

**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 carapace, 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 (FY2020) 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. This project is now almost completed.

On the other hand, we conducted a joint research with the University of Tokyo to understand the origin of the thyroid gland and the evolutionary significance of an organ, called endostyle. The endostyle is an exocrine gland that secretes mucus to catch organic particles in water when our ancestors were filter feeders before they acquired their jaws. In lamprey larvae, ammosites, it was known that an endostyle was first formed at the floor of the pharynx, which differentiated into the thyroid gland during metamorphosis, thus the differentiation process was thought to reflect the process of evolution from the endostyle to the thyroid gland. However, by observing the hagfish in detail, it was found that the inner column apparently disappeared once in the dawn of vertebrate evolution. Behind this is a paleontological discovery by another research group that the primitive lampreys of the Paleozoic era did not appear to have a larval stage. In the future, we plan to enter the stage of more detailed verification through comprehensive cell-level search using single cell RNA-seq and gene manipulation experiments using the CRISPR / cas9 system.



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

### (3) Members

as of March, 2021

Juan Pascual Anaya: Permanent Research Employee (Research Scientist)

### (4) Representative research achievements

1. Novel developmental bases for the evolution of hypobranchial muscles in vertebrates. Kusakabe, R., Higuchi, S., Tanaka, M., Kadota, M., Nishimura, O., and Kuratani, S. *BMC Biol.* 18 (2020) 120.
2. Development and evolution of the neck muscles. Kusakabe, R., and Kuratani, S. In: Nuno de la Rosa L., Müller G. (eds.) *Evolutionary Developmental Biology: A Reference Guide*. Springer (2020) Cham. [https://doi.org/10.1007/978-3-319-33038-9\\_191-1](https://doi.org/10.1007/978-3-319-33038-9_191-1).
3. Evolution of Skeletal Tissues. Hirasawa, T., and Kuratani, S. In: Nuno de la Rosa L., Müller G. (eds.) *Evolutionary Developmental Biology: A Reference Guide*. Springer, Cham (2020); [https://doi.org/10.1007/978-3-319-33038-9\\_190-1](https://doi.org/10.1007/978-3-319-33038-9_190-1).
4. Neural crest and craniofacial evolution of vertebrates. Kuratani, S. In: D.M. Medeiros & B. Eames eds. *Evolving Neural Crest Cells (Evolutionary Cell Biology)*. Taylor and Francis, (2020) 219-241.

Supplementary

N/A

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)

<http://emo.riken.jp/>