

**Evolutionary Morphology Laboratory**  
**Chief Scientist: Shigeru Kuratani (Ph.D.)**



**(0) Research field**

**CPR Subcommittee:** Biology

**Keywords:** Evolution, Development, Vertebrates, Body plan, Embryos

**(1) Long-term goal of laboratory and research background**

Evolution can be viewed as series of changes introduced to developmental programs of organisms. The ultimate goal of our research project is to reconstruct the mechanical background of development behind evolutionary novelties in vertebrates, such as jaws and turtle crapace, by comparing developmental processes and patterns between different animal species to identify the changed portion of development, by constructing phenocopies to modify a part of developmental programs of model animals, and by integrating the experimental data with fossil data, phylogenetic trees based on molecular data, and variety of genomes in animals.

**(2) Current research activities (FY2019) and plan (until Mar. 2025)**

During FY2019 we continued the hagfish genome project, a major study that is requiring the participation of several laboratories around the world, including the Chinese Academy of Science, the University of Tokyo, Bristol University in the UK and the Center for Genomic Regulation in Barcelona, Spain, among others.

This project will provide the first reference genome assembly of the hagfish, one of the only two surviving groups of jawless vertebrates, and therefore crucial to understand the last common ancestor of vertebrates, or in other words, to understand our very first origins. For instance, as a result of our in-depth analyses, we have been able to provide answers to important, long-standing questions about the whole genome duplications that occurred during vertebrate evolution.

The generation of the first hagfish genome is but the first step of a new era in jawless vertebrate research. We are already planning on experiments that will make use of the new assembly for functional genomics analysis, such as ATAC-seq and ChIP-seq, or even single cell OMICS, assays which were unthinkable just a few years ago. For the success of such experiments it will be crucial to keep improving the hagfish genome assembly with new technologies. We will use third generation sequencing platforms, such as PacBio, together with better ways to scaffold the genomes in order to generate a genome assembly up to the level of chromosomes. The above-mentioned assays will enable the observation of the genome architecture and the regulatory landscape of the hagfish genome over developmental time as well as in adults, which will permit to perform comparative genomics analysis at an unprecedented level to decipher the genome of our last common ancestor.



Figure: Cyclostomes (top: lamprey; bottom: hagfish)

### **(3) Members**

as of March, 2020

#### **(Chief Scientist)**

Shigeru Kuratani

#### **(Research Scientist)**

Juan Pascual Anaya

### **(4) Representative research achievements**

1. Inner ear development in cyclostome and the evolution of vertebrate semicircular canals. Higuchi, S., Sugahara, F., Oisi, Y., Pascual Anaya, J., Takagi, W., and Kuratani, S. *Nature* 565 (2019) 347-350
2. History and Current Theories of the Vertebrate Head Segmentation. Kuratani, S. In: Nuno de la Rosa L., Müller G. (eds.) *Evolutionary Developmental Biology: A Reference Guide*. Springer, Cham., Springer. 2019.
3. Evolution and Development of the Vertebrate Cranium. Kuratani, S. In: Nuno de la Rosa L., Müller G. (eds.) *Evolutionary Developmental Biology: A Reference Guide*. Springer, Cham., Springer. 2019.

### **Laboratory Homepage**

[https://www.riken.jp/en/research/labs/chief/evol\\_morphol/index.html](https://www.riken.jp/en/research/labs/chief/evol_morphol/index.html)

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