IV-25 Evolution by Trials

.. dinosaur bones were just buried in the ground by God to test our faith.

-A biology teacher in a Christian school in USA

Ingenuity of survival by evolution comes from more than three billion years of trial and error. Evolutionary success is about learning by trial and error, and less about inventing a solution - let alone an explanation. Even those who arrived new to the scene found a repertoire of genes on which they could base new strategies. The evolutionary survival game is about living within the physical limits by following the chemical rules and metabolic constraints. It happens without any grand plan or knowledge of the analytical or molecular basis that goes into solving problems.

Success follows from feedback - that is changing behaviors early enough from modest failures or successes. As we learn from the evolutionary successes, one thing is clear: No single strategy works to the advantage of all. Yet we can read certain generalizations into the patterns of behaviors. After all at a very basic level the survival need of organisms are not too different. As the bearers of such traits become the evolutionary successes, their genes allow for the feedback with suitable behaviors when needed. Abilities to camouflage ward off the intruders and attract mates under a variety of conditions give understandable evolutionary advantages to the bearers of such traits.

Genes of the successful ones are to be found in the surviving mutations that also control the epigenic development through nurture. Those who could not deal with such issues are

lost into the oblivion of the evolutionary failures. Beyond this not only the individuals but also the species disappear by forces beyond their own control. What is the tolerance: How wide is the range of conditions that could have led to us? Or would carry us forward?

Ant garden. Workings of gardens tended by leaf-cutter ants for fungi-culture provide insight into sustainable agriculture practices. Ant fungi-culture is labor-intensive organized group effort on renewable materials carried to dark spaces underground or under the bark of dead trees. They cultivate and transplant multiple species of selected fungi. They practice crop rotation without use of external fertilizers. The practices do not compete with trees that provide fresh leaves for fungi-culture. Not only the colonies share germ-plast with others, but also beg, borrow and steal crops of other colonies in the case of crop failures. In addition, the ants have developed successful strategies to ward off *Escovopsis* mould by strategically applying *Streptomyces* bacteria that secrete antibiotic. Occasional mould infected parts of the crop are chopped off and hauled out of the colony.

The long term success of fungi-culture comes from the fact that the symbiotic practice is beneficial to ants, plants and fungi. Contrast this to agriculture by present day humans. Fungi-culture by certain species of ants are about 50 million year old, compared to the beginnings of human agriculture less than 10,000 years ago. More than 90% of the cultivated land and virtually 100% of the polluting agrochemicals ever used have come into use during the 100 years. In the process humans have destroyed thousands of potentially useful strains and species of organisms.

The Hundreth Monkey. A book of this title developed an anecdote to a parable. A monkey on a Japanese Island learnt to wash its sweet potatoes. Initially practice spread to other

monkeys on the same island, and then to the monkey populations in the neighboring islands. Did all the monkeys discover the practice around the same time, or the practice diffused mysteriously, or was it just a transformation by learning the advantages of washing potatoes, or something else? The factual basis for the practice seems to stem from a study on monkey behavior. Apparently, one monkey found out (by chance? Or by watching a scientist do it) the advantage of washing potatoes left out on the ground. Others apparently repeated the practice. As the children mimicked (learnt from) mothers, the innovation spread with the diffusion of populations.

Apparently this story is not true, but it has all the elements about what we would like to believe. Some decisions fall in place easily and some solutions follow naturally by trial and error. Humans learn through mimicry, initially from parents and then from peers. Such enterprises related to survival seem to come easily and naturally because during the development we learn to deal with such issues.

Choices built on feedback. The view from the world of inherited genes is cold and calculating. Biodiversity emerged from a universal genetic code and possibly diverged from a single starting point. We have come to accept certain results. All the genetic information about human organism is in 30,000 or so genes that form <10% of the human geneome. We share more than 97% of these with monkeys who can hardly talk, and about 50% are in common with a banana that cannot walk. Insects and birds are somewhere in between.

Biological survival is not just the survival of the individual. It is about perpetuating the species. Mutations make it possible by providing selective advantage through trial and error. Evolution from simpler to more complex occurs without major

redesign. Such evolutionary changes are necessary to increase the fidelity, control, and coordination of the functions distributed over the different parts and the environment of a more complex organism. Rather simpler changes in the instructions for control and regulation can lead to significant improvement. These are implemented with rather minor additions or changes in the existing instructions set.

Evolutionary change is not gradual but proceeds by fits and starts. As the evolutionary experience tends towards overall zero-error rate, natural decisions are made by trials, and some correct non-lethal errors. Such considerations are built not only into morphology, plurality, redundancy and niches, and possibly in the choices and preferences that guide organisms towards ensuring success of their genes. Other ideas about fitness, commonly interpreted as beauty and health are cultural artifacts.

Evolutionary success has come without guidance from the knowledge of the processes that go into it. Making babies comes easily and reproductive methods have evolved to explore alternatives within the boundaries of the species. With a desire for a different, and possibly better, genetic starting point most animals search for mate beyond the family or tribal boundaries. Without any analysis or proof most human and animal societies have learnt to avoid in-breeding. It is the sure way to repeat the same mistakes. One thing that can be said about cloning in the post-genomic world: Incestuous choices are inherent in the designer genes.

From the glimpses into the intellectual endeavors and achievements of the last several millennia a broad range of knowledge-related activities touch on issues of the *I am that exists in relation to the rest*. The range of human behaviors is determined by epigenic variables. From the evolutionary and historical

continuity follows the philosophical premise that the knowledge of the inquiring self lies in the genetic reality of the physical self in the broader epigenic context. Criteria for the viable methods and searches lie in the sustainability of the results and products ranging from the languages to technologies. Although not necessarily genetic in their origin, such epigenic traces of human activities have orthogonal influences on human behaviors.

Epigenic world is also about learning from the choices and feedback. We still work with the set of the same stone-age genes that the humans had about 10,000 years ago. There is advantage to behaviors that change much faster than the genes. Often we shape our worlds through choices made haphazardly. Their outcome is learnt empirically through trial and error. The cost of such practices is lost in the evolutionary oblivion.

Considering the interdependence of the life-forms, the very biological instinct of survival can not prevail without survival of most if not all. The on-going revolution in biology is now an integral part of human tinkering. Its influence on our collective behavior and practices is a necessary part of social discourse. Individuals, as well as the society at large, will continue to examine and elaborate the implications to reconcile the changes until they are ingrained in the collective conscience as the epigenic behavioral trace. By emphasizing a need for consilience of a broad range of human activities, one hopes that we learn to live with new knowledge and antecedent technologies.

Room for Doubt