

EDITORS' CHOICE

My Personal Epiphany

I will never forget the first time as a PhD student I did a growth curve on *Leishmania* cells in culture. As I began to plot the data I found that the number of cells increased at around 9h doubling time and then began to slow down and finally level off and actually decrease as the cells died. When I plotted the number on a semilog scale against time, I suddenly realized what was meant by "exponential growth" and why Malthus had concern. This was a true epiphany for me as I ran through simple calculations showing what would happen if the cell growth did not slow down and continued doubling every 9h. The numbers of cells and the space they would occupy blasted my mind when I tried to compare the *Leishmania* cells with larger animals and with humans. In the case of *Leishmania* the natural slow down, whether it be caused by nutrient deprivation or more exotic physiological reasons, is what has saved the world from being covered with *Leishmania*. In the case of humans, it remains to be seen what causes will slow down the exponential growth. The two alternatives are to decrease the rate of increase, i.e. the number of offspring per family until this rate equals the death rate, or to experience a catastrophe such as a major rapid die off from a disease, a nuclear holocaust or a world-wide famine ("famine, distress, havoc and dismay" in the words of Malthus) or a slower die off from the degradation of life produced by the loss of an essential resource required for modern civilization such as oil.

Why do I bring up this ancient epiphany (that I am sure each person at one time experiences) in the pages of this journal? My main reason is that this journal exists within a civilization and culture and even scientists doing research on protists must be cognizant of possible oncoming doom. There is great concern recently about climatic warming and how human activities have contributed to this phenomenon by increasing green-

house gases in the atmosphere. The appearance of a huge hole in the life-preserving ozone layer in the atmosphere over Antarctica is another recent concern since this may allow UV irradiation to affect phytoplankton in the ocean at the base of the world's food chain. Failures of most of the world's fisheries have occurred. Species are being extinguished due to habitat encroachment by humans at a rate greater than during any of the major extinctions seen in the fossil record. The price of oil is rising rapidly and may skyrocket as supplies are depleted in the near future. The supply of clean water is running out in many places.

The common theme underlying all these dramatic events and those yet to come is exponential growth of the human population. Yet no one talks about this, and religions and governments, at least in the United States and apparently elsewhere also, actually almost forbid any rational discussion. Yes climatic warming is occurring and will cause major disasters, but even if we decrease the emissions of CO₂ into the atmosphere, the real underlying problem will not be touched — exponential growth. Sure one can simply ignore this and live from day to day studying our protists and let our children and grandchildren find a solution (or suffer the catastrophe). But I myself feel we should take a lesson from the *Leishmania* cells growing in culture and somehow decrease our growth rate.

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