【Grant-in-Aid for Transformative Research Areas（Ｂ）】

Life-history reconstruction in marine animals: Transdisciplinary approach of geochemistry, physical oceanography, and ecology

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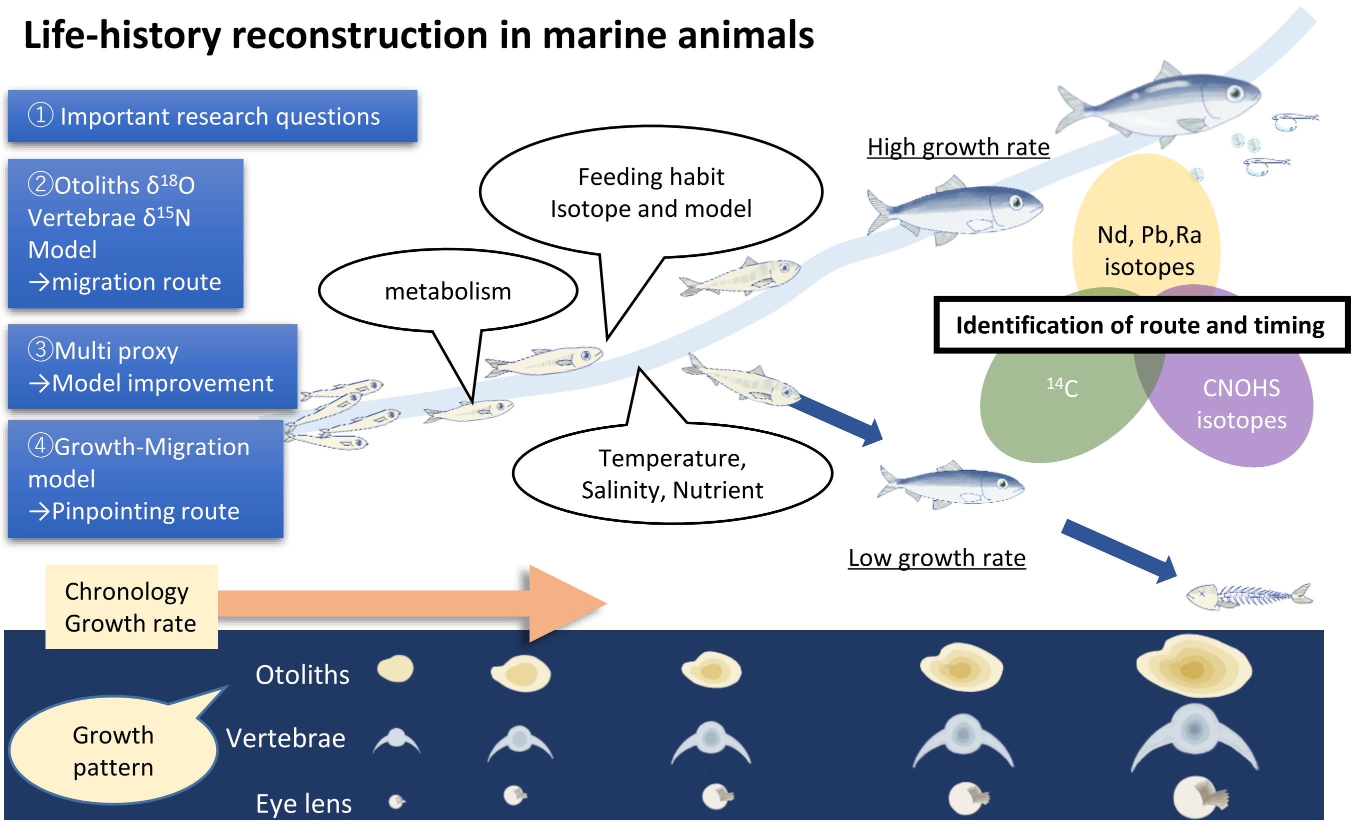
Research Area Information	Number of Research Area : 22B203 Keywords: Isotope, Ecological reconstruction, Migration, Modelling	Project Period (FY) : 2022-2024

Purpose and Background of the Research

●Outline of the Research

The objective of this study is to establish a "Biogeochemical tag" method for estimating migration history throughout the entire life history trait of marine organisms by integrating advanced geochemical techniques and numerical modeling. The "Biogeochemical tag" will enable us to elucidate a migration history with high temporal and spatial resolution. The "Biogeochemical tag" will open an avenue to answer one of the most fundamental mysteries in marine ecology, namely, how environmental changes affect the migration, growth, and survival strategies of marine organisms.



