Journal of Bioeconomics 3: 1–26, 2001

Saltatory Ontogeny and the Life-History Model: Neglected Processes and Patterns of Evolution*

EUGENE K. BALON
Department of Zoology, University of Guelph, Guelph, Ontario N1G 2W1, Canada (ebalon@uoguelph.ca)

Synopsis: A single cell – an egg – cannot be in the same stabilized state as a differentiated multicellular embryo or reproducing adult. The entire ontogeny must, therefore, consist of a sequence of stabilized states. Ontogeny of a phenotype cannot progress gradually but is a saltatory homeorhetic system, proceeding via natural thresholds from one self organized state to the next, hierarchically ever more complex and specialized. The natural boundaries of ontogeny – the far-from-stabilized thresholds – represent also states when changes can be easiest inserted or induced, and especially in the early ontogeny, from the intervals where evolution (change) can occur. As a result, ontogeny can also be divided into distinct life-history intervals called periods, be it embryo, larva (infant, pup), juvenile, adult and senescence, each divided in turn into phases, and each of these into natural steps. It is left to the imagination of scholars in social sciences to find parallels of saltation in economics and history.

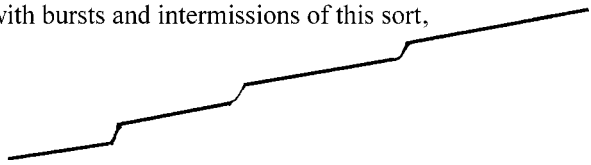
Key words: discontinuity, development, selforganization, stability, thresholds, natural boundaries

Are discontinuity universal and *natura non facit saltum*[1] a myth?

> No one thing ever merges gradually into anything else; the steps are discontinuous, but often so very minute as to seem truly continuous. If the investigation is carried deep enough, the factor in question, instead of being graphable as a continuous process, will be seen to function by discrete quanta with gaps or synapses between . . .
>
> John Steinbeck (1960)
> in 'The Log from the Sea of Cortez'

Science fiction writers, like poets, often unwittingly associate correct elements into a new 'theorem' other did not dare to advance. We have already thanked elsewhere H.G. Wells posthumously (Cunningham & Balon 1985, p. 115) for his contribution to the theory of saltatory ontogeny[2]; here it is once more:

*Invited editorial

> Redwood, you know, had been measuring growing things of all sorts, kittens, puppies, sunflowers, mushrooms, bean plants, and (until his wife put a stop to it) his baby, and he showed that growth went on, not a regular pace, or, as he put it, so:
>
> 
>
> but with bursts and intermissions of this sort,
>
> 
>
> and that apparently nothing grew regularly and steadily, and as far as he could make out nothing could grow regularly and steadily; it was as if every living thing had first to accumulate force to grow, grew with vigour only for a time and then had to wait for a space before it could go on growing again.
>
> Herbert George Wells (1904)
> in 'The Food of the Gods'

Most scientists view changes in structures and functions during ontogeny as gradual processes. In their mind development proceeds via continuous, inconspicuous accumulations of small changes, in spite of numerous proofs to the contrary by novelists and scientists alike (e.g., Wells 1904, Brody 1945, Steinbeck 1960, Hedgpeth 1978, Lampl et al. 1992, Wray 1995). Big changes in form and function are admitted only rarely when a dramatic transformation called metamorphosis occurs. During this interval the animal which initially looked very different from its parents, changes rapidly into a parent-like juvenile. Some of these so called larval forms, which typically require metamorphosis to change into definitive phenotypes were first described as separate organisms (Balon 1990). To elaborate further on the Figure 1, '. . . butterfly begins its life cycle by emerging from an egg as a caterpillar, enters a pupal or chrysalis stage, and re-emerges as the familiar winged insect. While inside its pupa' [writes Milton 1997, p. 220 further] '. . . The body of the caterpillar dissociates completely into an amorphous cellular liquid referred to as a "soup." The soup then reorganizes itself into the structure of a butterfly.' (. . .) this process is not understood . . . It is completely beyond us.'

Populations of phenotypes which form a recognizable unit (e.g., species, subspecies, morph, race, variety), however, occur only as various intervals in ontogeny (stages in the lives of these phenotypes) at any given time. A single cell – an egg – cannot be in the