

(2003) 2<sup>nd</sup> International Meeting on Yeast Apoptosis, Smolenice, 17<sup>th</sup>-20<sup>th</sup> September 2003.  
Meeting book, p. 42-43

## **Eros and Thanatos naturalized: Thermodynamics of evolutionary and developmental ratchets**

**Ladislav Kováč**, Department of Biochemistry and Center for cognitive biology, Comenius University, Mlynská dolina, 842 15 Bratislava, Slovakia

Existence, maintenance of onticity, can be defined as dynamic persistence of entities of the world in states out of thermodynamic equilibrium with their environment. The world exhibits the tendency toward moving the entities from their transitory dwelling states out of equilibrium into the state of equilibrium. The state of thermodynamic equilibrium, removal of potential gradients, loss of correlations, symmetry of all available degrees of freedom, is the ultimate attractor of any dynamics. On the other hand, “dissymmetry creates the phenomenon” (Pierre Curie). A specific kind of entities that persist for a relatively long time are living systems: Darwinian evolution has equipped them with activities, which preserve, and in the course of biological evolution increase, the distance of the systems from thermodynamic equilibrium. These activities are not spontaneous, they depend on the input of free energy: any living system is permanently doing ontic work. One type of ontic work are processes of repair: spontaneous loss of correlations relevant for survival is being permanently repaired by energy-dependent policing and restitution. A perfect, time-invariant onticity, permanently keeping all relevant correlations, would demand an infinitely large input of free energy. As this is impossible, all living systems are aging, wearing out, and eventually wind up, disappear. This inevitably holds at all levels of maintaining onticity (and thus, at all levels of selection), for genes, cells, individuals, species, ecosystems – and, by extrapolation, for life as a whole. Persistence, onticity, of an individual organism is relatively short when compared with the onticity of its genes or with the onticity of the species it belongs to: in spite of the busy repair activities the rate of loss of correlations in the course of individual life is high. In contradistinction to the relatively rapid developmental aging and passing away, the long-lasting onticity of genes and species is ensured by sorting processes, which function as ratchets. One type of sorting is the asymmetric distribution of components at cell division: the mother cell serves as a dump, while the daughter cells receive less disabled components. Another type of sorting is provided by sex: the germ line, idle, exempt from “mundane” activities, secures continuity of the species upon throwing out the worn-out somatic line. In addition, sexual recombinations ward off cumulation of harmful mutations (Muller’s ratchet) by stowing the inappropriate genes away into individuals which end as deadlocks and ensuring permanence of the genome through the properly sorted individuals. Sorting is a problem of recognition, hence of epistemic work, which complements the ontic work. All these mechanisms of sorting have been poorly elucidated so far and should be placed into a focus of contemporary research. A traditional pet of biologists, yeast, a simple multicellular organism with blurred borders between independent cell, individual organism and species, may serve as a suitable model for the studies of sorting.