Matishalin Patel

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Research Positions

2022 → now **University of Hull**, *Lecturer*, Department of Biology and Centre for Data Science, AI, and Modelling

I use mathematical models of evolution and computational simulations to understand the evolution of between species mutualisms. I am interested in formalising between species cooperation in a similarly rigorous way as inclusive fitness and kin selection has done for within-species cooperation. Also, I am investigating the behaviour and evolutionary pressures on reinforcement learning agents in the Animal-AI framework I am especially interested in how Multi-agent groups learn and evolve.

2022 → 2023 **University of Cambridge**, *Visiting Researcher*, Centre for the Future of Intelligence

I was allowed ongoing access to University computing resources for my Animal-AI and major transitions research. I remained an active member of CFI seminar series and attended conferences and workshops to maintain research links.

2021 → 2022 **University of Cambridge**, *Post-doctoral Research Associate*, Centre for the Future of Intelligence

Using evolutionary theory to understand the foundations of intelligence and use these insights to build better Artificial Intelligence algorithms. I directly implemented artificial agents and evaluated their performance as well as modelling evolutionary pressures on neural architectures in a more general way.

2020 → 2021 **University of Cambridge**, *Post-doctoral Research Associate*, Dept. of Zoology

I developed models to help understand intergroup conflict in mongoose groups. The models used nonlinear optimisation and recursion equations. I worked with field researchers from Exeter to create models informed by the real world behaviours of Banded Mongooses.

2020 → 2022 **University of Cambridge**, *Research Fellow*, Darwin College

2015 → 2019 **University of Oxford**, *DPhil*, BBSRC DTP Interdisciplinary Biosciences, Helping and Harming

My DPhil focused on the evolution of altruism and spite. I used mathematical models and computer simulations to explore and predict evolutionary outcomes. In my last two chapters on mutualisms and between species cooperation.

DPhil thesis

Title *Helping and Harming*

Supervisors Stuart West and Michael Bonsall

Description My DPhil focused on the evolution of altruism and spite. I modelled the evolution of a public good (Cry toxin) in a bacterium that infects a seasonally varying host — looking at the short and long term dynamics. I developed theory on the evolution of spiteful behaviour and how it is sometimes conflated with selfishness when fitness effects are mis-partitioned. I investigated how a host can evolve to control the relatedness among its symbionts to force cooperation and reap the benefits.

Education

2015 → 2019 **DPhil Interdisciplinary Biosciences DTP**, *University of Oxford*, Oxford

My DPhil used mathematical techniques such as function optimisation and stability analysis as well as game theory and computer simulations to investigate eco-evolutionary dynamics of various social evolution problems.

2014 → 2015 **MSc. Computational Methods in Ecology and Evolution**, *Imperial College London*, London, *Distinction*

I took modules in multivariate calculus, linear algebra, statistics (linear models, GLMs and ANOVA), Maximum likelihood methods, and Bayesian statistics. The course also covered agent based simulation and evolutionary simulations as well as model fitting and phylogenetic methods.

2011 → 2014 **MA Biological Sciences**, *University of Oxford*, Oxford, *1st*

I focused on: social evolution, behavioural ecology, evolutionary ecology, bio-mechanics, and animal cognition.

Other Qualifications

2025 **Postgraduate Certificate in Academic Practice**, *University of Hull*

I studied learning theory and best practice in managing student needs. I learnt about curriculum and module design and how to create assessments. Following this I was awarded FHEA status.

2024 **Introduction to Mathematical Proofs**, *University of Oxford*, Remote

I learnt the basics of proof reading and making. We covered the basics of logic, set theory, and number theory along with key proofs in the fields. I wrote my final essay on Borel sigma algebras and the Lebesgue measure on the Reals.

2021 **Machine Learning**, *Stanford University*, Remote
I learnt how to implement and interpret supervised and unsupervised machine learning algorithms such as feed-forward neural networks, logistic regressions, K-means, and Support Vector Machines. I also learnt algorithm testing, performance evaluation, and pipeline testing and construction.

