

Quantitative and Computational Methods in Ecology & Evolution: Introduction

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Silwood Park

Imperial College
London

October 1, 2018

WHY ECOLOGY AND EVOLUTION?



Big Fish Eat Little Fish, 1557, Pieter van der Heyden

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- Ecosystem engineering (think yogurt cheese & wine!)

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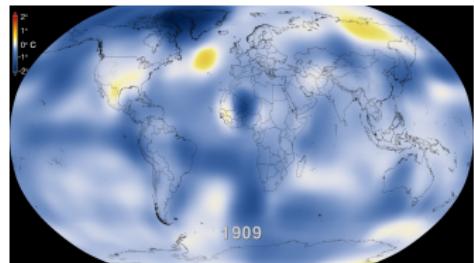
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- Species invasions and ecosystem collapse

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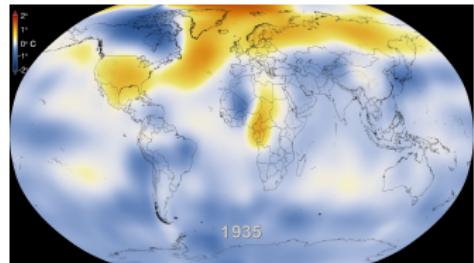
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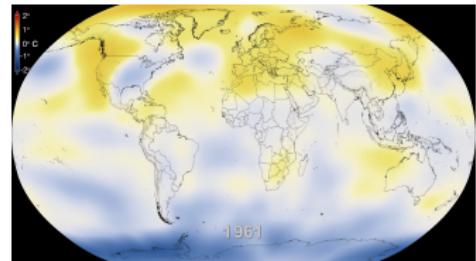
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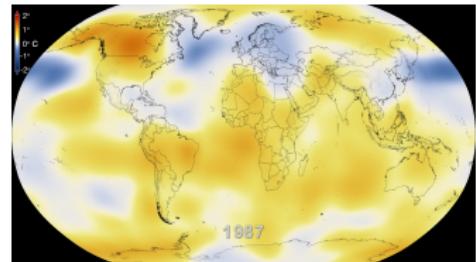
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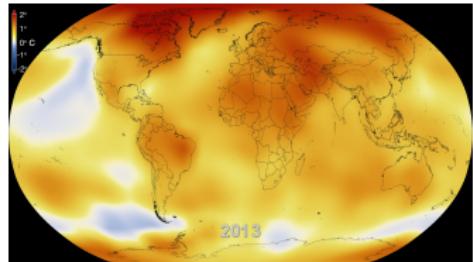
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<http://www.invasive.org>

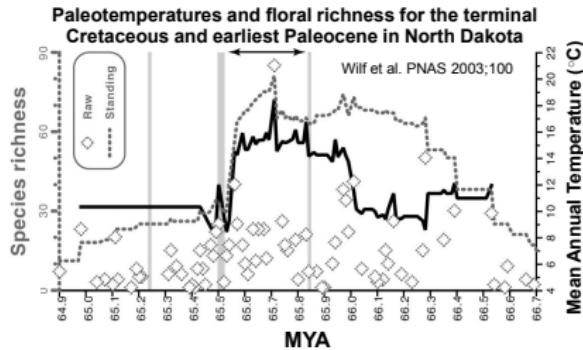
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- Species range shifts and invasions
- Overexploitation of ecosystems



