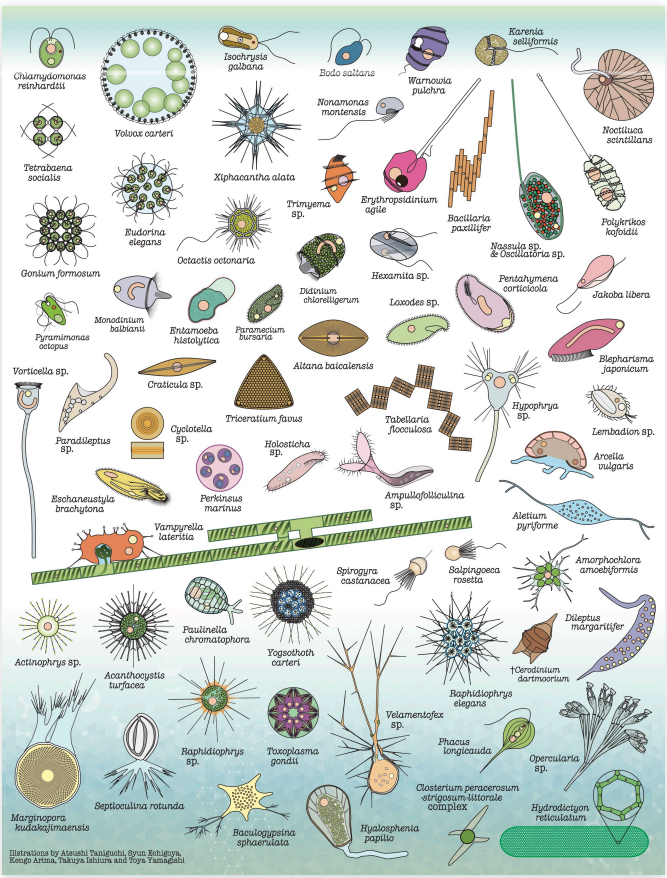
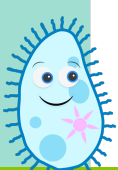
Ethological Dynamics on
Diorama Environments

Oxford-Japan Symposium on Cell Behaviors in Simple to Complex Environments

Date 22nd–26th, September 2025

Venue Mathematical Institute, University of Oxford





http://diorama-ethology.jp/eng/

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Aim of this workshop

Ethology, the study of behavioral patterns in organisms, reveals that even single-celled organisms like bacteria and protists possess remarkable adaptive abilities. These cellular behaviors are often mirrored in multicellular organisms, as seen in phenomena like sperm motility.

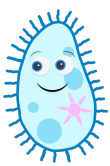
These adaptive skills in cellular locomotion can be seen as a form of "Proto-Intelligence" acquired through evolution. Such abilities become more apparent in controlled environments, like microfluidic chambers, where they can be studied and analyzed.

Our research, titled "Ethological Dynamics," focuses on extracting fundamental biological algorithms or mathematical models from cellular movement in complex environments. Through experiments, modeling, and simulations, our KAKENHI project "Ethological Dynamics in Diorama Environment" seeks to establish "Ethological Equations" that link environmental stimuli to cellular behavioral responses. This work enables us to uncover universal biological algorithms, such as sperm chemotaxis, phototactic spirals in microalgae, and reinforcement learning in maze-solving slime molds.

We also explore whether these algorithms can be applied to a wide range of behaviors in both single and multicellular organisms. For example, could the principles guiding chemotactic sperm swimming also explain the navigation of migratory birds? Do microalgae and their phototactic responses share common algorithms? Could the reinforcement strategies of maze-solving slime molds inform the development of human infrastructure, such as roads and railways? How can we extract the key environmental response from red-tide plankton?

To advance our understanding, we propose diverse experimental, computational, and theoretical approaches. These range from modeling single-cell to collective behavior, employing simple mathematical models, studying fluid dynamics with detailed cell shapes and motions, and mining vast experimental data. The themes and keywords include:

- Agent dynamics: Taxis, navigation, strategies
- Behavioral mining: Novel behaviors, measurement, diorama assay
- Collective dynamics: Slime mold, environmental red tide, tissue
- Data-driven algorithms: Data analysis, method, extraction of algorithms
- Exploring universality: Non-biological systems, multicellular organisms
- Fluid dynamics: Flow, swimming, body-environment coupling



The workshop's purpose is to share insights on these topics and discuss the potential of biological algorithms to address health and environmental challenges in society.

