

# Yuriy Pichugin

*Theoretical biologist*

## Research interests

Primary research topic Evolution of multicellular life cycles.

Major evolutionary transitions, eco-evolutionary dynamics, evolutionary game theory, mathematical oncology.

## Research experience

2021 - present **Postdoctoral researcher**, *Princeton University, Ecology and Evolutionary Biology department*, Princeton, USA.

Supervisor: Prof. Dr. Corina Tarnita

2016 - 2021 **Postdoctoral researcher**, *Max Planck Institute for Evolutionary Biology, Evolutionary Theory Department*, Ploen, Germany.

Supervisor: Prof. Dr. Arne Traulsen

2011 - 2015 **PhD student**, *Massey University, Rainey lab*, Auckland, New Zealand.

Thesis title: Theoretical investigation into the origins of multicellularity. Supervisor: Prof. Dr. Paul B. Rainey

2008 - 2010 **Master research project**, *Institute of Chemical Kinetics and Combustion, Laboratory of cytometry and biokinetics*, Novosibirsk, Russia.

Thesis title: Research of cellular cycle taking account of cells distribution function in accordance with division rate. Supervisor: Dr. Andrey V. Chernyshev

2006 - 2008 **Bachelor research project**, *Institute of Chemical Kinetics and Combustion, Laboratory of cytometry and biokinetics*, Novosibirsk, Russia.

Thesis title: Abilities of the spectral approach in the analysis of light scattering indicatrices of mononuclear cells. Supervisor: Dr. Maxim A. Yurkin

## Education

2011–2015 **PhD in Theoretical Biology**, *Massey University*, Auckland, New Zealand.

2008–2010 **Master in Physics**, *Novosibirsk State University*, Novosibirsk, Russia.

2004–2008 **Bachelor in Physics**, *Novosibirsk State University*, Novosibirsk, Russia.

## Grants and Awards

2020 Marie Curie Individual Fellowship, EU (grant respectfully declined to accept position at Princeton), EUR 200'000

2015 DAAD short-term research grant, Germany, EUR 9'000

2012 Sir Neil Waters scholarship, New Zealand, NZD 5'000

- 2010 Schlumberger scholarship, Russia, RUB 50'000
- 2010 Master diploma with excellence. Average score 5.0 out of 5.0, Russia
- 2009 Kovalsky award, Russia
- 2008 Bachelor diploma with excellence. Average score 5.0 out of 5.0, Russia
- 2004 President award for school graduates, Russia

## Organisational experience

- Sep. 2019 **Co-organiser of the workshop “Evolution of interacting populations”**, Max Planck Institute for Evolutionary Biology, Ploen, Germany.
- Jul. 2019 **Organiser of the mini-symposium “Evolution of multicellular life cycles”**, part of the conference MMEE-2019, Lyon, France.
- 2018 - 2019 **Initiator and coordinator of the peer study group “Machine learning”**, Max Planck Institute for Evolutionary Biology, Ploen, Germany.

## Teaching and mentoring experience

- 2017 - 2021 **Co-supervisor of the PhD student**, Yuanxiao Gao, University of Luebeck, Germany.  
Thesis title: Evolution of life cycles of heterogeneous cell groups.
- Apr. - Oct. 2019 **Co-supervisor of the master student**, Vanessa Ress, University of Luebeck, Germany.  
Thesis title: Eco-evolutionary dynamics of simple life cycles.
- 2018 - 2019 **Rotating lecturer in the peer study group “Machine learning”**, based on the book “Pattern Recognition and Machine Learning” by Bishop, Ploen, Germany.
- 2017 - 2018 **Rotating lecturer in the peer study group “Statistical physics”**, based on the book “A Kinetic View of Statistical Physics” by Krapivsky, Redner, and Ben-Amin, Ploen, Germany.
- 2008 - 2010 **Teacher of physics**, Specialized Scientific Study Center (high school), Novosibirsk, Russia.
- Aug. 2006, Aug. 2007, Aug. 2008 **Teacher of physics**, Summer school at Specialized Scientific Study Center (high school), Novosibirsk, Russia.

## Industry experience

- 2010 - 2011 **Internship**, Schlumberger, Novosibirsk Technological Center, Novosibirsk, Russia.

## Peer-reviewed publications

- ✉ indicates corresponding author
- ⊕ indicates shared first authorship

- 2022 V.Ress, A.Traulsen, **Y.Pichugin**<sup>✉</sup>, Eco-evolutionary dynamics of clonal multicellular life cycles, *eLife* 11, e78822.