●In this research project, a new method for migration history reconstruction will be developed through the complementary integration of four groups with different fields of expertise, including ecology, geochemistry, and physical oceanography. Migration history will be pinpointed by repeating the cycle of cross-validation between multi-element isotope proxy and modeling. In addition, by combining metabolic, dietary, and environmental reconstruction based on geochemical and model analysis, and chronological and growth rate estimation based on growth pattern analysis, the interaction among environment, migration ecology, and growth of marine organisms will be discussed.

● The isotopic composition of each element varies slightly with location, environment, food, and body parts. Compositional characteristics in seawater are retained in the body of fish, and precise analysis of the body isotopic composition may allow us to identify which part of the ocean they migrated. The isotopes of more elements and body parts will provide more detailed information on migration ecology.

Modeling will complementary provide more generalized information. By combining the information obtained from isotopes with oceanographic observation data, a numerical model can simulate the growth and migration of fish in the ocean.

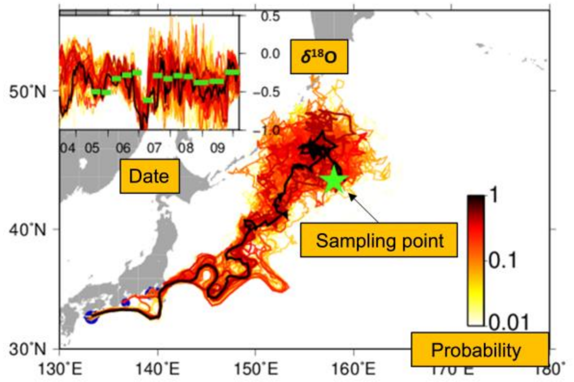


Fig. 2 Combination of isotope and modelling.Migration routes can be estimated by using a numerical model to select areas where the otolith analysis results match the ocean environment.

Expected Research Achievements

● The marine ecosystem is in critical condition due to human-induced environmental changes such as global warming, acidification, and ocean pollution. Because of the vast area of the ocean, "direct observation" of marine organisms is sometimes difficult. Thus, the migration routes of even familiar fish such as eels and tuna have not yet been fully estimated. The current picture of migration is just imaginary routes based only on fragmentary surveyed knowledge and on the changes in fishing grounds. Humans still have not been able to answer such simple questions as what areas the fatty tasty Japanese sardine caught off the Tohoku coast migrated where, what kind of food they eat, and how and where they accumulate fat.

This research project will specifically address the ecology of Japanese eels, salmon, Pacific bluefin tuna, cetaceans, and other species for which a rough picture of their migration is known but the details are not yet elucidated. The ultimate goal of this project is to answer the question, "Why do marine organisms migrate?" “How can we sustainably use the oceans in a changing global environment, such as global warming?”. Ecological information through entire life history traits on where, when, and under what conditions marine organisms have experienced and what they have eaten is the most fundamental information for understanding their ecology.
During the time frame of this 3-year project, we will accomplish the establishment of the method. By taking advantage of its high versatility, the future application can be expanded to various topics, such as clarifying universal life history strategies, predicting migration routes of marine organisms after global warming, and predicting changes in fisheries resources.

The methods developed in this research will also provide essential information for the conservation of the environment and ecosystems, including the protection of endangered species, and the preservation of ecosystems and nature. Without detailed knowledge of the habitat, behavior, and other ecological information of organisms to be conserved, it is difficult to conserve them. This methodology is particularly strong in its ability to elicit information on location and timing that are not (or cannot be) directly observed. For example, the conservation of fish that move between the river and the ocean is not effective if only the ocean is conserved. Since conservation measures cannot be perfectly implemented, it is necessary to focus on the protection of highly effective areas, and the ecological information obtained from this study will be very useful for ecosystem conservation.

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