RITA CASTILHO

MARINE BIOGEOGRAPHY AND EVOLUTION

COURSE CONTENT
COURSE OVERVIEW

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COURSE CONTENT
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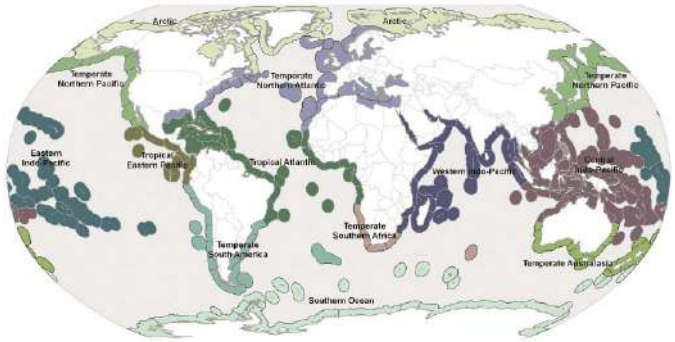
COURSE CONTENT

Scope

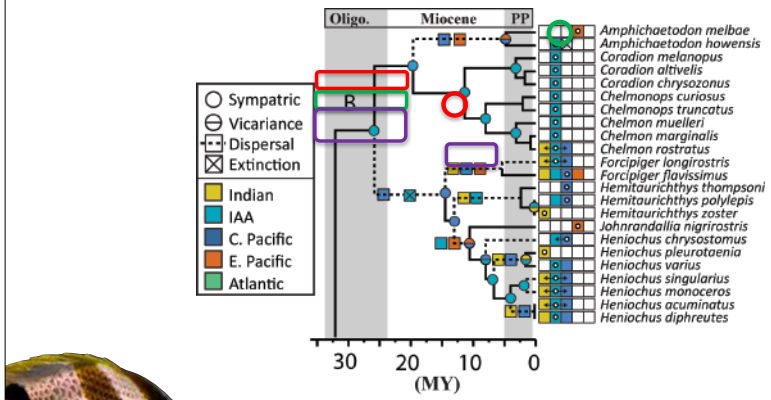
Biogeography investigates the relationships between patterns and processes of geographic distribution of organisms



Spalding et al. 2007

Scope

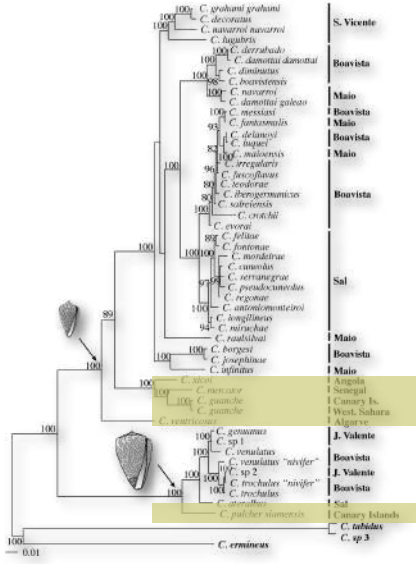
Reconstructing the historical development of lineages and biotas, including their origin, spread, and diversification



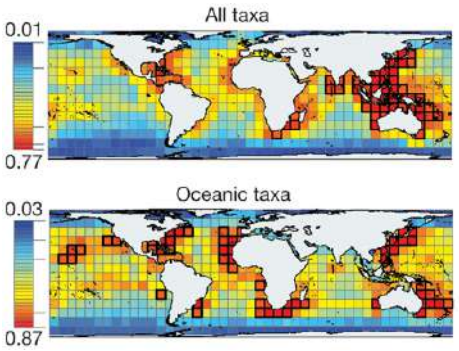
Bannerfishes
(Chaetodontidae)

Cowman, http://eprints.jcu.edu.au/23789/

Cunha et al. (2005) Syst. Biol.



Cunha et al. 2005

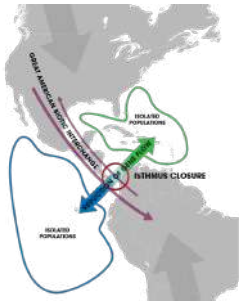


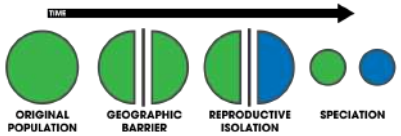
Scope

Explaining the differences in numbers as well as types of species among geographic areas, and along geographic gradients including those of areas, isolation, latitude, elevation, and depth

Scope

How have historical events shaped species' distribution?

