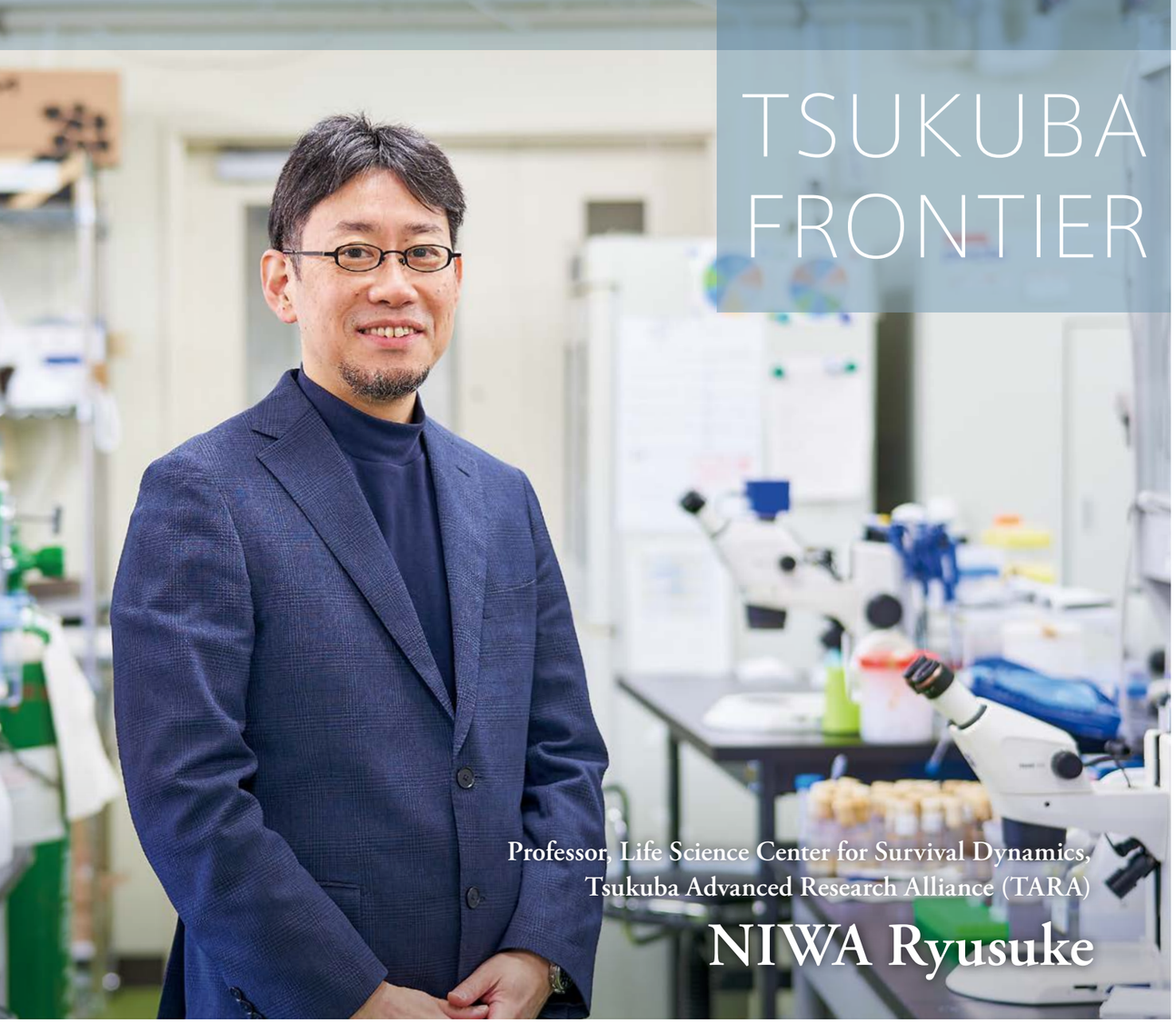

TSUKUBA FRONTIER

Professor, Life Science Center for Survival Dynamics,
Tsukuba Advanced Research Alliance (TARA)

NIWA Ryusuke

Hormones, Autonomic Nerves, and Venom

Mechanisms of Interorgan and Interspecies Interactions Between Fruit Flies and Parasitoid Wasps

Living organisms survive through the intricate coordination of the activities of their cells and organs. In addition, individuals within species interact and cooperate with each other to ensure their collective survival. Furthermore, organisms from different species coexist by exchanging substances, forming a network of interdependence. In other words, coordinated interactions within the body, among individuals, and across species are fundamental to life and survival. We have been focusing on biological phenomena such as mating and parasitism and exploring the reliance of organisms on chemical communication and physiological interactions to coordinate functions within and beyond individuals.