Publications

1. Rueger, T., Barbasch, T. A., **Patel, Matishalin**, Bogdanowicz, S. M. & Buston, P. M. No Evidence for Kin Selection as an Explanation for Social Group Formation in Clown Anemonefish. *Behavioral Ecology* **36,** araf075. ISSN: 1465-7279. https://doi.org/10.1093/beheco/araf075 (2025) (July 1, 2025).
2. Sankey, D. W. E., **Patel, Matishalin**, Buston, P., Cant, M. A., Johnstone, R. A. & Rueger, T. *Spend Today or Build for Tomorrow? Kinship Dynamics and the Evolution of Alternative Helping Strategies in Cooperative Breeders*. July 12, 2025.
3. Voudouris, K., Barron, A., Halina, M., Klein, C. & **Patel, Matishalin**. *Exploring Major Transitions in the Evolution of Biological Cognition With Artificial Neural Networks* arXiv: 2509.13968 [cs]. http://arxiv.org/abs/2509.13968 (2025). prepublished, in review at PNAS.
4. Voudouris, K., Slater, B., Cheke, L. G., Schellaert, W., Hernández-Orallo, J., Halina, M., **Patel, Matishalin**, Alhas, I., Mecattaf, M. G., Burden, J., Holmes, J., Chaubey, N., Donnelly, N. & Crosby, M. The Animal-AI Environment: A Virtual Laboratory for Comparative Cognition and Artificial Intelligence Research. *Behavior Research Methods* **57,** 107. ISSN: 1554-3528. https://doi.org/10.3758/s13428-025-02616-3 (2025) (Feb. 28, 2025).
5. Hunt, K. L., **Patel, Matishalin**., Croft, D. P., Franks, D. W., Green, P. A., Thompson, F. J., Johnstone, R. A., Cant, M. A. & Sankey, D. W. E. The Evolution of Democratic Peace in Animal Societies. *Nature Communications* **15,** 6583. ISSN: 2041-1723. https://www.nature.com/articles/s41467-024-50621-5 (2024) (Aug. 3, 2024).
6. **Patel, Matishalin** & Arvid Ågren, J. Calculating Relatedness: A Pedigree of Definitions. *Cold Spring Harbor Perspectives in Biology*, a041667. ISSN: 1943-0264. PMID: 39433392 (Oct. 21, 2024).
7. Voudouris, K., Alhas, I., Schellaert, W., Crosby, M., Holmes, J., Burden, J., Chaubey, N., Donnelly, N., **Patel, Matishalin**, Halina, M., Hernández-Orallo, J. & Cheke, L. G. *Animal-AI 3: What's New & Why You Should Care* arXiv: 2312.11414 [cs]. http://arxiv.org/abs/2312.11414 (2024). Pre-published.
8. Karlsson, C., Willis, J., **Patel, Matishalin** & de Perera, T. B. Visual Odometry of Rhinecanthus Aculeatus Depends on the Visual Density of the Environment. *Communications Biology* **5,** 1045. ISSN: 2399-3642. https://www.nature.com/articles/s42003-022-03925-5 (2025) (Oct. 1, 2022).

9. **Patel, Matishalin** & West, S. Microbial Warfare and the Evolution of Symbiosis. *Biology Letters* **18,** 20220447. https://royalsocietypublishing.org/doi/full/10.1098/rsbl.2022.0447 (2023) (Dec. 21, 2022).
10. **Patel, Matishalin**, West, S. A. & Biernaskie, J. M. Kin Discrimination, Negative Relatedness, and How to Distinguish between Selfishness and Spite. *Evolution Letters* **4,** 65–72. ISSN: 20563744. http://doi.wiley.com/10.1002/evl3.150 (2020) (Feb. 2020).
11. **Patel, Matishalin**, Raymond, B., Bonsall, M. B. & West, S. A. Crystal Toxins and the Volunteer's Dilemma in Bacteria. *Journal of Evolutionary Biology* **32,** 310–319. ISSN: 1420-9101. https://onlinelibrary.wiley.com/doi/abs/10.1111/jeb.13415 (2019) (2019).
12. Vila, J. C. C., Jones, M. L., **Patel, Matishalin**, Bell, T. & Rosindell, J. Uncovering the Rules of Microbial Community Invasions. *Nature Ecology & Evolution* **3,** 1162–1171. ISSN: 2397-334X. https://www.nature.com/articles/s41559-019-0952-9 (2019) (Aug. 2019).

Prepared for publication

M. Patel, M. A. Cant, and R. A. Johnstone. Group warfare and environmental harshness. 2024

Grants

2026 **COEXIST: A novel citizen science approach to manage human-wildlife coexistence in the Anthropocene**, ***£50,000***, INTERNAL, FERENS TRUST, HEIF, Building an AI enabled citizen science pipeline for Fox, Pine Marten and Seagull human-wildlife conflict data. I am programming the web app and helping set up Machine Learning models for data validation and behaviour classification from camera trap data.

2024 → 2026 **Shad population assessment via Diglis AI**, ***£83,195***, EDF ENERGY, Grant to develop a modelling pipeline combining statistical models and fish counts for Shad in the river Severn. I am responsible for AI detecton of Shad in fish pass video.

2024 → 2025 **Experiencing human-wildlife conflict management through playful learning**, ***£3,460***, BRITISH ECOLOGICAL SOCIETY, Grant to develop a card game, Defishient, to help teach conservation principles to students and stakeholders. The game is printed and distributed with training workshops run at several universities and it has been using in the conservation Masters at Hull

Academic Supervision

2023 → now **Mathematical models of neuroblastoma evolution**, *PhD Co-Supervisor*, Francesca Covell, Unviersity of Hull

Teaching

2024 → now **Lecturer, Biology**, *School of Natural Sciences*, Hull
Teaching a 10-week introductory course to organismal biology and cladistics to first year undergraduates (100 students). The course covers key animal, plant and microbial groups and their defining evolutionary and ecological features. I also teach 4 lectures on Animal Behaviour to the second year undergraduates (60 students). Additionally, I am module leader for a third year science communication module (70 students).