- 2022 J.T.Lange<sup>+</sup>, J.C.Rose<sup>+</sup>, C.Y.Chen<sup>+</sup>, **Y.Pichugin**<sup>+</sup>, L. Xie, J. Tang, K.L. Hung, K.E.Yost, Q. Shi, M.L. Erb, U. Rajkumar, S. Wu, S. Taschner-Mandl, M. Bernkopf, C. Swanton, Z. Liu, W. Huang, H.Y. Chang, V. Bafna, A.G. Henssen, B. Werner, P.S. Mischel, The evolutionary dynamics of extrachromosomal DNA in human cancers, *Nature Genetics* 54, 1527–1533.
- 2022 **Y.Pichugin**, A. Traulsen, The possible modes of microbial reproduction are fundamentally restricted by distribution of mass between parent and offspring, *Proceedings of the National Academy of Sciences* 119 (12), e2122197119.
- 2022 Y.Gao, **Y.Pichugin**, C.S.Gokhale, A. Traulsen, Evolution of reproductive strategies in incipient multicellularity, *Journal of the Royal Society Interface* 19 (188), 20210716.
- 2021 Y.Gao, H.J.Park, A. Traulsen, **Y.Pichugin**<sup>✉</sup>, Evolution of irreversible somatic differentiation, *eLife* 10, e66711.
- 2021 O. Yaryhin, J. Klembara, **Y.Pichugin**, M. Kaucka, I. Werneburg, Limb reduction in squamate reptiles correlates with the reduction of the chondrocranium: a case study on serpentiform anguids, *Developmental Dynamics*, 1-18.
- 2020 **Y.Pichugin**<sup>✉</sup>, A.Traulsen, Evolution of multicellular life cycles under costly fragmentation, *PLoS Computational Biology*, 16 (11), e1008406.
- 2020 H.J. Park, **Y.Pichugin**, A.Traulsen, Why is cyclic dominance so rare?, *eLife* 9, e57857.
- 2020 C.J. Rose, K. Hammerschmidt, **Y.Pichugin**, P.B.Rainey, Meta-population structure and the evolutionary transition to multicellularity, *Ecology Letters* 23 (9), 1380-1390.
- 2019 **Y.Pichugin**<sup>✉</sup>, H.J.Park, A.Traulsen, Evolution of simple multicellular life cycles in dynamic environments, *Journal of the Royal Society Interface* 16 (154), 20190054.
- 2019 H.J.Park, **Y.Pichugin**, W.Huang, A.Traulsen, Population size changes and extinction risk of populations driven by mutant interactors, *Physical Review E* 99 (2), 022305.
- 2019 Y.Gao, A.Traulsen, **Y.Pichugin**<sup>✉</sup>, Interacting cells driving the evolution of multicellular life cycles, *PLoS Computational Biology* 15(5), e1006987.
- 2017 **Y.Pichugin**<sup>✉</sup>, J.Peña, P.B.Rainey, A.Traulsen, Fragmentation modes and the evolution of life cycles, *PLoS Computational Biology* 13 (11), e1005860.
- 2015 **Y.Pichugin**<sup>✉</sup>, C.S.Gokhale, J.Garcia, A.Traulsen, P.B.Rainey, Modes of migration and multilevel selection in evolutionary multiplayer games, *Journal of Theoretical Biology* 387, 144-153.
- 2012 **Y.G.Pichugin**, K.A.Semiyanov, A.V.Chernyshev, I.G.Palchikova, L.V.Omelyanchuk, V.P.Maltsev, Peculiarities of cytometrical methods of DNA content determination in the nucleus, *Cell and Tissue Biology* 6 (3), 302-308.

## Preprints and manuscripts in preparation

- 2021 S. Tang<sup>+</sup>, **Y.Pichugin**<sup>+</sup>, K.Hammerschmidt, Phenotypic plasticity, transient multicellularity, and an environmentally dependent life cycle, <https://www.biorxiv.org/content/10.1101/2021.09.29.462355v1>.

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## Invited talks

- 2022 **Eco-evolutionary dynamics of multicellular life cycles**, Modeling on Ecology and Evolution Workshop, KIAS, Seoul, South Korea, *online talk*.
- 2022 **Mathematics of multicellularity**, University of Toronto, Ecology and Evolutionary Biology department seminar, Toronto, Canada.
- 2022 **Evolution of irreversible somatic differentiation**, Online seminar series Modelling Cell Development and Regeneration, *online talk*.
- 2020 **Stochastic dynamics of ecDNA in tumors**, Theory division seminar at Cleveland clinic, Cleveland, USA, *online talk*.
- 2019 **Evolution of simple multicellular life cycles**, Biomathematics seminar at Harvard University, Boston, USA.
- 2018 **Evolution of life cycles in early multicellularity**, Complex systems seminar at Queen Mary University of London, UK.
- 2017 **Fitness correlation metric as a method of detection of the transition in individuality**, Invited talk in Prof. R.Watson group in University of Southampton, UK.