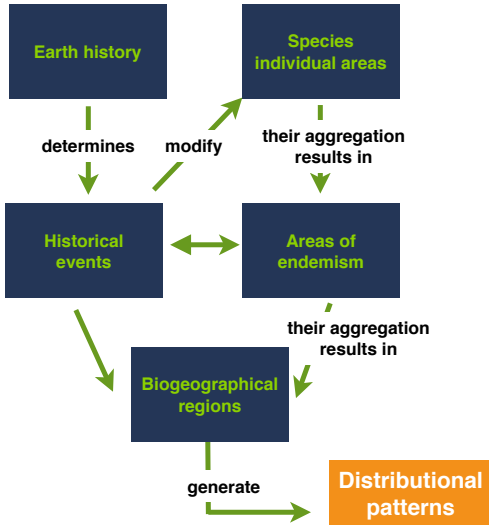




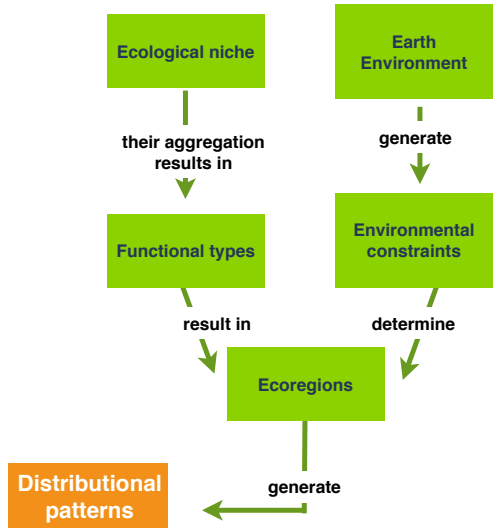
Scope

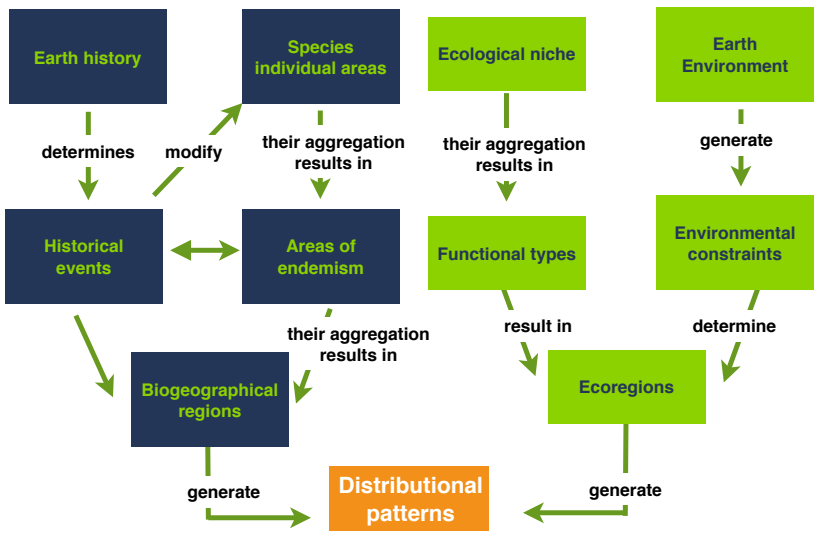
Intra and inter-specific approaches, different time-scales,

Historical Biogeography



Ecological Biogeography





Goals

Explain the differences in numbers as well as types of species among geographic areas, and along geographic gradients including those of areas, isolation, latitude, elevation, and depth

Techniques

Simulation modeling - GIS - Statistical Analysis - Remote Sensing - Submersible vessels - Automated ground-based data collection systems - Radioisotopes - Stable isotopes - Genetic tools

Week 1

Introduction and a case study to setup the scene:

World-wide phylogeography of sardines

Week 2

Historical and Ecological biogeography

Week 3

Ocean Ecosystems

Evolution of Coral Reef Fish

Dispersal

Week 4

Phylogeography

Biogeographic and genetic consequences of the glaciations

Week 5

Island Biogeography

Case-studies

Week 1

Learning insights

Publishing in science

Visualizing data: software, graphs, the use of color and shapes.

Week 2

Area relationships

Part 1. Exploratory data session: summary of biodiversity and graph building

Week 3

Area relationships

Part 2. Exploratory data session: area cladograms

Part 3. Presence records and plot

Week 4

Area relationships

Part 4. Species distribution modeling

am I teaching

WHY THIS COURSE?

- Assistant Professor
- PhD Evolutionary Biology/Population Genetics (UK)
- Research in Evolutionary Biology/Population Genetics/ **Phylogeography**
- Classes: [Animal Diversity], [Bioinformatics], Evolution,

  Population Genetics applied to Fisheries

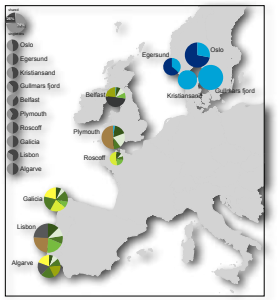
R2C2 research group

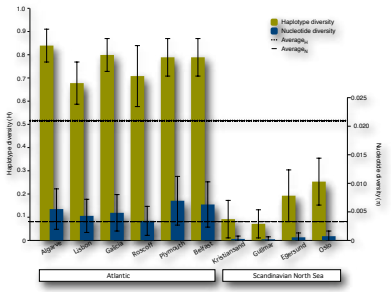
Ecology and Evolution

Open Access

Northern refugia and recent expansion in the North Sea: the case of the wrasse *Symphodus melops* (Linnaeus, 1758)

Joana I. Robalo[1], Rita Castilho[2], Sara M. Francisco[1,3], Frederico Almada[1], Halvor Knutsen[4,5,6], Per E. Jorde[4,5], Ana M. Pereira[1,7] & Vitor C. Almada[1]



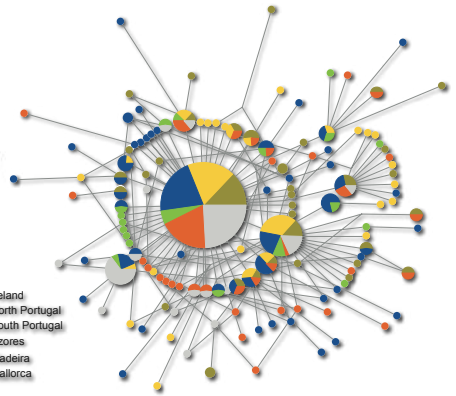


Mar Biol (2012) 159:1509–1525
DOI 10.1007/s00227-012-1936-3

ORIGINAL PAPER

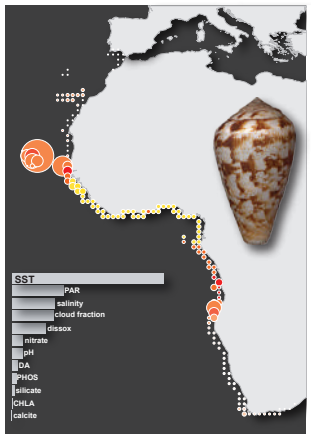
Population structure and connectivity of the European conger eel (*Conger conger*) across the north-eastern Atlantic and western Mediterranean: integrating molecular and otolith elemental approaches