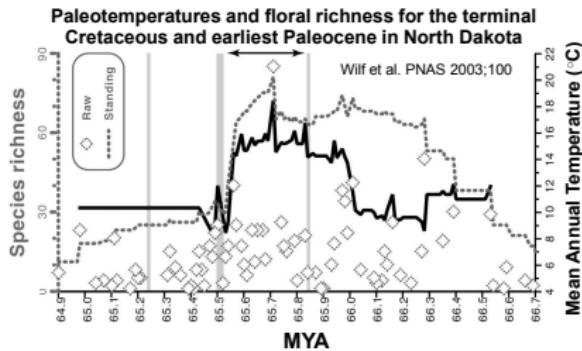
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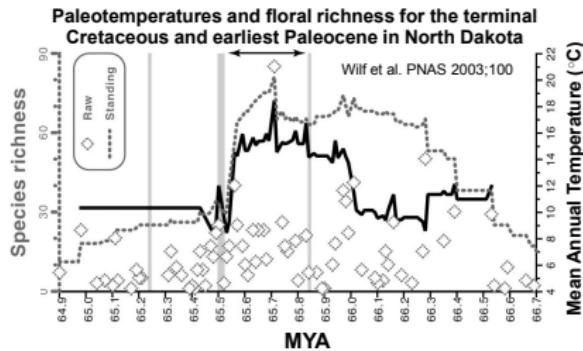
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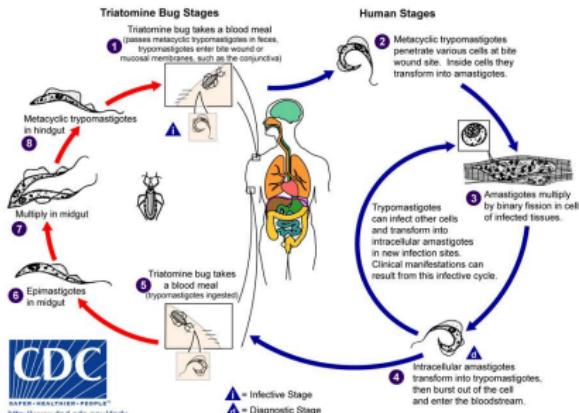
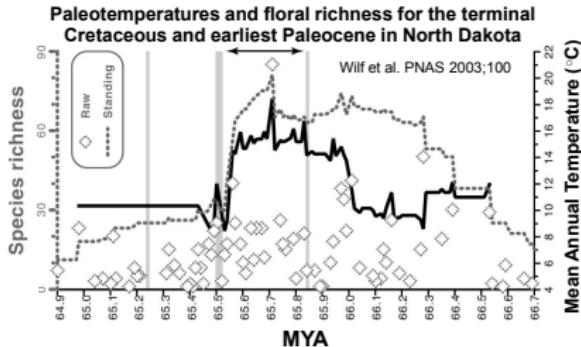
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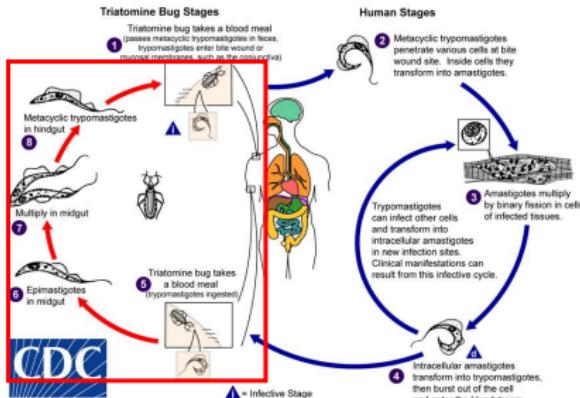
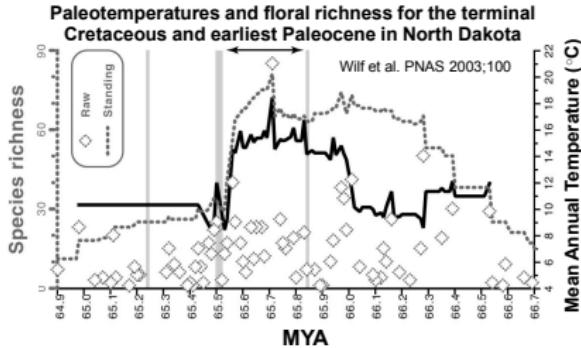
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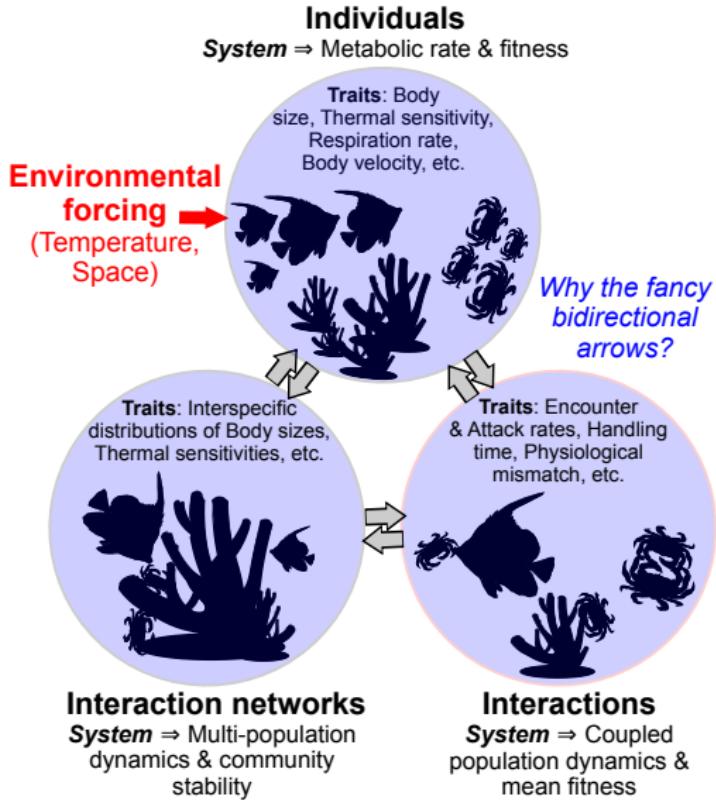