Living in Harmony: The Physiology of Interorgan Communications

The body of an organism consists of numerous cells and organs that function in concert. Signals from the autonomic nervous system and hormones secreted by the body guide internal coordination in response to external stimuli. These signals travel throughout the body, prompting specific cellular and tissue responses. Importantly, such coordinated interactions extend beyond the individual, as communication can also occur among individuals and even between different species, maintaining ecological balance. Understanding the mechanisms of these multilevel interactions is a central issue in modern life sciences.

Reproduction is a key biological phenomenon driven by interactions between individuals of the same species. After mating, female fruit flies increase their food intake, but they do not mate again. This behavior is driven by specific molecules in the male's semen. This illustrates how chemical signals mediate cooperation between individuals and optimize reproductive success.

The Fruit Fly *Drosophila*: An Excellent Model Organism

Our research has mainly used the fruit fly, which initially emerged as a model organism in the early 20th century through the work of geneticist Thomas Hunt Morgan. Before the molecular basis of heredity was understood, Morgan's discovery of eye color mutations linked to specific chromosome locations in fruit flies revolutionized genetics. Fruit flies remain a powerful model because they are easy to culture on simple artificial diets, they have a short 2-week generation time, and they offer an unparalleled range of genetic mutants. Global stock centers, including that in Kyoto, maintain vast collections of *Drosophila* strains, facilitating global research. Despite being a few millimeters long, *Drosophila* is among the most versatile and impactful organisms in experimental biology.

The Intricacies of Parasitism: Lessons from Parasitoid Wasps

Certain parasitoid wasps target *Drosophila*, injecting venom and laying eggs inside the fly. This represents a sophisticated form of interspecies interaction. Our recent research identified specific venom components that manipulate the physiology of the host. For instance, two venom proteins suppress *Drosophila* development to create an optimal environment for the wasp's offspring without killing the host.

Remarkably, although *Drosophila* and parasitoid wasps are evolutionarily distant, they reliably find each other in nature. The enduring coevolution of these two species, despite their antagonistic relationship, is a striking example of biological interdependence.

A Personal Journey in Biology

My passion for biology began in high school, inspired by an interview with Dr. Susumu Tonegawa (Nobel Prize in Physiology or Medicine 1987) and the engaging teaching of my biology teacher. During my university studies, my interests deepened through coursework in genetics and developmental biology.

Since joining the University of Tsukuba in 2008, I have pursued research under the motto "enjoy what is served," an approach that emphasizes respect for data and adaptability in research direction. With the support of dedicated colleagues, students, and tens of thousands of fruit flies and parasitoid wasps, we have produced internationally recognized findings.

Our work continues the legacy of Morgan and his academic lineage: I am part of the seventh or eighth generation of researchers in this field. With recent advances such as chemically defined diets and AI-assisted behavioral analysis tools, *Drosophila* research is entering a new era. Together with parasitoid wasps, these organisms are facilitating a deeper understanding of cooperative, interactive biological systems.

Life Science Center for Survival Dynamics, Tsukuba Advanced Research Alliance
Niwa Project (Physiological Genetics Research)

Living organisms are exposed to the ever-changing environment of the natural world. In response to environmental changes, complex information is exchanged via neurotransmitters and hormones among the various organs that comprise the individual, as well as between individuals and different species, and these interactions control and maintain the respective biological activities of the individuals. We are conducting research focusing on interorgan and interspecies communications using *Drosophila* as a model organism to elucidate the mechanisms and significance of these interactions.

PROFILE

NIWA Ryusuke graduated from Senior High School at Komaba, University of Tsukuba in 1993. He received his B.S. from the Faculty of Science, Kyoto University in 1997 and his Ph.D. from the Graduate School of Science, Kyoto University in 2002. After postdoctoral fellowships at Kyoto University, the University of Tokyo, and Yale University (US), NIWA joined the University of Tsukuba in 2008 as an Assistant Professor at the Graduate School of Life and Environmental Sciences. He was promoted to Associate Professor at the Institute of Life and Environmental Sciences in 2012 and Professor at the Life Science Center for Survival Dynamics, Tsukuba Advanced Research Alliance in 2019. NIWA was later appointed as Special Assistant to the Director at the Center in 2024. Concurrently, he serves as a Research Fellow at the Research Center for Academic Systems, Japan Society for the Promotion of Science. He specializes in developmental biology, insect physiology, and molecular genetics.