Alberto T. Correia · Ana A. Ramos · Filipe Barros · Gonçalo Silva · Paul Hamer · Pedro Morais · Regina L. Cunha · Rita Castilho



Evolution at a Different Pace: Distinctive Phylogenetic Patterns of Cone Snails from Two Ancient Oceanic Archipelagos

Regina L. Cunha[1,*], Fernando P. Lima[2], Manuel J. Tenorio[3], Ana A. Ramos[1], Rita Castilho[1], and Suzanne T. Williams[4]



OPEN

Heredity (2015), 1–11
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www.nature.com/hdy

ORIGINAL ARTICLE

Establishment of a coastal fish in the Azores: recent colonisation or sudden expansion of an ancient relict population?

S Stefanni[1,2], R Castilho[3], M Sala-Bozano[4], JI Robalo[5], SM Francisco[5], RS Santos[5], N Marques[1], A Brito[6], VC Almada[5,8] and S Mariani[2,8]

P PORTUGAL ECONOMIA MUNDO DESPORTO CULTURA+ÍPSILON TECNOLOGIA CIÊNCIA OPINIÃO MULTI

MULTIMÉDIA TÓPICOS

A safia chegou aos Açores

RITA PONCE

Começou a ser avistada nos Açores no final dos anos 1990, hoje a safia é comum nestas águas. Pensa-se que o aquecimento do mar terá facilitado esse fenómeno.

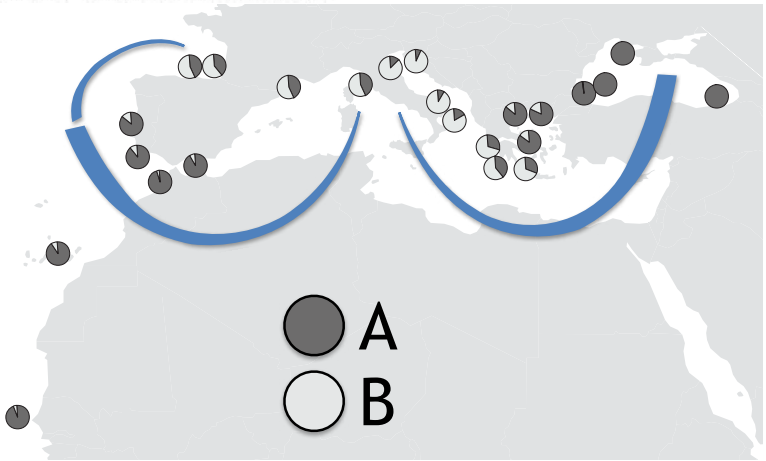
ELSEVIER

Available online at www.sciencedirect.com
SCIENCE DIRECT®
Molecular Phylogenetics and Evolution xxx (2006) xxx–xxx

MOLECULAR PHYLOGENETICS AND EVOLUTION
www.elsevier.com/locate/ympev

Mitochondrial DNA reveals a mosaic pattern of phylogeographical structure in Atlantic and Mediterranean populations of anchovy (*Engraulis encrasicolus*)

A. Magoulas [a,*,1], R. Castilho [b,1], S. Caetano [b], S. Marcato [c], T. Patarnello [a]

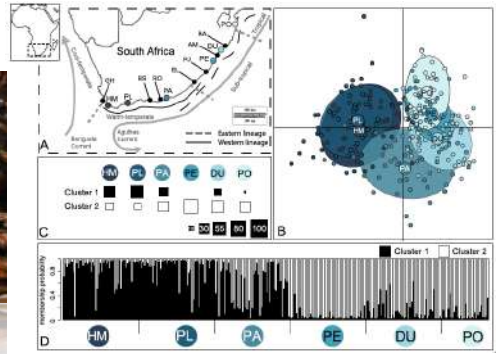


BMC Evolutionary Biology

RESEARCH ARTICLE Open Access

Intraspecific genetic lineages of a marine mussel show behavioural divergence and spatial segregation over a tropical/subtropical biogeographic transition

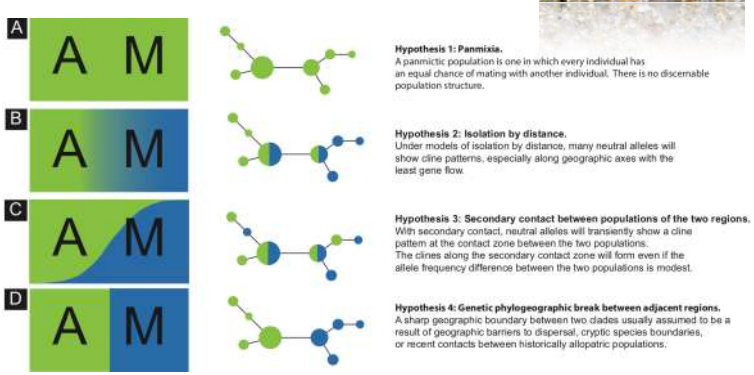
Gerardo I Zardi[1*], Katy R Nicastro[1*], Christopher D McQuaid[1], Rita Castilho[2], Joana Costa[2,3], Ester A Serrão[3] and Gareth A Pearson[3]



Asymmetrical dispersal and putative isolation-by-distance of an intertidal blenniid across the Atlantic–Mediterranean divide

Rita Castilho[1], Regina L. Cunha[1], Cláudia Faria[2], Eva M. Velasco[3] and Joana I. Robalo[4]

PeerJ



Hypothesis 1: Panmixia.
A panmictic population is one in which every individual has an equal chance of mating with another individual. There is no discernable population structure.