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Program

Monday 22nd

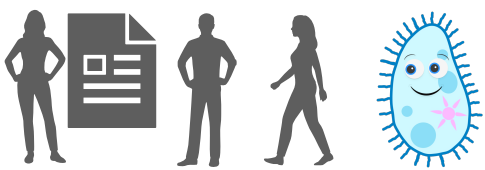
9:30-10:00		**Registration**
10:00-10:20		**Opening Address + General Introduction**
		Session:MA - Chair: **Sungrim Seirin-Lee (Kyoto, Japan)**
10:20-10:45	M-1	**Kogiku Shiba** (Shimoda Marine Research Center, University of Tsukuba, Japan) "Chemotaxis Strategy of Ascidian Sperm Revealed by "Ethological Dynamics in Diorama Environments""
10:45-11:15		Break
		Session:MB - Chair: **Robert Guy (UC Davis, US)**
11:15-11:40	M-2	**Rahil Valani** (Rudolf Peierls Centre for Theoretical Physics, University of Oxford, UK) "Nonlinear dynamics of a microswimmer in unidirectional flows"
11:40-12:05	M-3	**Mohit Dalwadi** (Mathematical Institute, University of Oxford, UK) "A robust exchange: bacterial conversations in fluid flow"
12:05-12:30	M-4	**Kenji Kikuchi** (Tohoku University, Japan) "Three-dimensional sperm flagellar waveform measurement by DIC microsopy"
12:30-14:00		Lunch
		Session:MC - Chair: **Maria Bruna (Oxford, UK)**
14:00-14:50	P-M-1	**Kirsty Wan** (Living Systems Institute, University of Exeter, UK) "Decoding microscale navigation through integrative biophysical modelling"
14:50-15:20		Break
		Session:MD - Chair: **Takashi Tominaga (Tokushima, Japan)**
15:20-15:45	M-5	**Kees Weijer** (School of Life Sciences University of Dundee, UK) "Analysis of critical cell behaviours driving tissue morphogenesis during gastrulation in the chick embryo early embryogenesis"
15:45-16:10	M-6	**Takeo Matsumoto** (Dept of Mech Sys Eng, Grad Sch of Eng, Nagoya Univ, Japan) "Observation of Morphological Response of MC3T3-E1 Cells to Anisotropic and Isotropic Rotating Strain Fields"
16:10-16:35	M-7	**Clément Moreau** (CNRS, LS2N, Nantes Université, France) "Locomotion with bending-compression coupling in slender bodies"
16:35-18:00		**Welcome Party+Poster Session**

Tuesday 23rd

		Session:TuA - Chair: **Andrew Krause (Durham, UK)**
9:30-9:55	Tu-1	**Maria Bruna** (Mathematical Institute, University of Oxford, UK) "Excluded-volume and anisotropic effects in particle systems"
9:55-10:20	Tu-2	**Mitsusuke Tarama** (Department of Physics, Kyushu University, Japan) "Modelling durotactic cell crawling on an elastic substrate"
10:20-10:45	Tu-3	**Benjamin Walker** (Department of Mathematics, University College London, UK) "Multi-timescale frontiers in microswimming"
10:45-11:15		Break
		Session:TuB - Chair: **Yu Fukasawa (Tohoku, Japan)**
11:15-11:40	Tu-4	**Robert Guy** (Department of Mathematics, University of California Davis, US) "How fluid rheology shapes micororganism swimming gait"
11:40-12:05	Tu-5	**Eric Keaveny** (Imperial College London, UK) "Emergent cilia-driven propulsion on a model ciliate"
12:05-12:30	Tu-6	**Alid Al-Asmar** (Research Institute for Electronic Science, Hokkaido University, Japan) "Caenorhabditis elegans foraging outcomes in patchy environments"
12:30-14:00		Lunch
		Session:TuC - Chair: **Hiraku Nishimori (Meiji, Japan)**
14:00-14:50	P-Tu-1	**Jose Carrillo** (Oxford, UK) "Cell sorting due to cell-cell Adhesion via Aggregation-Diffusion systems"
14:50-15:20		Break
		Session:TuD - Chair: **Benjamin Walker (UCL, UK)**
15:20-15:45	Tu-7	**Denis Headon** (Roslin Institute, University of Edinburgh, UK) "Cell movement during chicken skin embryogenesis"
15:45-16:10	Tu-8	**Kenta Ishimoto** (Department of Mathematics, Kyoto University, Japan) "Modelling multiscale mechanics in cell locomotion"
16:10-16:30		Break
16:30-17:00		**Poster Flush Talk**
17:00-18:00		**Poster Session**

