

MSc and MRes in Computational Methods in Ecology & Evolution: Introduction

Samraat Pawar & James Rosindell

Silwood Park

**Imperial College
London**

October 2, 2016

WHY ECOLOGY AND EVOLUTION?

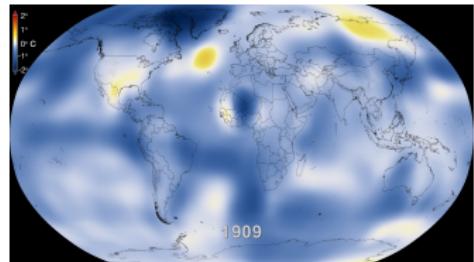


Big Fish Eat Little Fish, 1557, Pieter van der Heyden

BECAUSE WE LIVE IN “INTERESTING” TIMES

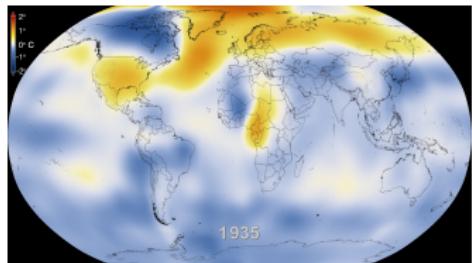
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- Climatic warming and fluctuations



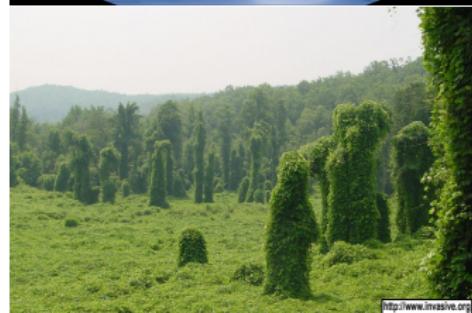
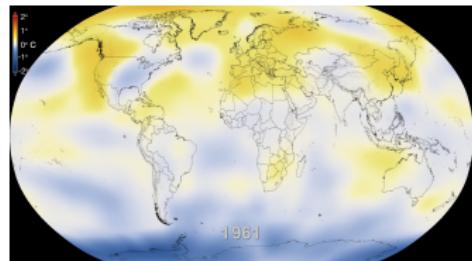
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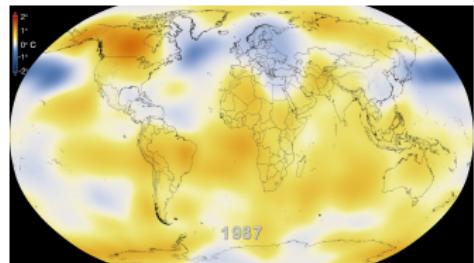
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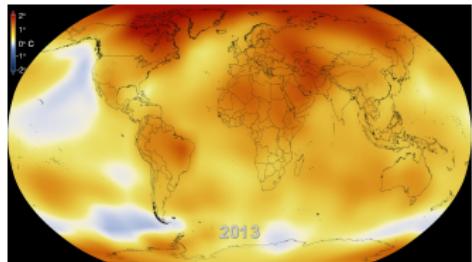
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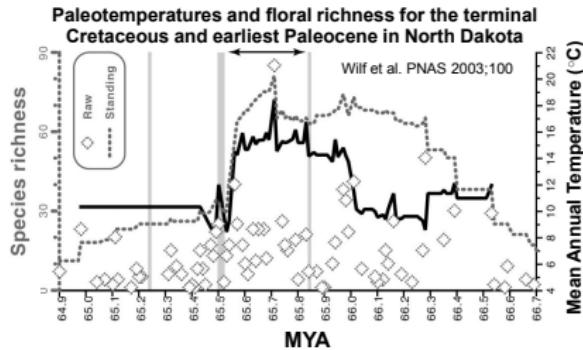
BECAUSE WE LIVE IN “INTERESTING” TIMES

- Climatic warming and fluctuations
- Species range shifts and invasions
- Overexploitation of ecosystems