Hypothesis 2: Isolation by distance.
Under models of isolation by distance, many neutral alleles will show cline patterns, especially along geographic axes with the least gene flow.

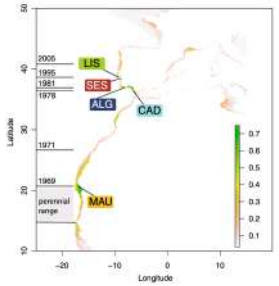
Hypothesis 3: Secondary contact between populations of the two regions.
With secondary contact, neutral alleles will transiently show a cline pattern at the contact zone between the two populations. The clines along the secondary contact zone will form even if the allele frequency difference between the two populations is modest.

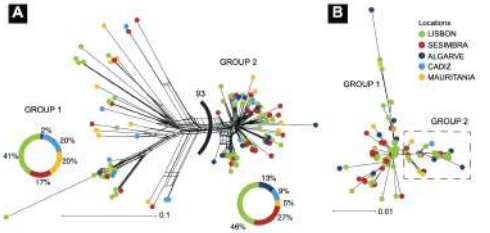
Hypothesis 4: Genetic phylogeographic break between adjacent regions.
A sharp geographic boundary between two clades usually assumed to be a result of geographic barriers to dispersal, cryptic species boundaries, or recent contacts between historically allopatric populations.

Against all odds: a tale of marine range expansion with maintenance of extremely high genetic diversity

Joana I. Robalo[1], Sara M. Francisco[1], Catarina Vendrell[1,2], Cristina S. Lima[1], Ana Pereira[1], Benedikt P. Brunner[3], Mamadou Dia[4], Leonel Gordo[2] & Rita Castilho[3,5]

SCIENTIFIC REPORTS





are you in

WHY THIS MASTER?

What term best describes your background?

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What is your intended professional future

- Academia (teaching + researching)
- Researcher
- Manager (conservation, fisheries, etc)
- None of the above

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Do you intend to pursue a PhD?

- Yes
- No
- C
- D
- None of the above

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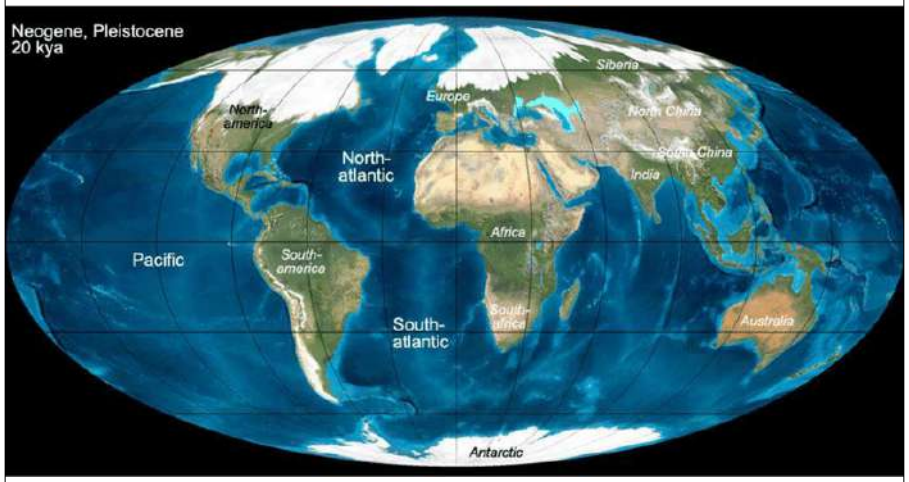
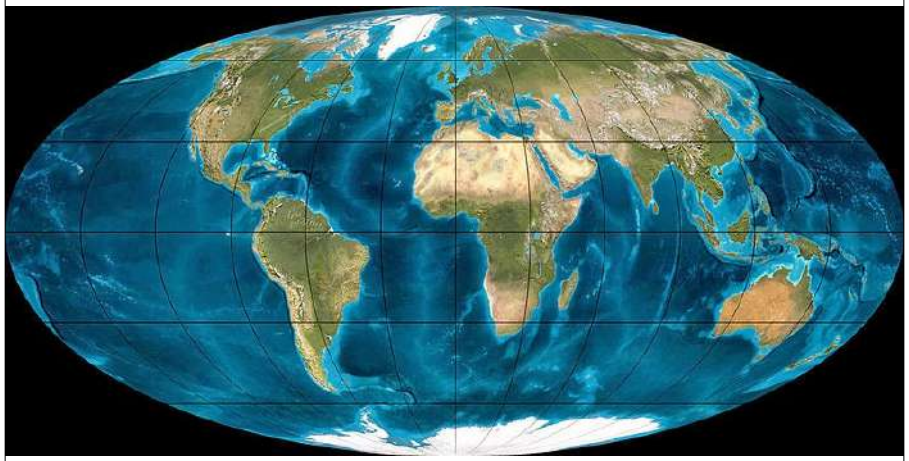
MAP EVOLUTION