List of Posters from Mon to Fri except Wed

number	Name	Affiliation	Title
1	Takaaki Aoki	Faculty of Data Science, Shiga University, Japan	Mathematical and geographical modelling for cities and roads
2	James Boyle	Mathematical Institute, University of Oxford, UK	Inferring Cell-Cell Interaction Dynamics from Cell Movement Data Using Deep Attention Networks
3	Rebecca Crossley	Wolfson Centre for Mathematical Biology, University of Oxford, UK	Electrotaxis alters cell interactions in human corneal epithelial cells
4	Syun Echigoya	Research Institute for Electronic Science, Hokkaido University, Japan	Swimming ciliates Stentor selects its anchoring sites influenced by extracellular geometry
5	Carles Falcó	Mathematical Institute, University of Oxford, UK	Modelling adhesion-based interactions in collective cell migration
6	Charles Fosseprez	Mathematical and Physical Ethology Laboratory, Hokkaido university, Japan	Cybernetic coupling for behavioral analysis
7	Yu Fukasawa	Graduate School of Agricultural Science, Tohoku University, Japan	Electrical potentials in mushroom populations in the field
8	Ali Hosseini	Institut Systèmes Intelligents et de Robotique, Sorbonne University, France	Active control of thigmotaxis by Paramecium
9	Nonoka Homma	Faculty of Engineering, Ryukyu University, Japan	Mathematical Modeling of the Cluster Formation Process in heterotypic cell populations
10	Samuel Johnson	Mathematical Institute, University of Oxford, UK	Mathematical Optimisation of Actin-Driven Protrusion Formation in Eukaryotic Chemotaxis
11	Thomas Jun Jewell	Mathematical Institute, University of Oxford, UK	Long ranged interactions drive pattern formation in biology
12	Masashi Kajita	Department of Applied Chemistry and Biotechnology, Faculty of Engineering, University of Fukui, Japan	Active thermodynamic force-driven mitochondrial alignment
13	Itsuki Kunita	Department of Engineering, Faculty of Engineering, University of the Ryukyus, Japan	Swimming Behavior of Coral Larvae Driven by Ciliary Motion
14	Ian McFarlane	Mathematical Institute/Ludwig Institute for Cancer Research, UK	Modelling the localisation of stem cell activation in the human stomach
15	Kota Nishi	Joint Graduate School of Mathematics for Innovation, Kyushu University, Japan	A Simple Mathematical Model for the Learning Behavior of True Slime Mold
16	Yukinori Nishigami	Research Institute for Electronic Science, Hokkaido University, Japan	Unique Locomotion of the Testate Amoeba, *Arcella*, on Different Substrates
17	Yoko Tominaga	Institute of Neuroscience, Tokushima Bunri University, Japan	Probing Membrane Potential with Light: From the Brain to Other Cells
18	Hironori Ueno	Aichi university of Education, Japan	Variations in swimming behavior and flagellar motion associated with multicellularity in the order Volvocales
19	Megumi Uza	Graduate School of Engineering and Science, University of the Ryukyus, Japan	Mathematical Modeling and Simulation of the Morphological Change Process in Slime Molds Driven by Environmental Adaptation



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Program

Wednesday 24th

		Session:WA - Chair: **Giulia Celora (Oxford, UK)**
9:30-9:55	W-1	**Sungrim Seirin-Lee** (KUIAS/Graduate School of Medicine, Kyoto Universisty, Japan) "Decoding Cell Geometry: Insights from Mathematical Modeling Based on Imaging Data"
9:55-10:20	W-2	**Dawn Walker** (University of Sheffield, UK) "Virtual cell cultures - Data-informed agent-based modelling as a tool to explore heterotypic cellular interactions in 2D"
10:20-10:45	W-3	**Takashi Tominaga** (Institute of Neuroscience, Tokushima Bunri University, Japan) "Exploring Voltage Control in Paramecium: Electrophysiology, Organelles, Thermotactic Learning, and Optical Recording"
10:45-11:15		Break
		Session:WB - Chair: **Yoshitaka Nishiyama (Saitama, Japan)**
11:15-11:40	W-4	**Yongyun Hwang** (Department of Aeronautics, Imperial College London, UK) "Nonlinear dynamics of cellular microfilament models"
11:40-12:30	P-W-1	**Eamonn Gaffney** (Oxford, UK) "Examining aspects of flagellate mechanics: individual cell dynamics and population behaviours. "
12:30~		Free time

