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Report on my visit to the Yukawa Institute for Theoretical Physics in 2018

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Abstract. This report summarizes my activities during a 2 month stay at the Yukawa Institute for Theoretical Physics. Beside discussions about the role of evolutionary biology in the complexity of upside-downside learning, lectures about 'Perception of the Biological World', 'Mysteries of Evolution' and 'While interested in many things, never reaching perfectness' were given.

Keywords: Evolution, Species, Typostrophen-Theorie, Mutation rates in populations

Personal Note

I thank Prof. M. Murase for his warm hospitality during my stay and Prof. T. Ohno, the director of Mie Prefectural Museum, who recommended me to work within the group of the International Research Unit of Advanced Future Studies, Kyoto University.

1. Lectures

1.1. Perception of the Biological World

This lecture was performed on October 23, 2018 in the session 'Kyoto University International Forum on Advanced Future Studies' working as a parallel session to the 'International Conference on Applied Physics and Mathematics 2018' held in Narita.

Abstract: Besides naming of the basic units of organism groups by the two nouns *genus* and *species*, Linné has established the hierarchical system of classes. This hierarchy is inclusive, because one class includes classes of higher connectivity. Therefore, the grade of connectivity is a measure for constructing a hierarchical system. While in the biological hierarchical system the species is regarded as the only 'natural category', all higher categories, also the genus category, are regarded as artificial, thus not comparable between different higher categories. By the lack of testability, the genus is regarded as a construct of the human mind which cannot be verified. Therefore, characterizing 'natural' against 'artificial' categories are necessary.

Homogeneity in characters is the scale for connectivity, thus decreasing homogeneity in class building rate leads to fusion of classes. Continuous class building rates make distinct levels (= categories) within the class building system artificial. Only discontinuous class building rates mark these discontinuities as natural categories (Fig. 1). The main criterion for finding natural classes is consistency of the classification criterion, meaning that the classification criterion must not change during the complete classification process.

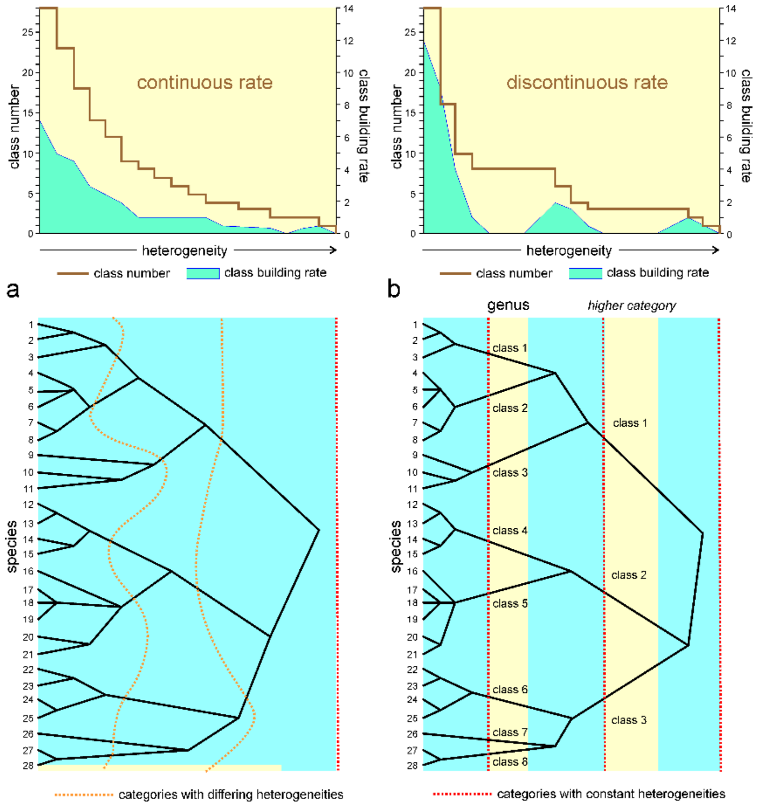

Figure 1. Differences between natural and artificial categories based on cladograms with the same topologies.

In phylograms and cladograms, where the connection points (levels) mark phylogenetic relationships, discontinuities are difficult to determine. This is the reason for failing the Linnean hierarchical system in phylogenetic systematics based on morphology or molecular genetics. Phylogenetic trees are also excluded from hierarchical classification based on heterogeneities, because they represent excluding hierarchies where fusion points are objects (species), not heterogeneity levels.

All biological classification systems are based on the biological species. As the basic classification object, species must represent homogeneous groups based on consistent classification criteria. Therefore, they must follow a general concept including all organisms. Since Darwin’s work on the origin of species, intensive efforts have been mounted to find a criterion for biological species. This has led to numerous species concepts, but none have met the requirement of universal application. Additionally, many concepts are based on criteria that can be used only for recognizing species (operational criteria), not defining the ‘being’ or make-up of the species (explanatory criteria). In an explanatory definition represented here, species are groups of organisms sharing a pool of genotypes with the potential to transfer genomes to the succeeding generation, perpetuating transferability. Splitting up/off the pool of genotypes without further transfer potential between pools gives rise to new species. Operative methods try to approximate the explanatory species, but fails in delimiting closely related species from subspecies. Methods for species recognition and delimitation are based on morphological or molecular genetic characters or both together. Species described as pools of contemporarily interconnected genotypes possessing their own history lead to evolutionary lines.