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It is hard for me to say confidently that, after fifty more years of explosive growth of computer science, there will still be a lot of fascinating unsolved problems at peoples' fingertips, that it won't be pretty much working on refinements of well-explored things. Maybe all of the simple stuff and the really great stuff has been discovered. It may not be true, but I can't predict an unending growth. I can't be as confident about computer science as I can about biology. Biology easily has 500 years of exciting problems to work on, it's at that level.

(Donald Knuth)

WHY Computational ECOLOGY AND EVOLUTION?

Open access, freely available online

Essay

Mathematics Is Biology's Next Microscope, Only Better; Biology Is Mathematics' Next Physics, Only Better

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Read it — its on the course's Git repository

<https://github.com/mhasoba/TheMulQuaBio>

COMPUTATIONAL ECOLOGY AND EVOLUTION AT *Silwood*

A wide range of theoretical and empirical research (big data!):

- Evolution and Developmental Genetics (Abzhanov)
- Genetics and behavior (Schroeder)
- Tropical biology (Ewers, Banks-Leite)
- Vector borne diseases (Cator, Burt)
- Phylogenetics, genomics (Savolainen, Fumagalli)
- Human genetics (Hodgson)
- Behavior (Cator, Gill)
- Paleontology (Brazeau)
- Food webs, networks (Woodward, O'Gorman, Pawar)
- Metabolic theory, population biology (Pawar)
- Pollinator behavior and ecology (Gill)
- Neutral theory, scientific visualization (Rosindell)
- Population genetics (Burt, Schroeder, Hodgson, Barraclough, Fumagalli)
- Conservation biology (Knight, Mills, Banks-Leite, Ewers)
- Microbial systems (Bell, Barraclough)

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WHAT YOU WILL LEARN

- Competence in stat-of-art quantitative methods for addressing modern biological problems
- How to select the correct quantitative tool to address a specific biological problem
- An ability to develop, analyse, numerically simulate, fit models to data and interpret
- Quantitative models of biological systems, including statistical and mathematical models
- Techniques in Population biology, Population genetics, Genomics and Geographical Information Systems
- How to design and conduct research, with the necessary computational workflows – *please have a look at past projects!*

COURSE ADMINISTRATION

<i>Course Director</i>	Dr. Samraat Pawar (ext. 42213, s.pawar@imperial.ac.uk)
<i>Course Co-Director</i>	Dr. James Rosindell (ext. 42242, j.rosindell@imperial.ac.uk)
<i>Postgraduate Administrator</i>	Mrs. Amanda Ellis (ext. 42251, amanda.ellis@imperial.ac.uk)
<i>Postgraduate Tutor</i>	Dr. Julia Schroeder (julia.schroeder@imperial.ac.uk)
<i>Director of Postgraduate Studies</i>	Dr. Niki Gounaris (ext. 4 5209, k.gounaris@imperial.ac.uk)
<i>Course Tutors</i>	Katie Willis (katie.willis16@imperial.ac.uk) & Tom Clegg (t.clegg17@imperial.ac.uk)
<i>Course Representative</i>	Up to you (see Silwood Masters Guidebook)