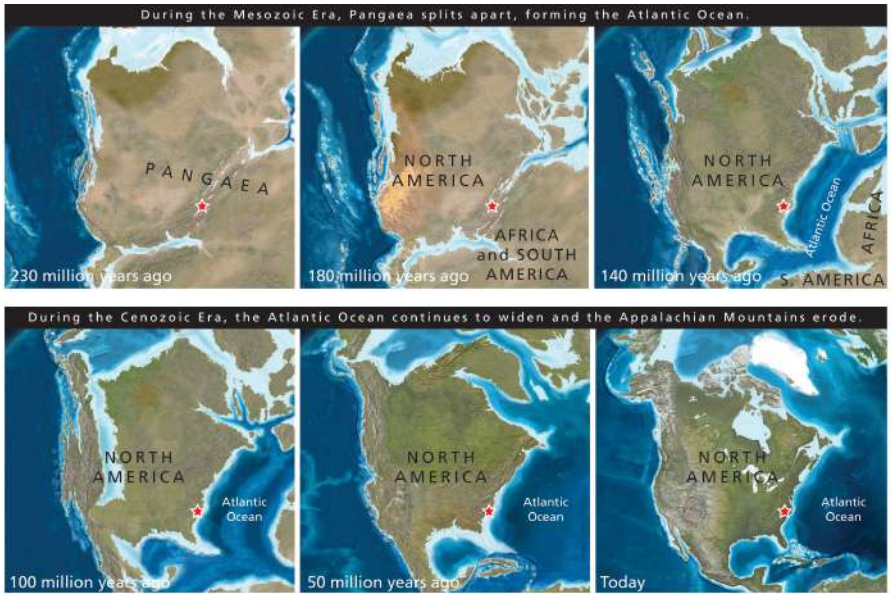
World map, c.1500, by Juan de la Cosa, pilot on Columbus's second expedition. Courtesy of Naval Museum, Madrid

500 YEARS LATER

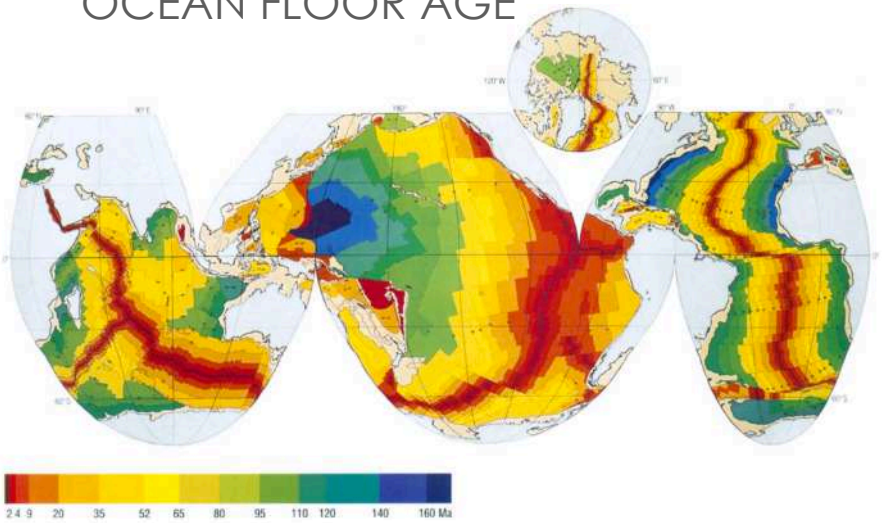




EARTH EVOLUTION

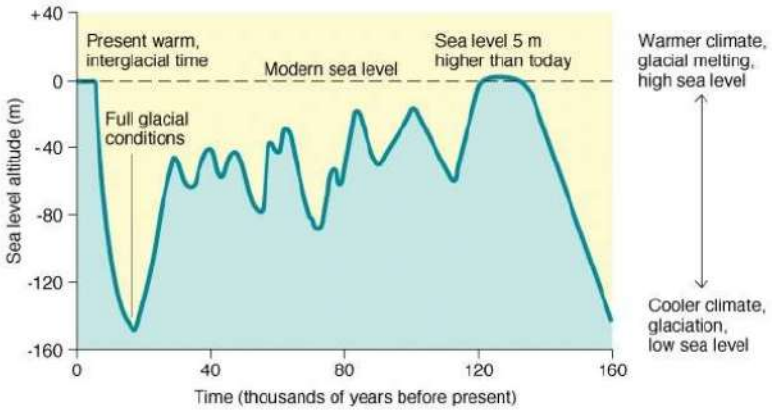


OCEAN FLOOR AGE



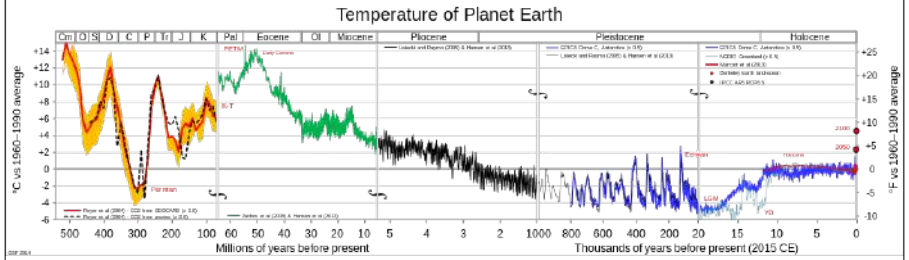
The age of the ocean floor, showing strips of floor of different ages derived mainly from measurements of magnetic anomaly stripes. Boundaries are drawn at 2, 4, 9, 20, 35, 52, 65, 80, 95, 110, 120, 140 and 160 Ma intervals in a colour scheme that runs from dark grey (youngest) through red, yellow, and green to blue (oldest). Pale brown areas are the continental shelves

LATE QUATERNARY SEA LEVEL



CLIMATE CHANGES

500 MILLION YEARS OF GLOBAL TEMPERATURE



CLIMATE CHANGE
EFFECTS ON MARINE BIODIVERSITY AND LOCAL COMMUNITIES

OCEAN TEMPERATURE INCREASE

As climate change has warmed the Earth, oceans have been increasing their temperatures.

