A Cybernetic View of Biological Growth: The Maia Hypothesis. By Tony Stebbing. xvi + 442 pp. New York, NY: Cambridge University Press. 2011. $110.00 (cloth).

The most ominous threat to the survival of the human species is the nearly exponential growth of human populations. With this in mind, Tony Stebbing sets out to describe and explain growth control process theory as it applies to all biological levels, from cellular to species. With great clarity, and within the framework of cybernetics and systems thinking, the author builds his explanation, step-by-step, beginning with mechanical control mechanisms and drawing the analogy to biological systems. However, in later chapters, as the topic moves to human population growth, the author abandons the very theory that he so painstakingly described.

A Cybernetic View first delineates populations' inclination towards exponential growth, problems inherent in this tendency, and the necessity for a self-regulating mechanism. Early on, simple control systems, such as the centrifugal governor, are described and noted to have eventually served as a metaphor for evolutionary, biological, and economic self-correction. This self-regulation is best exemplified by the negative feedback system of the household thermostat. In this case, a state of "too cold" activates the furnace and a state of "too hot" deactivates it, leading to temperature oscillations that hover around the thermostat setting. This basic feedback mechanism algorithm is put forth as the foundation for all control mechanisms, including control of cellular and population growth. Growth is seen as being activated when below a set goal, and deactivated upon reaching that goal. Additionally, biological mechanisms are noted to have evolved features that overcome temporal delays in feedback and lead to more accurate homeodynamic adjustments.

Negative feedback is shown to be essential in the control of rates of cellular growth, as well as the control of cell size, i.e., rate of individual cell growth. Thus, *A Cybernetic View* applies the negative feedback system to all biological levels, including intracellular processes. Furthermore, homeodynamic control mechanisms are depicted as having evolved to three levels of adaptation. The primary level is the basic negative feedback mechanism with genetically set goals. The secondary adaptive level allows for changes in the goal setting through other homeodynamic processes in response to sustained inhibition. The tertiary level includes behavioral adaptations that allow for adjustments to changes through behavioral conditioning.

A Cybernetic View then turns to the issue of species population growth and its control, and makes clear that it is highly advantageous for a species' survival that its population density remains near, yet below, the optimum carrying capacity of the particular habitat. The carrying capacity is understood as being the number of individuals that a particular habitat can support. In concrete terms, the carrying capacity consists of variables such as space, water, air, predation, and food. It is common knowledge that having hundreds of tourists feeding the ducks at the lake for 5 years causes there to be more ducks, as the carrying capacity is now increased. Precipitously ending this practice puts the duck population in this habitat in overshoot, and their numbers will decrease to below the new carrying capacity level. Yet, in addressing human population dynamics, *A Cybernetic View* shifts from considering these defining variables and moves toward a theoretical, long-term carrying capacity, envisioning it as the maximum population size that can exist indefinitely without exhausting resources.

A Cybernetic View posits the logistic equation as the growth control mechanism. Thus, exponential growth in a habitat is mitigated in response to the number of individuals present mathematically combined with the carrying capacity. The logistic equation incorporates the inclination towards exponential growth by including a maximum rate value (r), coupled with a negative feedback mechanism which includes the carrying capacity, designated by Kappa (K). In diagrammatic form, the logistic equation is shown to have two loops. The inner loop represents positive growth rate control, and the outer loop provides a limit to population density to the goal determined by K. The phenomenon of cancerous cell growth, the antithesis of cellular growth control, is then addressed. It is noted that positive feedback is not usually found in biological systems unless there is some mechanism that imposes limits, as any system devoid of a negative feedback mechanism is self-eliminating. The failure of the outer loop of the growth control mechanism is identified as being responsible for the loss of cancerous cell growth limitation.

As a precondition for accelerating human population growth, *A Cybernetic View* cites the development of the agrarian lifestyle. Also acknowledged is that a main feature of the agrarian lifestyle is the production of food surpluses. It is noted that the agrarian lifestyle ''made larger families possible'' (p 328). However, the fact that the human population invariably increases in response to these food surpluses goes unnoticed. Instead, human population growth is likened to the growth of cancer cells, which do not have the biological mechanisms responsible for negative feedback. The author proposes that the human species has lost the innate ability to control its population, i.e., has lost the negative feedback population control mechanism. Similarly, the notion of the tertiary level of adaptation mentioned above is disregarded. This level includes behavioral conditioning which, for humans, includes the phenomenon of cultural conditioning (Hopfenberg, 2009). One mainstay of the civilized-agrarian culture is the notion that we must continue to increase food production to feed the growing population. This third, outer/cultural loop then feeds back into the dual loop of the logistic equation and thwarts the effectiveness of the goal setting of K, having it ever increase, analogous to continually raising the temperature setting on the thermostat. With a third, outer/cultural loop in mind, all that the author has previously explained regarding negative feedback and growth control mechanisms now apply. The human species has not lost its innate ability to regulate its population as the author proposes; the self-regulating mechanism has been overridden.

The final chapter highlights anagenesis, the notion that the more complex the organism, the more it has evolved ''independence of the environment'' (p 409). Evolution, being a process that involves only selection by the environment, makes this notion a confusing one at best. On the one hand, it could be understood as organisms having evolved traits that are more flexible in response to environmental conditions. On the other hand, as with *A Cybernetic View's* description of human population growth, it could be seen that humans, arguably the most complex species, are ''the exception to the rule'' of environmental influence. If the latter is the case, it would make sense that issues such as the pollution of the environment, resource over-consumption, and species extinction are not so alarming that people make essential changes to ensure their survival, because, on some fundamental level, they believe that these issues won't affect them in any real way as humans are somehow ''independent of the environment.''

In *A Cybernetic View*, the author has included all of the elements that would lead to a full understanding of biological growth on every level. It seems that the cultural perspective mentioned above, however, took hold and interfered with the author applying his cogent thesis to the issue of human population growth.

LITERATURE CITED

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