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## Presentations at the conferences

- 2022 **The possible modes of microbial reproduction are fundamentally restricted by distribution of mass between parent and offspring**, AbSciCon-2022, Atlanta, USA (*talk*).
- 2021 **Mass conservation restricts the possible modes of microbial reproduction**, SMB-2021: Society of Mathematical Biology annual meeting, online conference (*online talk*).
- 2020 **Evolution of clonal life cycles: recipes for multicellularity, equal split, and single cell bottleneck**, SMB-2020: Society of Mathematical Biology annual meeting, online conference (*online talk*).
- 2019 **Evolution of simple multicellular life cycles**, Evolution of interacting populations workshop, Ploen, Germany (*talk*).
- 2019 **Towards a general theory of reproduction modes evolution**, MMEE-2019: Mathematical models in Ecology and Evolution, Lyon, France (*talk*).
- 2019 **Evolution of life cycles in early multicellularity**, CCCC-2019: Conflict, Competition, Cooperation and Complexity, Vaals, Netherlands (*talk*).
- 2018 **Evolution of simple multicellular life cycles in a dynamic environment**, Evolutionary emergence of life cycles workshop, Ploen, Germany (*talk*).
- 2018 **Evolution of life cycles in early multicellularity**, Evolutionary Models of Structured Populations: Integrating Methods workshop, Ploen, Germany (*talk*).
- 2018 **Reproduction costs can drive the evolution of groups**, ECMTB-2018: European Conference on Mathematical and Theoretical Biology, Lisbon, Portugal (*talk*).

- 2018 **Evolution of simple multicellular life cycles in a dynamic environment**, MPDEE-2018: Models in Population Dynamics, Ecology, and Evolution, Leicester, UK (*talk*).
- 2018 **Evolution of simple multicellular life cycles in a dynamic environment**, DPG-2018: Deutsche Physikalische Gesellschaft meeting, Berlin, Germany (*poster*).
- 2017 **Fragmentation modes and the evolution of multicellular life cycles**, MMEE-2017: Mathematical models in Ecology and Evolution, London, UK (*talk*).
- 2017 **Fitness correlation metric as a method of detection of the transition in individuality**, MBE-2017: Modelling Biological Evolution, Leicester, UK (*talk*).
- 2016 **Fragmentation modes and the evolution of multicellular life cycles**, CCCC-2016: Conflict, Competition, Cooperation and Complexity, Prague, Czech Republic, (*talk*).
- 2016 **Fragmentation strategies and the evolution of multicellular life cycles**, ECMTB-2016: European Conference on Mathematical and Theoretical Biology, Nottingham, UK (*poster*).
- 2015 **Modes of migration and multilevel selection in evolutionary multiplayer games**, MMEE-2015: Mathematical models in Ecology and Evolution, Paris, France (*poster*).

## Non peer-reviewed publications and outreach activities

- 2020 **Antibody tests and our return to a more normal life**, *Article in the scientific outreach web-site on the COVID pandemic*, Co-author and translator to Russian, [http://web.evolbio.mpg.de/evoltheo\\_corona/articles/YP\\_AntibodyTests/index\\_EN.html](http://web.evolbio.mpg.de/evoltheo_corona/articles/YP_AntibodyTests/index_EN.html).
- 2020 **Exponential virus growth and increasing the capacity of a health-care system**, *Article in the scientific outreach web-site on the COVID pandemic*, Co-author, [http://web.evolbio.mpg.de/evoltheo\\_corona/articles/AT\\_CommExpGrowth/01\\_english/Eng\\_ExponentiellesWachstum\\_May.pdf](http://web.evolbio.mpg.de/evoltheo_corona/articles/AT_CommExpGrowth/01_english/Eng_ExponentiellesWachstum_May.pdf).
- 2019 **Was können uns mathematische Modelle über die Evolution von einfachen Lebenszyklen sagen?**, *Chapter in Max Planck Society Year book (in German)*, Co-author, Munich, Germany.
- 2019 **The game of life cycles**, *The demonstration boardgame presented during European Researcher's Night*, Designer and demonstrator, Ploen, Germany.
- 2018 **From one to many**, *Popular science article*, Author, New Principia. <http://www.newprincipia.com>, Pilot issue 001 "Time".
- 2018 **The game of life cycles**, *The demonstration boardgame presented during Max Planck Institute open day*, Designer and demonstrator, Ploen, Germany.
- 2018 **Die Evolution von Lebenszyklen**, *Popular science article (in German)*, Co-author, *EvolBioMax* magazine.
- 2018 **Write your name with DNA**, *The demonstration at European Researcher's Night*, Demonstrator, Kiel, Germany.

2017 **Write your name with DNA**, *The demonstration at Max Planck Institute open day*, Demonstrator, Ploen, Germany.

## Computer skills

Office  $\text{\LaTeX}$ , MS Office (Power Point, Word, Excel), Omnigraffle, Scribus.  
Programming Python (numpy, scipy, matplotlib, scikit-learn, seaborn, pandas), R, Mathematica, Matlab.  
Other Git, Slurm.

## Languages

Russian Native speaker  
English Fluent  
German Basic

## Social media and contact information

Website <https://yuriypichugin.github.io>  
e-mail [pichugin@princeton.edu](mailto:pichugin@princeton.edu)  
Twitter [@ab\\_in\\_](https://twitter.com/ab_in_)  
ORCID <https://orcid.org/0000-0003-3078-2499>