OCEAN ACIDIFICATION

Increasing amounts of carbon dioxide (CO_2) in the oceans combined with seawater produces carbonic acid, increasing the acidity of the water.

SEA LEVEL RISE

Climate change is causing the oceans to heat up, melting polar glaciers, resulting in rising sea levels.

CHANGES IN OCEAN CURRENTS

Increasing ocean temperatures and significant amounts of melting fresh water may result in a slowing of the ocean conveyor belt, altering oceanic current patterns, changing global weather conditions and disrupting marine food webs.

EXTREME WEATHER EVENTS

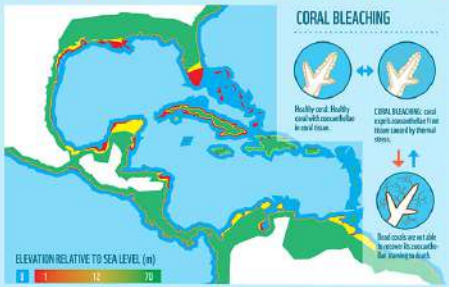
Increasing sea surface temperatures increase evaporation and atmospheric moisture, creating and facilitating environmental conditions for ocean storms to escalate into larger and more powerful systems.

Climate change is affecting the world's oceans modifying their temperature, nutrient supply, water chemistry, wind systems, and ocean currents, dramatically impacting marine biodiversity. The situation is no different in the Mesoamerican Reef, the second largest reef in the world.

Climate change is exacerbating anthropogenic (e.g., water pollution, land run off, overfishing) and natural (e.g., storms, coral disease) threatening the heart of Caribbean culture and economies.

VULNERABILITY TO SEA LEVEL RISE

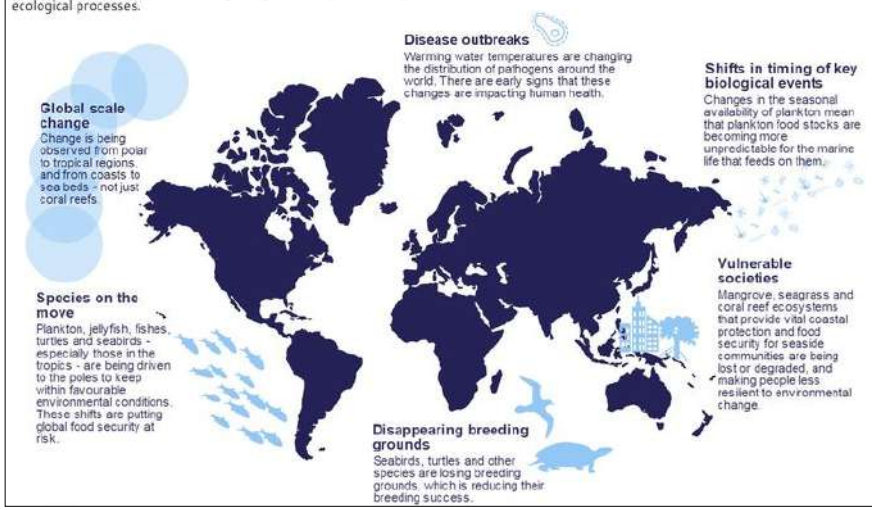
Numerous model predictions foresee a sea level rise of 1 additional meter by 2100, which would displace millions of people and would cause billionaire losses in infrastructure.

