Daniel Kronauer, Ph.D.

INVESTIGATOR, HOWARD HUGHES MEDICAL INSTITUTE • STANLEY S. AND SYDNEY R. SHUMAN PROFESSOR, LABORATORY OF SOCIAL EVOLUTION AND BEHAVIOR

Kronauer studies social evolution and behavior within complex societies. The sophisticated behavior, communication, and division of labor within ant colonies make these social insects ideal model systems for this work. His lab uses an integrative approach to understand how natural selection shapes the evolution of insect societies and how social life is regulated at the level of genes, brains, individuals, and colonies.

Insect societies are socially integrated to such an extent that they are often portrayed as "superorganisms," in which different morphological or behavioral castes have different functions and coordinate their actions, similar to the cells and tissues of an organism. The Kronauer lab uses ants to study how complex animal societies evolved from solitary ancestors, and the molecular mechanisms controlling caste development and division of labor. The group also explores how ants produce, perceive, and process social signals, and how the composition and network structure of social groups affects group-level properties and fitness.

The lab uses molecular genetics and neuroscience in combination with quantitative behavioral and morphological measurements under controlled laboratory conditions. In particular, the researchers are developing and using the clonal raider ant Ooceraea biroi as a new social insect model system. The clonal raider ant is a powerful model system because it uniquely combines the rich biology of social insects with unparalleled experimental accessibility. The unusual biology of this species makes it possible for Kronauer's team to control and replicate the size, genetic composition, and age structure of colonies—three central factors affecting individual behavior, division of labor, and social networks in ants. The team has sequenced the species' genome and has developed protocols for genome editing, along with automated tracking setups that allow precise quantification of individual and group behavior.

The lab's recent results reveal that a massive expansion in odorant receptors allows ants to perceive the many chemical cues they use to communicate, and that genetic ablation of these receptors results in the collapse of ant societies. They have also discovered new molecular and developmental mechanisms underlying the ants' sophisticated chemosensory system. Implementing the first neurogenetic tools in an ant, they showed how pheromones are represented in the ant brain, and that these representations change as ants assume different behavioral roles in the colony. Kronauer's team also discovered a novel type of social fluid that creates dependencies across different ant developmental stages, thereby acting as a glue for the colony's social fabric. Finally, the lab has shown that behavioral division of labor and improved colony performance emerge automatically with increasing group size, identifying some of the factors that make sociality adaptive. They subsequently showed that changes in group size also underlie changes in group behavior in various other contexts, from foraging to collective decision making.

Lately, the lab has been studying how genetic factors and neural circuits contribute to behavior, with the ultimate aim to understand how ants communicate, assume different behavioral roles, and carry out their sophisticated social and collective actions at the level of the brain. These insights will inform our understanding of how social behavior evolves and is regulated.

EDUCATION

Diploma in biology, 2003
University of Würzburg

Ph.D., 2007
University of Copenhagen

POSTDOC

University of Copenhagen, 2007–2008

University of Lausanne, 2008

POSITIONS

Junior Fellow, 2008–2011
Harvard University

Assistant Professor, 2011–2017
Associate Professor, 2018–2024
Professor, 2024–
The Rockefeller University

Investigator, 2021–
Howard Hughes Medical Institute

AWARDS

Searle Scholar, 2012

NIH Director's New Innovator Award, 2012

Irma T. Hirschl/Monique Weill-Caulier Trust Research Award, 2013

Kavli Fellow, 2013

Klingenstein-Simons Fellowship, 2014

Sinsheimer Scholar, 2015

Pew Biomedical Scholar, 2015

Howard Hughes Medical Institute Faculty Scholar, 2016

The Rockefeller University Distinguished Teaching Award, 2016

Quadrivium Award for Innovative Research in Epigenetics, 2018

Gabrielle H. Reem and Herbert J. Kayden Early-Career Innovation Award, 2018

SELECTED PUBLICATIONS

Lacy, K.D. et al. Co-inheritance of recombined chromatids maintains heterozygosity in a parthenogenetic ant. *Nature Ecology and Evolution* (2024).

Brahma, A. et al. Transcriptional and post-transcriptional control of odorant receptor choice in ants. *Current Biology* 33, 5456–5466 (2023).

Hart, T. et al. Sparse and stereotyped encoding implicates a core glomerulus for ant alarm behavior. *Cell* 186, 3079–3094 (2023).

Snir, O. et al. The pupal molting fluid has evolved social functions in ants. *Nature* 612, 488–494 (2022).

Gal, A., Kronauer, D.J.C. The emergence of a collective sensory response threshold in ant colonies. *PNAS* 119, e2123076119 (2022).