Animal behavior as a complex adaptive system

Ichiro Shimada and Masayuki Koganezawa
Department of Developmental Biology and Neurosciences, Graduate School of Life Sciences, Tohoku University, Sendai 980-8578, Japan

The fruit fly, *Drosophila melanogaster*, displays a scale-free behavior in foraging, i.e., the dwell time on food exhibits a power law distribution. The significance of the scaling exponent itself with respect to the scale-free behavior remains elusive. We propose a model whereby the scaling exponent of the scale-free behavior of an animal depends on the memory of the individual. The proposed model is based on the premise that animal behaviors are associated with internal states, i.e., the states of neural networks in the brain. The changes in the scaling exponent are derived by considering *losing memory* as *increasing uncertainty of information,* which is expressed in terms of information entropy of the internal states. Predicted model behaviors agree with experimental results of foraging behavior in wild-type and learning/memory *Drosophila* mutants. The concept of changes in the scaling exponent due to the amount of memory provides a novel insight into the emergence of an adaptive behavior to the changing environments**.** In new environment, animal has small exponent due to no memory. Resulting variability of the behavior makes the animal responsible to the new environment. Accustomed to the environment, the animal exhibits efficient scale-free behavior with large exponent due to the accumulated memory.