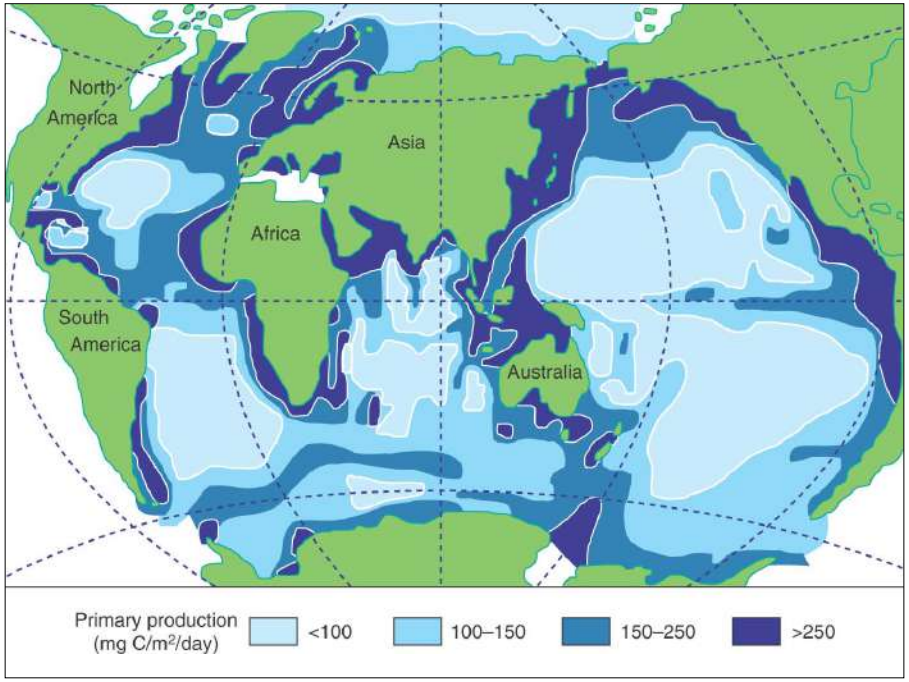


CORAL BLEACHING

A warming ocean

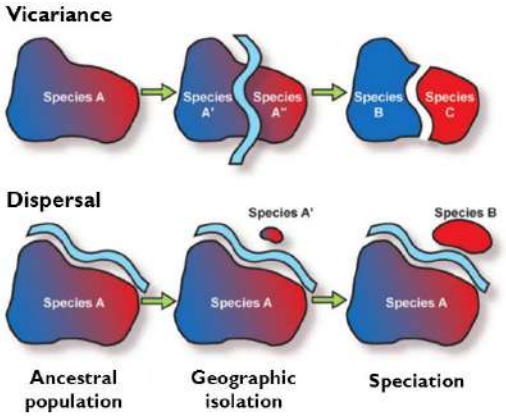
Since the 1970s, the Earth's ocean has absorbed more than 93% of the enhanced heating arising from human activities. This extra heat is causing changes in the ocean, which are beginning to alter species, ecosystems, and ecological processes.

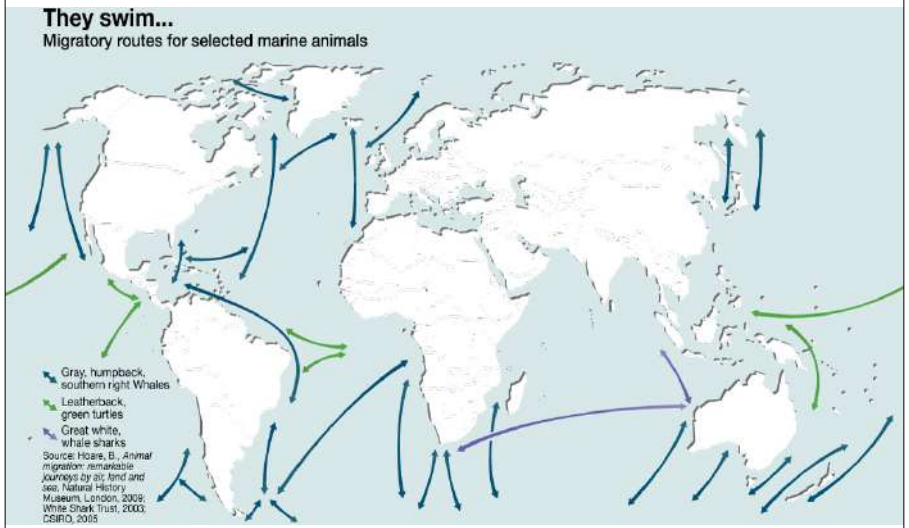




ORGANISMS' MOVEMENTS

VICARIANCE VS DISPERSAL

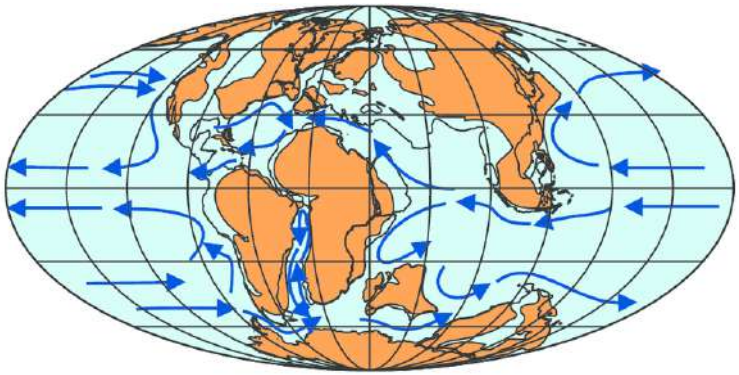




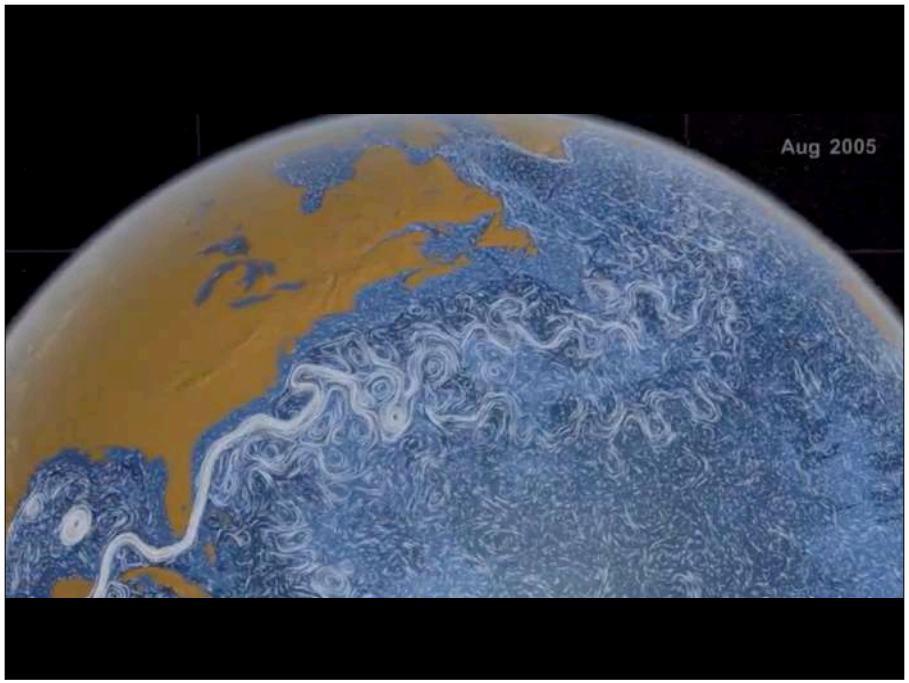
Carlton 2017 .Science

CURRENTS

OCEANIC CIRCULATION IN THE MID-CRETACEOUS



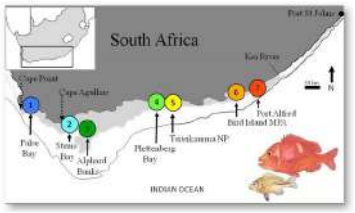
from Hay 2009 Cretaceous oceans and ocean modeling