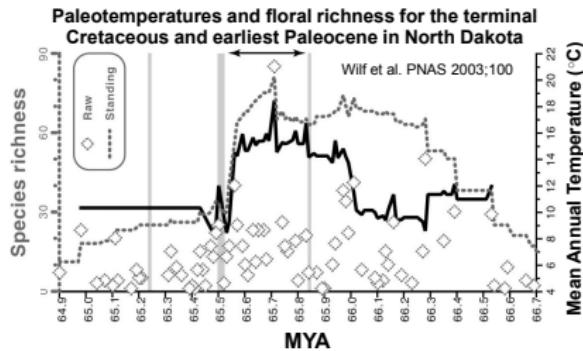
SOME WORRYING EFFECTS ON (COMPLEX) BIOLOGICAL SYSTEMS

- Loss or collapse of ecosystem function



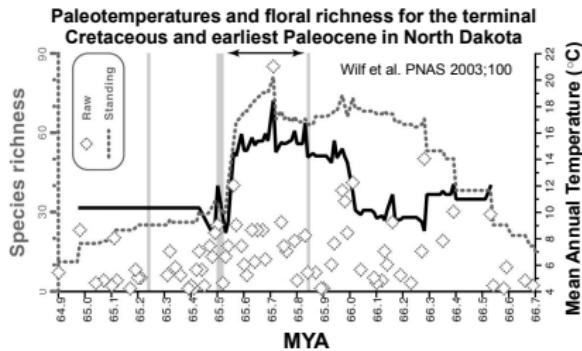
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- Loss or collapse of ecosystem function
- Loss of ecosystem recovery or succession



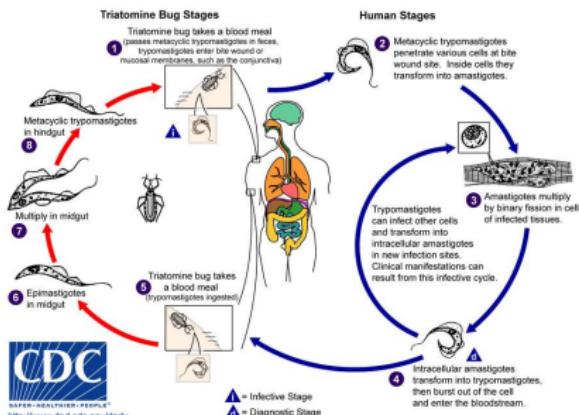
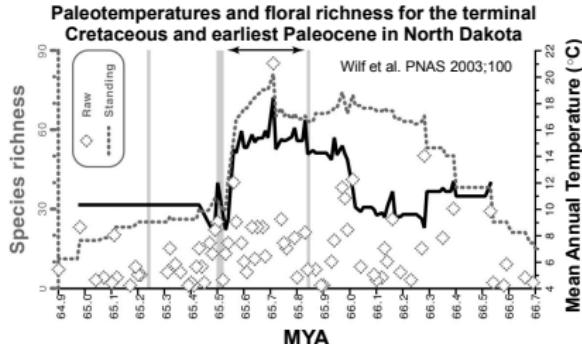
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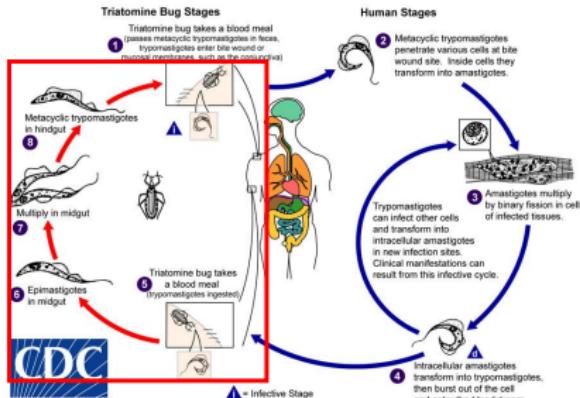
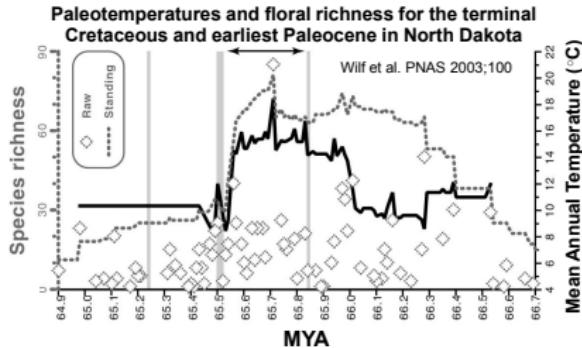
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- Loss or collapse of ecosystem function
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- Disease emergence & outbreak



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WHY ECOLOGY AND EVOLUTION?

Individuals

System \Rightarrow Metabolic rate & fitness

Traits: Body size, Thermal sensitivity, Respiration rate, Body velocity, etc.



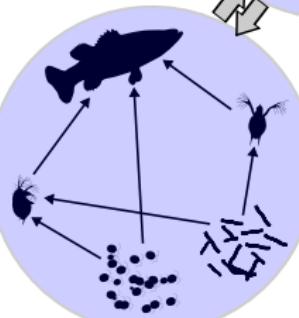
- Generalities and deviations in metabolic and biomechanical traits
- Evolution of thermal responses and origins of physiological mismatches

Environmental forcing
(Temperature, Physical medium)

- Stability of ecosystem services
- Ecosystem resilience, invasions, re-assembly
- Disease dynamics
- Evolution in complex networks

Interaction networks

System \Rightarrow Multi-population dynamics & community stability



Interactions

System \Rightarrow Coupled population dynamics & mean fitness

- Biomechanics of interaction rates
- Consequences for consumer-resource and competitive dynamics (including invasions)

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

Joel E. Cohen

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Read it! (its on the course repository)

WHY Computational ECOLOGY AND EVOLUTION?

