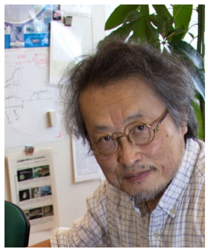

Evolutionary Morphology Laboratory
Chief Scientist: Shigeru Kuratani (Ph.D.)

(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 (FY2021) 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. In 2021, this project was still continuing. In addition, a joint research project with the University of Tokyo to understand the origins of the thyroid gland and the evolutionary significance of the endostyle has been completed and submitted for publication. The endostyle is an exocrine gland that secreted mucus to capture organic particles in water when our distant ancestors were filter feeders before they acquired jaws. In juvenile lampreys, or ammocoete larvae, the endostyle first forms at the base of the pharynx, and during metamorphosis it was known to differentiate into the thyroid gland, which was thought to reflect the evolutionary process from the endostyle to the thyroid. However, close examination of the lamprey eel has revealed that the inner column apparently disappeared completely at the dawn of vertebrate evolution. This is supported by the palaeontological discovery by another research group that the primitive lamprey of the Palaeozoic did not seem to have had a larval stage. As another cyclostome project, a morphological analysis of the Devonian fossil organism Paleospondylus, long known as a mysterious fossil, has been carried out in collaboration with Spring8 and the University of Tokyo, and a tentative conclusion has been reached. In the previous study, we thought that this fossil organism represented a member of cyclostomes, but synchrotron observations allowed the identification of three semicircular canals in the inner ear, making it clear that the previous paper was an error, and rather almost certain that the fossil was a stem group of tetrapods close to our direct ancestors.

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

(3) Members as of March, 2022

N/A

(4) Representative research achievements

1. Forebrain architecture and development in cyclostomes, with reference to the early morphology and transition of the vertebrate head. In: Special issue; “Comparative Neuromorphologic Studies: in homage to Luis Puelles and Agustín González”. Sugahara, F., Murakami, Y., Pascual-Anaya, J., and Kuratani, S. Brain, Behavior and Evolution (2021) 1-13.
2. Mammalian face as an evolutionary novelty. Higashiyama, H., Koyabu, D., Werneburg, I., Hirasawa, T., Kuratani, S., & Kurihara, H. Proc. Nat. Acad. Sci. U.S.A. 118 (2021): 44 e2111876118.
3. Polymorphism in the symmetries of gastric pouch arrangements in the sea anemone Diadumene lineata. Sarper, S. E., Hirai, T., Matsuyama, T., Kuratani, S., & Fujimoto, K. Zool. Lett. (2021) 7: 12.
4. Genetic mechanism for the cyclostome cerebellar neurons reveals early evolution of the vertebrate cerebellum. In: Special issue; “New approaches in chordate and vertebrate evolution and development”. Sugahara, F., Pascual-Anaya, J., Kuraku, S., Kuratani, S., & Murakami, Y. Frontiers in Cell and Dev. Biol. (2021) 9: 1-10.
5. Selection on phalanx development in the evolution of the bird wing. De Bakker, M. A. G. de, van der Vos, W., de Jager, K., Yu Chung, W., Willemse, J., Dondorp, E., Spiekman, S. N. F., Yih Chew, K., Jiménez, R., Bickelmann, C., Hirasawa, T., Kuratani, S., Renfree, M. B., & Richardson, M. K. Mol. Biol. Evol (2021) 38: 4222-4237.
6. Measuring potential effects of developmental burden associated with the vertebrate notochord. Fujimoto, S., Yamanaka, K., Tanegashima, C., Nishimura, O., Kuraku, S., Kuratani, S., & Irie, N. J. Exp. Zool. Part B, MDE (2021) 1-8.
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8. Developmental fates of shark head cavities reveal mesodermal contributions to the tendon progenitor cells for extraocular muscles. Kuroda, S., Adachi, N., Kusakabe, R., & Kuratani, S. Zool. Lett. (2021) 7: 3.
9. The developmental hourglass model and recapitulation: An attempt to integrate the two models. Uesaka, M., Kuratani, S., & Irie, N. J. Exp. Zool. Part B, (2021) Epub ahead of print; https://doi.org/10.1002/jez.b.23027.
10. How can recapitulation be reconciled with modern concepts of evolution? Kuratani, S., Uesaka, M., & Irie, N. J. Exp. Zool. Part B, (2021) Epub ahead of print; doi: 10.1002/jez.b.23020. PMID: 33382203.
11. Evo-Devo studies of cyclostomes and origin and evolution of jawed vertebrates. Kuratani, S. In: S. F. Gilbert (ed) Evolutionary Developmental Biology (2021) Elsevier/Acad. Press; pp. 207-240.

Supplementary
N/A

Laboratory Homepage
https://www.riken.jp/en/research/labs/chief/evol_morphol/index.html
http://emo.riken.jp/