Add 020 759 to extension numbers to call from external phones

GETTING STARTED

- You each will receive a laptop computer and peripherals – *If you want it*
- You will be provided a USB stick with Ubuntu 16.04 64 bit – *If you need it (ubuntu 18.04 will also work)*
- If you are using your own laptop – use Ubuntu/Lubuntu/Xubuntu 14.04 64 bit or higher, or Mac OS
 - If using Mac OS, remember that not all commands behave the same between Mac OS and Linux
- Make sure you can access secured Imperial College wireless (use college name and password) — external Bootcampers, use Eduroam or a guest account (ask me later)
- Get an bitbucket or github account (read their Git tutorials (quite intuitive)) — free private repos using your college email account
- You will be assisted by very capable demonstrators – also, learn collaboratively with your classmates!

COMPUTER GUIDELINES AND RULES

- You are responsible for your computer hardware and software (we have your money!)
- You should be able to install all necessary (open source) software
- Your computer is your main tool, you are expected to achieve a high degree of mastery of it!
- Return it to Martin Selby at end of Course (CMEE Masters) or Bootcamp/Winter term (QMEE CDT)
- We expect it to be undamaged
- Please do not leave your computer in any room (other than your residence!) overnight, starting now

HANDBOOK AND LECTURES

- Please check key dates for coursework and reports in your guidebook
- Lectures:
 - 2 1-hr lectures in the morning (1000 – 1230, except in some cases)
 - 3-hour practical in afternoon, except on Wednesdays
 - Lecturers will stay for at least 1 hour of practical session
 - There may be deviations from this – check updated timetables (usually)!
 - Demonstrators will be available during practicals in botcamp and most other weeks
 - Most lectures in CPB or Hamilton Comp room in first 9 weeks, then Wallace Room after MRes cohort finishes

SEMINARS

- Thursday seminars at 1300 hrs in this building (web link in guidebook)
- Students must attend Thursday seminars – 1/2 page summary each of min 12 seminars (seminar diary) due after seminar series ends in summer
- You are encouraged to give talks for feedback / discussion at other times of the week, especially in the Spring — great for running ideas past peers (you can give multiple short ones)
- There bi-weekly Social Seminar Series (Beer, Pizza, Talks!) is also a great platform to give a talk.

WORKSHOPS AND SYMPOSIA

- Workshops organized by us are all optional, but strongly recommended – check guidebook
- Some important ones this week
- Summer graduate symposium on Frontiers in Ecology and Evolution (FrEEC Symposium – freesymp.org):
 - Week 2 of September, organized by Masters + PhD students + Postdocs
 - More details in Silwood Masters Student Guidebook

ASSESSMENT AND MARKING

Activity	MSc CMEE	MRes CMEE
<i>Lectures + practicals, with assessment</i>	Required for 19 weeks	Required for first 9 weeks, optional attendance in MSc modules within reason thereafter
<i>Exams</i>	Required	Not required
<i>Project report (Dissertation)</i>	Required	Required
<i>Seminars</i>	Required, seminar diary to be submitted based on the attendance of a minimum of 12 seminars	Required, seminar diary to be submitted based on the attendance of a minimum of 12 seminars
<i>Workshops</i>	All optional	All optional

WARM-UP FOR THE BOOTCAMP AND REST OF THE COURSE

- Get Linux on your computer (if applicable)! (google - “Install Ubuntu”)
- Lots of UNIX tutorials out there. Try
<https://software-carpentry.org/lessons/> (Chapter “shell”).
- Excellent book on Git: <http://git-scm.com/book>, also,
<https://www.atlassian.com/git/>
- See <http://www.andy-roberts.net/writing/latex/benefits>
- Also, Word vs. L^AT_EX:
http://openwetware.org/wiki/Word_vs._LaTeX
More extensive list in Guidebook and Course notes (are you getting my emails?)

REST OF THE COURSE/BOOTCAMP

- A number of Readings/Resources on the git repo
- Read, Read, Read about concepts and models in Ecology & Evolution!
- Happy QMEE (Boot)campers — if you plan to attend any of the weeks beyond the Bootcamp, please let Joel Santana-Mondo know!
 - You may skip parts of the Bootcamp that are too basic for you
 - You need to return your Laptop (if applicable) latest by end of Winter term

More extensive list in guidebook and Course notes (did you get my email?)

QUESTIONS?



(soon to be) Famous CMEE Fungus