2023 → 2025 **Lecturer, Programming for Data Science and AI**, *DAIM*, Hull
Teaching a 4-week introductory course (100 students) in Python programming for Data Science and AI/Machine Learning.

2022 **Lecturer, Part 1B: Evolution and Animal Diversity**, *Zoology*, Cambridge
Gave 3 lectures and 1 seminar on Development of Adaptive Behaviour course.

2021 → 2022 **Part 1A: Ecology and Evolution Tutor**, *Lucy Cavendish*, Cambridge
Teaching a group of 3 undergraduate students in weekly supervisions for all three terms of the 2021-2022 academic year.

2020 → 2022 **Lecturer, Part II Zoology: Evolution and Behaviour**, Cambridge
Researched and designed a four lecture module on parental care and the fundamentals of social evolution. Using Panopto and Moodle to deliver the course and interact with students.

2019 → 2020 **Statistics Tutor, New College**, Oxford
Gave a term of Statistics tutorials to second year undergraduates for two successive years. Tutorials were in groups of 2-4 and each tutorial went over key concepts and past paper examples.

2016 → 2019 **Undergraduate Statistics demonstrator**, Oxford
Demonstrator for the undergraduate bio-statistics course: statistical modelling, data management, and R programming skills.

2017 → 2019 **Undergraduate Tutor in ecology and social evolution**, Oxford
Tutorials on programming, social evolution, Neutral theory and sensory ecology. Tutorials given to groups of two students at a time, from various Oxford colleges, and tutorial work in essay or problem sheet form.

Academic Roles

2026 → now **NERC (National Environmental Research Council) Peer Review College Member**

2025 **Chair of Doctoral Thesis Committee**, *University of Hull*

2025 → now **EDI Champion for the School of Environmental and Life Sciences**

2023 → now **ECR representative for Faculty of Science and Engineering**

2023 → 2024 **Member of the AI in Assessment and Learning working group**

Talks and Workshops

June 2026 **Internal Conflicts and Organismal Adaptation: Mathematical Foundations**, *NITMB, Chicago*, Invited as a participant to discuss a framework for internal conflicts.

2025 **Neural ODEs**, *ESEB 2025 Barcelona*, I gave a talk at a symposium on new technologies in evolutionary biology. I introduced the concept of Neural Ordinary Differential Equations and their possible application to ecological and evolutionary modelling

2025 **Evolutionary game theory for AI agents**, *INFORMED AI Summer School, Bristol*, I gave a talk on the possible application of evolutionary game theory to understanding the behaviour of AI swarms. As well as using AI swarms as a test-bed for evolutionary game theory experiments.

2023 **The Price equation and Relatedness**, *Flat Iron Institute, NY, USA*, I gave a chalk talk on the derivation of the Price equation and Hamilton's Rule along with a short explanation of relatedness and it's utility.

2023 **Warfare and resources**, *Yale University, CT, USA*, Invited talk to the Quantitative Biology Department at Yale, I presented on two recent projects on microbial warfare and mongoose warfare.

2023 **Warfare and resources**, *University of California Davis, CA, USA*, Invited talk to the Biology Department at UC Davis, I presented on two recent projects on microbial warfare and mongoose warfare.

2021 **Intra-group cooperation and Intergroup conflict in Banded Mongooses**, *Max Planck, Germany*, Invited talk to the Institute for Evolutionary Biology discussing my postdoctoral work and future plans as part of an internal seminar series

2021 **Major Transitions Past and Future**, *CRI Paris, France*, Invited talk to the CRI Paris where I presented my thesis work and future research plans in an internal seminar

2018 **Crystal Toxins: A volunteers' dilemma**, *EMPSEB 2019*, Conference Talk at EMPSEB 2019 in Granada Spain. I presented the findings from my work on volunteers' dilemmas

Awards and Prizes

2016 **BBSRC Interdiscplinary Bioscience DTP award**, *Oxford University*, £15,000 stipend and £5000 a year research expenses for 4 years

2015 **Imperial College Masters Scholarship**, *Imperial College London*, Course fees paid and £10,000

Scientific Activities

2019 **Symposium Chair Evolution 2019**, Co-chairing a symposium titled "Mathematical models in evolutionary biology". Aimed at exploring the consequences of the premises and axioms we use when developing models

2018 **Symposium Chair Evolution 2018**, Co-chaired a symposium titled "Major transitions in individuality and levels of selection"

2018 **Poster - Evolution 2018**, Presented a poster of a paper at Evolution 2018 — "Crystal Toxins and the volunteer's dilemma in bacteria."

2015 → 2018 **Cheltenham Science festival**, Three years of public outreach at Cheltenham Science Festival, UK

Languages

Spanish Intermediate – CEFR B2/C1

Referees

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Manager Dr Domino Joyce, Department of Biology, University of Hull, D.joyce@hull.ac.uk, +44 (0)1482 466856