A new approach to studying the origins of animal intelligence and its relationship to complex societies（Cognitive Evolutionary Ecology）

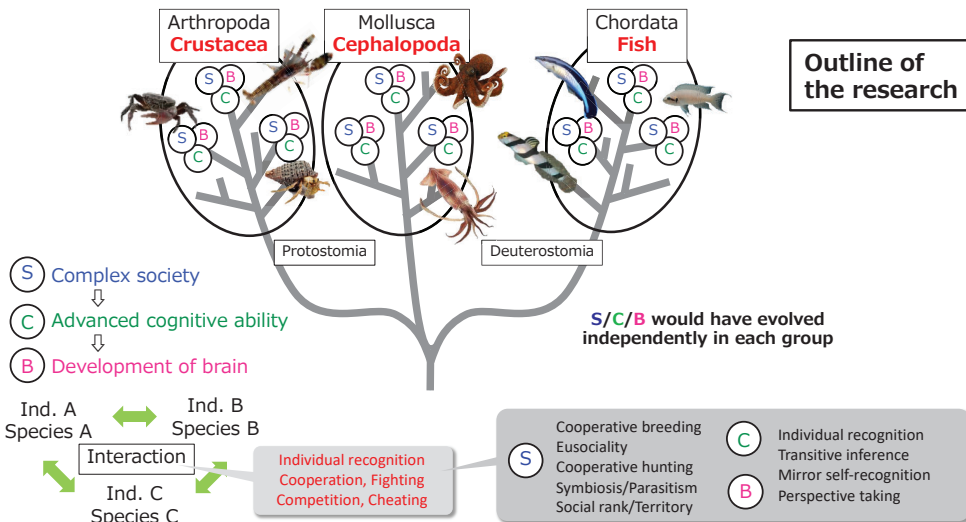| Head Investigator	Kyoto University, Field Science Education and Research Center, Assistant Professor Takahashi Kohji Researcher Number: 70723211
Research Area Information	Number of Research Area: 23B402 Project Period (FY): 2023–2025 Keywords: aquatic animals, brain, cognition, ecology, evolution

Purpose and Background of the Research

●Research outline [Exploring the intelligence of aquatic animals]

It has long been believed that animal intelligence is limited to terrestrial vertebrates, including humans. Recently, however, this conventional view has begun to be shattered by the discovery of a series of unexpected forms of intelligence in aquatic animals. It is difficult to explain the intelligent behaviors that behavioral ecologists often encounter solely through innate release mechanisms and/or associative learning, which is the subject of animal psychology. Our aim is to reconsider the intelligence of animals in general, including humans.
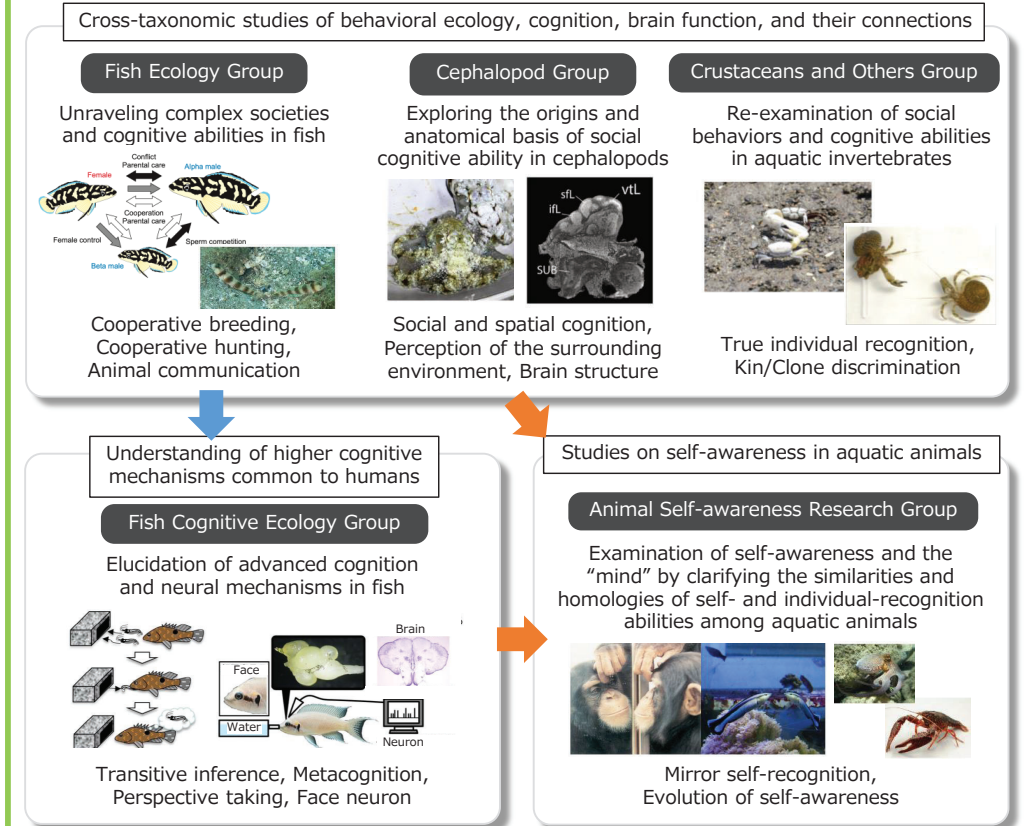
The social intelligence hypothesis was originally proposed to explain the evolution of intelligence in primates. The hypothesis suggests that social complexity is the main selective force for the evolution of sophisticated intelligence and developed brain functions in animals. In this light, aquatic animals, which have strong ties with other individuals in their complex societies, must have evolved the advanced cognitive abilities and brain functions that make these abilities possible. We have explored the intelligence of aquatic animals such as fish, cephalopods, and crustaceans, based on the social intelligence hypothesis, and established a new discipline, "cognitive evolutionary ecology," which integrates behavioral ecology, comparative cognitive science, and neuroscience to overturn conventional ideas on animal intelligence.