WHAT DO I EXPECT YOU TO LEARN?

Basic information

Course description



Marine biogeography:
study of the geographical distribution of marine organisms

- Origins of biogeography as an historical science,
- The biogeographic evidence that supports the theory of evolution.
- Continental drift.
- The relationship of phylogeny and biogeography.
- Basic concepts of evolution and biogeography
- Application of methods used to study evolution and biogeography
- Case histories to demonstrate the role of historical events

Marine biogeography: study of the geographical distribution of marine organisms

I. The **History** of Biogeography (the science of biogeography, phylosophy and basic principles and approaches, pivotal biogeographers, examples of contemporary biogeography)
II. **Phylogeography** - models of speciation, phylogenetic inference, molecular clock, historical demography.
III. **Paleogeography** - dating events, geological time scales, continental drift, evolution of ocean basins (Tethys, Atlantic, Mediterranean), paleoclimates, past sea levels.
IV. **Case studies**: the Atlantic/Mediterranean divide; coastal species, estuarine species; open ocean species and deep-sea species.

WEB

http://rcastilho.pt/MBE

Basic information

Worktime

Contact time (hours)
Theoreticals: 15h (10 sessions)
Computer Labs: 24h (6 sessions)

Independent study: ca. **100h**

Basic information

Teaching and learning methods

I. Dedicated **webpage**, with all relevant information: chronogram of lectures, with reading materials available beforehand.
II. **Audio-visual** subject presentation, with open discussion in class. Lectures will be mixed with discussions of assigned readings from the primary literature to stimulate critical thinking about the various topics.
III. **Computer lab classes** with exercises available beforehand. Group discussion encouraged.

Basic information

Teaching and learning methods

Computer lab classes

- **Objectives**
- **Work**
- **Computers**
- **Breaks**

Basic information

Expected learning outcome

I. To understand and be familiar with the methods used to study the biogeography of marine organisms;
II. To have a knowledge of the evolutionary history, life history, distribution patterns, speciation patterns of a number of marine organisms;
III. To be able to critically evaluate current concepts of marine species and factors influencing speciation and distribution patterns;
IV. To understand the applications of historical and ecological biogeographic analyses in the study of marine systems.
V. Critically evaluate arguments and assumptions and interpret published data relating to marine biogeography and phylogeography in particular;
VI. Utilize the scientific process to form hypotheses and design studies for gathering and analyzing data from which to draw scientifically valid conclusions

Basic information

EVALUATION

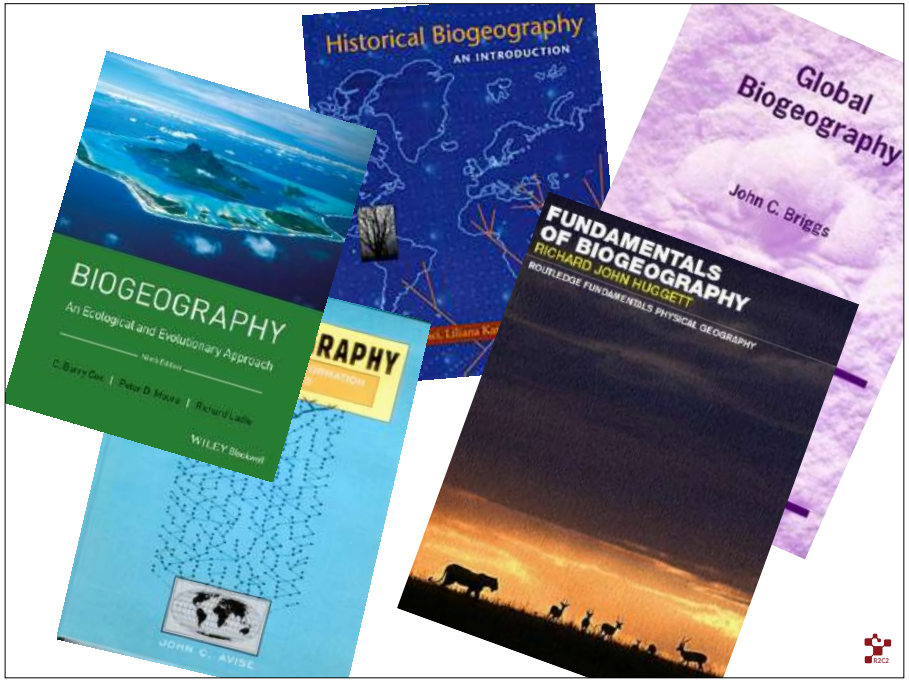
The evaluation will be based on:

1. written examination. **70%**

Students scoring less than 10/20 on the written examination are required to have a re-sit exam.

2. Flash talk. **30%**

Oral presentation in 3 minutes on a a free topic related to biogeography.



LET'S JUMP INTO A CASE STUDY