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- Need reproducible analyses and work-flows that link theory, data, analyses

ergo, Computing!



BUT ABOVE ALL, IT'S ABOUT THE BIOLOGY!

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)

OK, BUT WHY 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)
- 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)
- Conservation biology (Knight, Mills)
- Microbial systems (Bell, Barraclough, Raymond)

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- Population genetics (Burt, Schroeder, Hodgson, Barraclough)
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- Lots more, and there are multiple campuses!

WHAT YOU WILL LEARN

- Good competence in quantitative methods for addressing modern biological problems
- How to select a quantitative tool to address a biological problem
- An ability to develop, analyse, numerically simulate, fit models to data and interpret
- Quantitative models of biological systems, including statistical and mathematical (MSc) models
- Techniques in Population biology, Population genetics, genomics and GIS
- How you design and conduct research, with the necessary computational workflows – *please have a look at past projects!*

Note that MSc's have about double the coursework in these areas

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 Tutor</i>	Mr. Samuel D Thompson (samuel.thompson14@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 should receive a computer, bag, mouse, keyboard, room key, power supply, stand if you want it
- Turn it on – its Ubuntu 14.04 64 bit
- If you are using your own laptop – use Ubuntu 14.04 64 bit or higher
- Make sure you can:
 - Access secured imperial wireless (use college name and password)
 - Access the library website
 - Access Blackboard (bb.imperial.ac.uk) and give it a spin
- Get an account at bitbucket.org using your imperial college account, read their Git tutorials (very intuitive!)
- 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
- You should be able to install all necessary (open source) software
- Your computer is your tool, you are expected to achieve a high degree of mastery of it!
- You return it to Jim Culverhouse at end of course
- We expect it to be undamaged
- Please lock Seminar room 2 (we will keep it open for study) when not in it – should happen automatically (talk to Jim Culverhouse)
- Please do not leave your computer in any room (other than your residence!) overnight, starting now

HANDBOOK AND LECTURES

- Printed guidebooks may become outdated, download updated ones from the bitbucket repo
- Please check key dates for coursework and reports
- 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 one more demonstrators will be available during practicals
 - All lectures in this room (Wallace) or CPB, except where noted

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 16 seminars (seminar diary) due at end of course
- 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)!

SEMINARS AND WORKSHOPS

- 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 (FrEE):
 - Week 1 of September, organized by Masters + PhD students
 - More details in Silwood guidebook

ASSESSMENT AND MARKING

Activity	MSc CMEE	MRes CMEE
<i>Lectures + practicals, with assessment</i>	Required for first 20 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 required for a minimum 16 weeks	Required, seminar diary required for a minimum 16 weeks
<i>Workshops</i>	All optional	All optional

ASSESSMENT AND MARKING

Component	MSc CMEE		MRes CMEE	
	% of Course	% of Component	% of Course	% of Component
Coursework				
<i>Computing</i>	13.75	55	13.75	55
<i>CMEE Mini-project</i>	6	24	6	24
<i>HPC Long Practical</i>	5	20	5	20
<i>Seminar Diary</i>	0.25	1	0.25	1
Coursework Total	25	100	25	100
Exams				
<i>Exam 1</i>	10	40	–	–
<i>Exam 2</i>	15	60	–	–
Exam Total	25	100	–	–
Project				
<i>Final Report + Presentation</i>	35	70	52.5	70
<i>Viva</i>	12.5	25	18.75	25
<i>Supervisor mark</i>	2.5	5	3.75	5
Project Total	50	100	75	100

IMPORTANT DATES

Date	Activity/Item due
9 Dec, 5PM	MRes: Project proposal
15 Dec, 5PM	MSc, MRes: HPC Long Practical
17 Feb, 5PM	MSc, MRes: CMEE Miniproject
7 April, 5PM	MSc, Project proposal
25 Aug, 5pm	MSc, MRes: Seminar Diary

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Further important dates, including thesis submission are same across all Silwood Masters courses – **please refer to the Silwood Student Guidebook**

WARM-UP FOR REST OF THE WEEK

- Lots of UNIX tutorials out there. Try
<http://software-carpentry.org/lessons.html>
(Chapter “shell”). (watch video tutorials or read pdfs)
- 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 (did you get my email?)

QUESTIONS?



(soon to be) Famous CMEE Fungus