Thursday 25th

		Session:ThA - Chair: **Denis Headon (Edingurgh, UK)**
9:30-9:55	Th-1	**Hermes Gadelha** (University of Bristol, UK) "Motor Organization in Axonemal Machines: A Story Far from Over"
9:55-10:20	Th-2	**Tomas Alarcon** (ICREA-Centre de Recerca Matematica (CRM), Barcelona, Spain, Spain) "Multiscale modelling of cell-ECM interactions"
10:20-10:45	Th-3	**Makoto Iima** (Graduate School of Integrated Sciences for Life, Hiroshima University, Japan) "Ascidian Sperm Navigation via Signal Transduction with Fold-Change Detection Property"
10:45-11:15		Break
		Session:ThB - Chair: **Takeo Matsumoto (Nagoya, Japan)**
11:15-11:40	Th-4	**Alexander Mietke** (Rudolf Peierls Centre for Theoretical Physics, Department of Physics, University of Oxford, UK) "Mechanics, stability and self-organization of active surfaces in biology"
11:40-12:05	Th-5	**Andrew Krause** (Department of Mathematical Sciences, Durham University, UK) "Exploring Complex Biological Dynamics through Interactive Simulations"
12:05-12:30	Th-6	**Katsuhiko Sato** (University of Toyama, Japan) "Asymmetric aggregation patterns in Chlamydomonas under symmetric conditions"
12:30-14:00		Lunch
		Session:ThC - Chair: **Tomas Alarcon (ICREA-CRM, Spain)**
14:00-14:50	P-Th-1	**Toshiyuki Nakagaki** (Research Institute for Electronic Science, Hokkaido University, Japan) "Behavioral heuristics of an amoeba under the complex environment"
14:50-15:00		Break
		Session:ThD - Chair: **Tetsuya J. Kobayashi (Tokyo, Japan)**
15:00-15:50	P-Th-2	**Raymond Goldstein** (University of Cambridge, UK) "Phototactic Decision-Making in Green Algae"
15:50-16:10		Break
16:10-17:10		**Panel Discussion**
17:10-18:00		Break
18:00~		**Conference Dinner**

Friday 26th

		Session:FA - Chair: **Clément Moreau (CNRS, France)**
9:30-9:55	F-1	**Tetsuya J. Kobayashi** (Institute of Industrial Science, University of Tokyo, Japan) "Optimality theory of stigmergic collective information processing by chemotactic cells"
9:55-10:20	F-2	**Hans-Günther Döbereiner** (Institut für Biophysik, Universität Bremen, Germany) "From basal cognition in Physarum polycephalum networks to information infrastructures for digital transformation of state"
10:20-10:45	F-3	**Hiraku Nishimori** (Meiji Institute for Advanced Study of Mathematical Sciences, Meiji University, Japan) "Diversity of Workload and Function of Errors in Ant Colonies"
10:45-11:15		
		Session:FB - Chair: **Takaaki Aoki (Shiga, Japan)**
11:15-11:40	F-4	**Giulia Celora** (Mathematical Institute, University of Oxford, UK) "Migration of living droplets: a novel paradigm for chemotaxis of multicellular communities"
11:40-12:05	F-5	**Andrea Perna** (IMT School for Advanced Studies Lucca, Italy) "The role of movement in the adaptation of ciliates (Tetrahymena pyriformis and Euplotes magnicirratus) to environments with different temperature and resources"
12:05-12:30	F-6	**Dagmar Iber** (ETH, Switzerland) "Developmental Pattern Formation via Directed Cell Migration"
12:30-14:00		Lunch
		Session:FC - Chair: **Erick Keaveny (Imperial, UK)**
14:00-14:50	P-F-1	**Takuji Ishikawa** (Department of Biomedical Engineering, Tohoku University, Japan) "Ciliary fluid dynamics of swimming, feeding, pumping, and sensing"
14:50-15:20		Break
		Session:FD - Chair: **Mitsusuke Tarama (Kyushu, Japan)**
15:20-15:45	F-7	**Yoshitaka Nishiyama** (Department of Biochemistry and Molecular Biology, Graduate School of Science and Engineering, Saitama University, Japan) "Ecophysiological study of swimming behavior in noxious red-tide-forming microalgae"
15:45-16:10	F-8	**Timothy John Pedley** (University of Cambridge, UK) "Experiments on the interaction of Heterosigma akashiwo with a plane wall"
16:10-16:30		**General Conclusion + Closing**

See you next time!
Have a safe trip !