Outline of the research

Arthropoda **Crustacea** | Mollusca **Cephalopoda** | Chordata **Fish**

Protostomia | Deuterostomia

S **Complex society**
↓
C **Advanced cognitive ability**
↓
B **Development of brain**

S/C/B would have evolved independently in each group

Ind. A Species A ↔ Ind. B Species B
Interaction
Ind. C Species C

Individual recognition Cooperation, Fighting Competition, Cheating

S Cooperative breeding, Eusociality, Cooperative hunting, Symbiosis/Parasitism, Social rank/Territory

C Individual recognition, Transitive inference, Mirror self-recognition

B Perspective taking

Expected Research Achievements

●Research Policy

Our project aims to clarify the connections among behavioral ecology, cognition, and brain function in aquatic animals. We have five groups of approaches. Based on the findings from the fish ecology, cephalopod, and crustaceans and others groups, which examine cross-taxonomic cognitive abilities based on behavioral ecology, and the fish cognition group, which aims to understand higher cognitive abilities common to humans and to elucidate their neural mechanisms, the animal self-awareness group is used to conduct a cross-taxonomy study of self-recognition, a form of higher-order cognition, to understand the intelligence of aquatic animals.

Cross-taxonomic studies of behavioral ecology, cognition, brain function, and their connections

Fish Ecology Group
Unraveling complex societies and cognitive abilities in fish

Cooperative breeding, Cooperative hunting, Animal communication

Cephalopod Group
Exploring the origins and anatomical basis of social cognitive ability in cephalopods

Social and spatial cognition, Perception of the surrounding environment, Brain structure

Crustaceans and Others Group
Re-examination of social behaviors and cognitive abilities in aquatic invertebrates

True individual recognition, Kin/Clone discrimination

Understanding of higher cognitive mechanisms common to humans

Fish Cognitive Ecology Group
Elucidation of advanced cognition and neural mechanisms in fish

Transitive inference, Metacognition, Perspective taking, Face neuron

Studies on self-awareness in aquatic animals

Animal Self-awareness Research Group
Examination of self-awareness and the "mind" by clarifying the similarities and homologies of self- and individual-recognition abilities among aquatic animals

Mirror self-recognition, Evolution of self-awareness

●Expected scientific impacts

1. Better understanding of social behavior and cognitive abilities in aquatic animals
2. A break from the conventional view of animal intelligence
3. Contribute to our understanding of human intelligence by reconsidering cognition, brain structures, and functions in animals
4. Have an impact on disciplines such as medicine, pharmacology, and psychology, leading to the development of new technologies in AI and medicine

Web site	https://www.omu.ac.jp/sci/cogevolecol/