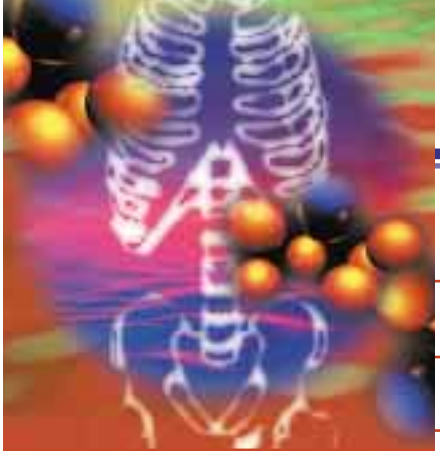


Shimadzu Developments in Biotechnology

Biohistory: Looking for a New View of the World

Keiko Nakamura, Deputy Director-General of the JT Biohistory Research Hall and Professor at the Osaka University Graduate School.

Excerpt from her speech at Shimadzu's 125th anniversary celebration, November 27, 2000

In the year 2000, the Shimadzu Corporation celebrated its 125th anniversary, and Professor Nakamura was invited to the celebrations to give a speech on her pioneering biohistory research work into the genome. A translated abstract of her speech is presented below.

Humans: The Link Between the Natural and the Artificial

The importance of science and technology is ever increasing at the dawn of the 21st century.

Though Western culture in particular has attempted to put itself above nature and create a comfortable lifestyle by inserting the artificial between humans and the natural world, the truth is that humans themselves form a part of the natural world. We are fundamentally no different from any of the other 50 million types of organism that live and procreate as individuals and species. In reality, rather than putting the artificial between ourselves and nature, we humans instead serve as the bridge between the natural and the artificial. This is why it is so vital that we make skillful use of science and technology.

Although contemporary science is strongly based on universality, I believe that in the 21st century we will also need to pay attention to diversity.

Among the different branches of research into living things, natural history has come to emphasize diversity, while physiology and anatomy have come to emphasize universality. I call the former "navigation with the macroscopic view" and the latter "navigation with the microscopic view" and this microscopic navigation has come to focus on cells. All living things, from E. coli to humans, are made of cells, and thus the conclusion was reached in the 19th century that the cell represented the pinnacle of universality. However, it was then discovered in the 20th century that every cell contains DNA, the entirety of which is called the "genome" and forms the basis of all living things. And so we discovered that the pinnacle of universality is, in fact, not only the cell, but also the genome that supports it.

Genome Links the Universality and Diversity of Living Things

From the viewpoint of the DNA contained in all organisms, the genome is universal; while from the viewpoint of the characteristic genome of individual organisms, the genome is diverse. As genes with the same functions are identical, when DNA is regarded as genes - be it in E. coli or in a human being - only its universality is visible. However, from the point of view of the genome, an E. coli genome is an E. coli genome and a human genome is a human genome, and differences within the human genome create the infinite variety among people, making us all individuals. In this way, we can see that the genome

exists as the link between the universality and diversity of organisms. The hierarchy of molecules, cells, organs, organisms, species, and ecosystems is apparent when observing organisms, but it is the genome that determines the state of the individual cells, organs, organisms, species, and ecosystems. This means that all levels of life, from the molecular level to the ecosystem, can be considered from the common viewpoint of the genome. As a result, formerly unrelated academic disciplines such as molecular biology and ecology, for example, now have a solid relationship based on the genome.

Studies of the genomes of various organisms indicate an approximate proportionality between the complexity of an organism and the size of its genome. This is thought to reflect the process of evolution of the organism, and shows that the genome was altered through evolution. How the various organisms currently on the Earth came into being and the mutual relationships between them can now be clarified by studying the genomes of living organisms.

History of Continental Drift Written on the Genome

Let me give an actual example. At our Research Hall, we studied ground beetles to investigate their relationship with history. We studied the DNA of various types of ground beetle from around the world and then grouped the beetles according to DNA differences. Based on the results, the ground beetles living in Japan were classified into four groups. Plotting the habitat of each group on a map showed that the four groups classified according to DNA are also spatially distributed in four distinct regions.

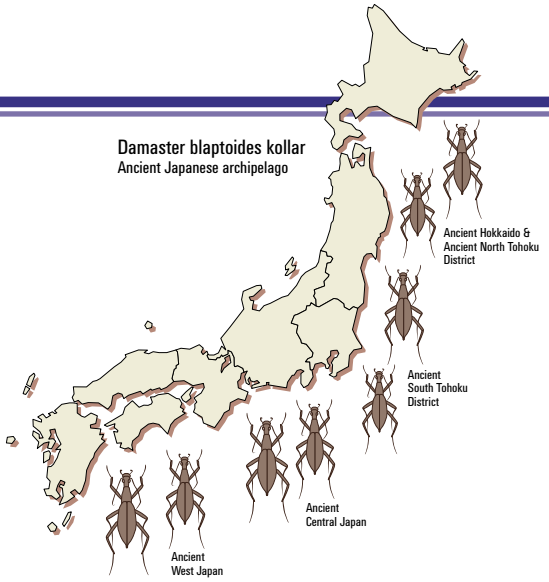
But what formed the boundaries between them? We found that the regions corresponded to the boundaries of four geographic regions existing approximately 7.5 million years ago, which resulted from the drifting of the Japanese islands away from the Asian continent and further joining and separation of the land within the Japanese archipelago itself over the aeons. Consequently, we are able to read the geological history of the Japanese archipelago from the genomes of ground beetles. Similar studies of ground beetles from around the world allowed us to read the history of the evolution of ground beetles and the history of continental drift. Indeed, this is the first example showing that we can learn about natural movements by looking at genomes.

Importance of Thinking in Multiple Time Units

Whereas the life scientist thinks in units of genes, the biohistorian thinks in units of genomes. In the natural world, genes exist not alone but rather in the form of genomes. And whereas the life scientist pursues only the structure and functions of an organism, the biohistorian attempts to reflect history as well as other concepts related to the organism.

People tend to think of things in terms of time units such as one day (today) or one year (this year). Our normal temporal sensation extends to about ten years, at the most. But the genomes of organisms living on this planet today are inscribed with the history of several billion years. From this we know that we are capable of observing things in longer time intervals or multiple time intervals, and that it is probably important for us to do so.

Genome research promises success against problems in starvation, disease, the environment, and other areas. Advancements in the field of medicine are particularly promising, with great potential to develop prevention and new treatments for diseases such as cancer and diabetes. During the research process, however, it is important that we think in periods of billions of years, pursue the true essence of nature, and never forget that we humans, too, are part of the natural world.



Habitat Distribution of ground beetles related to the drifting of the Japanese islands
The ground beetles living in Japan were classified into four groups based on DNA differences.

Profile

Dr. Nakamura is Deputy Director-General of the JT Biohistory Research Hall and Professor at the Osaka University Graduate School. She graduated in chemistry from the Faculty of Science at the University of Tokyo, and was formerly the head of the Department of Natural and Social Environmental Science at the Mitsubishi Kasei Institute of Life Sciences, and Professor at Waseda University's School of Human Science.