the leaders of the Catholic Christian Church, which is very influential in these parts of Africa, have shown an irrational opposition to the use of condoms. It is surely an evil thing to allow one's personal ideology, whether it be a religious or a secular one, to stand in the way of a simple and available means of alleviating human misery.

The HIV virus is highly mutable. Therefore, the close similarity between the human strain of the virus and the simian SIV strain suggests that it has been transferred recently from monkeys to humans. However, it is unlikely that this is the first time that the virus had infected humans. It may have infected them on many occasions in the past.

The HIV virus is fragile and weakly infective; and the only means by which it passes from one person to another is via the transfer of bodily fluids. Therefore, if it were introduced into a small group of people with closely circumscribed sexual relationships, such as an isolated village society in pre-colonial Africa, then, in all probability, the disease would be quickly extinguished. The circumstances that have allowed it to be propagated so widely are entirely modern.

Cultural Norms

The means of defeating human disease in the modern world have had to be invented anew, and they depend upon international cooperation. To prevent a global pandemic of influenza of the sort that occurred in 1919, after the first world war, a world-wide early warning system is required. This necessitates some changes in attitudes and in culture.

The recent threat of a SARS epidemic was greatly exacerbated by the reticence of the Chinese officials, whose first reaction to the emergence of the disease was to conceal the problem from the rest of the world. To defeat the epidemic of AIDS, a worldwide program is required. For this to be effective, the opinions of conservative religious leaders, which would hinder such a programme, must change, or else they must be disregarded.

Our fear is that, throughout the world, the cultural values that govern the norms of sexual behaviour are changing far too slowly to staunch the growth of population or to avert a crisis of disease.