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

Contrarian biology: social equilibrium shaped by asynchronous strategies（Contrarian）

Head Investigator	RIKEN Center for Brain Science, Team leader MIYAMOTO Kentaro　Researcher Number:20778047
Research Area Information	Number of Research Area : 23B302　Project Period (FY) : 2023-2025 Keywords : contrarian, population biology, ecogenetics, neurophysiology

Purpose and Background of the Research

●Outline of the Research

For animals, forming a herd or group has many benefits, such as finding food efficiently, finding a partner, and protecting themselves from enemies. However, it also poses a dilemma in that members of a group are also rivals, intensifying competition for resources. It has been unclear how organisms have solved this problem and evolved collectivity. We focused on the existence of contrarians, individuals who are willing to do something different when everyone else is doing the same thing. Contrarians are widespread in a variety of organisms, and are even observed in clonal populations of individuals with uniform genetic backgrounds in laboratories. However, they are considered outliers and have not been treated systematically. Therefore, we designed this project with the participation of researchers working with four model organisms (flies, medaka, macaques, and humans) with the aim of establishing a common cross-species behavioral experimental paradigm that allows contrarians to be evaluated at the experimental level.

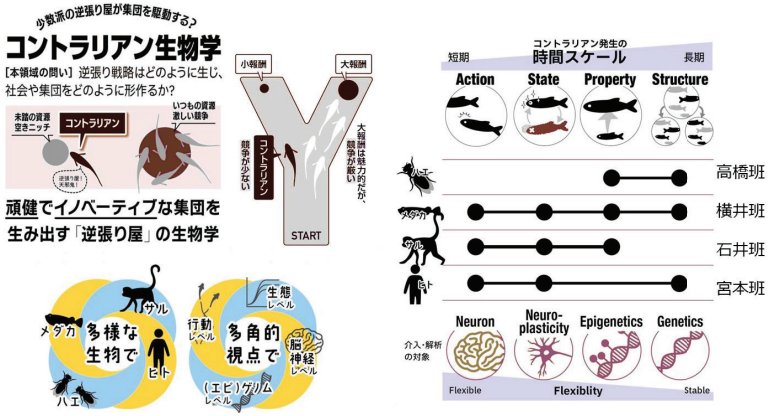

Figure 1. Outline of the research plan to elucidate the genetic and molecular neural basis of dynamically changing contrarian behavior

●A multidisciplinary approach that combines ecology and neuroscience

Contrarians can be effective in various scenes and time scales as long as they have a "group and individual" structure. In model organisms, various experimental techniques have been developed to take advantage of the characteristics of each organism. By using different model organisms, we can investigate a wide range of contrarians from the neural basis for manipulating the micro time scale, which instantly changes its own behavior in response to the behavior of others, to the molecular genetic basis on the macro time scale, where the composition of the population changes from generation to generation.

●Four model organisms with different social structures

Flies, medaka (fish), macaques, and humans all form social groups, but the degree to which they do so differs greatly, ranging from those at the level of a group to those that behave as if they are organized, those that establish a social order using a clear pecking order, and those with a multi-layered, complex, and multifaceted social structure. By using these model organisms, we aim to demonstrate at the experimental level that contrarians are ubiquitous in a variety of animals that form herds and social groups, and to elucidate the biological significance of contrarians.

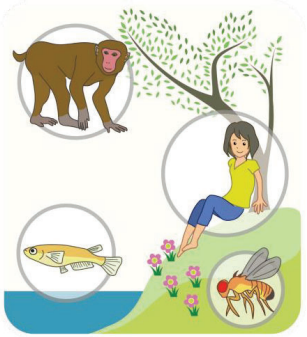

Figure 2. Four model organisms

Expected Research Achievements

●Two Research Goals of Contrarian Biology

The first goal is to determine what effects occur when contrarians are introduced into a population. This intervention manipulation will be accomplished by mixing genetically different strains (flies and medaka) and different personalities/generations (humans) to form populations or by manipulating individual behavior through neural activity manipulation (macaques). By examining the ripple effects on individuals and groups, we will test the contrarian hypothesis of this area, "the presence of contrarians improves individual and group productivity.

The second goal is to elucidate the molecular, genetic, and neural basis of contrarian behavior. We will elucidate the relationship between contrarian behavior and epigenetic changes in gene expression and brain neural activity due to genome sequence and environmental factors.

● Genesis of "Cognitive Population Biology

The future vision of contrarian biology is the creation of a new academic field called "cognitive population biology," which will elucidate the development and evolution of the cognitive systems that support group societies. Until now, the nature of social structure has been based on the dualism of groups with a homogeneous orientation or groups that maintain diversity. The former is efficient and has instantaneous productivity, but is vulnerable to environmental change, while the latter is robust but costly, and requires an abundance of resources and niches for the success of society as a whole. However, as the verification of our contrarian hypothesis progresses and our understanding of group structure advances, we can expect to realize a society that maximizes group benefits at low cost while minimizing individual sacrifices as a future application.

Figure 3. Research goals

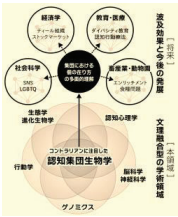

Figure 4. Future prospects and social applications

Homepage Address, etc.	https://www.contrarianbiology.com/