The genus category grouping similar species into classes cannot be based on phylogenetic classifications neither using (apomorphic) morphological nor molecular genetic characters. They can only be based on phenetic criteria using morphological characters indicative for the species group. Therefore, three theorems are proposed for defining the genus:

- The genus is a group of species in a nested hierarchical system of an organism group.
- The organism group must be based on a constant number of characters (morphological, physological, molecular genetic etc.) containing the maximum number of species detected.
- Genera are defined by the first significant discontinuity in the class building rate at the lowest heterogeneity level.

Higher natural categories in the specific classification group (e.g., agglutinating foraminifera with tubular tests) described by a constant set of characters must not be labelled (families, orders etc.), because comparison with other classifications are impossible since they are based on quite different classification criteria (e.g., families in Foraminifera versus families in Mammalia). Since the genus is solely based on morphological criteria, it can also be used for fossil forms.

1.2. Mysteries of Evolution

In this lecture for Junior High School Students held on October 27, 2018 at the Main Hall in the Clock Tower at Kyoto University the being of humans is explained by evolution using examples of

- 2 arms and 2 legs originating from early bone fishes entering the land using 4 pectorial fins
- The turning between radius and ulna for faster movement
- Evolution of a complex heart directing blood circulation
- Evolution of the vertebrate column from ancestors with a metameric body
- Evolution of the upright walking
- Evolution of the different specialized teeth in mammal jaws

1.3. While interested in many things, never reaching perfectness

In this lecture held on November 17, 2018 named ‘Open up our future through incubating learning power’ at the Mie Prefectural Museum I presented my curriculum and special interests demonstrating permanent learning. Starting in 1947 the studies at elementary schools, high schools and the following study system at the Austrian Universities were explained.

Abstract: Starting after senior high school, I elected from different university studies in which I was interested either to become a High School Teacher for Geography, Biology and Earth Sciences, or becoming a musician playing French horn. Two years later the concentration on Science resulted, again after additional 2 years, in a position as an assistant professor in Palaeontology, where by chance this position was newly founded. The Doctor of Philosophy was gained after finishing a thesis by strong examinations on Philosophy, Formal Logics, Zoology and 2 examinations on Palaeontology. Becoming an associated professor, my scientific work on micropaleontology resulted in many papers, up to now more than 150 in high quality journals. In these papers, I always tried to find new solutions to the given problem, mainly using formal logics, philosophy of science and mathematics. Beside these special studies, the problem of species and genera in biology, time estimation with periodic functions represented by orbital cycles, spatial statistics and ecology became interesting.

I like teaching, and many basic courses for bachelors in Earth Science were given by me. Beside scientific work, I rediscovered my musical interest and studied by myself to play the different types of lutes like Renaissance Lute, Archlute, Theorbo and the Barock Lute. Never reaching perfection, I always tried to find new ways of thinking in Earth Sciences and was responsible for the change of traditional lectures into new ones better answering the new questions arisen in Science. Since my retirement in

2012, I continued scientific work with 5 PhD students and published 35 papers. This made a permanent learning necessary.

2. Research Activities

My research activities during the stay in Kyoto encompassed discussions about rules in biological evolution and to find generality for all evolutionary processes. Today evolutionary biologists concentrate in evolution studies on molecular genetics, but documents for evolutionary processes can only be found in the fossil record, especially using microfossils possessing high evolutionary rates. Using these complex organisms with their long geological history, the different courses in evolution can be tested, e.g. differences between random walking and selection. This is important to explain modes in evolution. A model is developed based on the fact that species can be regarded as individuals, reacting to the organic and inorganic environment, but also influencing especially the organic environment. The birth of a species (speciation) is always effected by a more or less (geologically) abrupt change of the environment. When the environment keeps constant, then the species is exposed to selection. Similar to the lifetime of an organism, the mutation rates increase during lifetime of a species giving opportunity to gradual changes in morphology despite constant environmental conditions. Due to this variation, the threshold to other environments can abruptly being opened for a new (daughter) species (punctuated equilibrium model) or the complete species can exceed the threshold. A complex model will be developed for the different types of evolution, finally explaining the 'Typostrophen-Theorie' of Schindewolf (1950), based on Ammonites, which is divided into Typogenese, Typostase and Typolyse. While the first two stages could be explained by population genetics (Gould, 1993), the Typolyse can now be explained by the increasing mutation rates in the lifetime of a species. This idea and the dependence of species to oscillating environmental factors, but also their response to these factors will initiate further research.

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