Les microbes marins : acteurs de la santé de la planète et marquers de la santé des océans

Chris Bowler CNRS Institut de Biologie de l'Ecole Normale Supérieure







Summary of talk

The ocean that protects us

The ocean under threat

The ocean and human health
 Exploration of marine microbes

The ocean, the planet's thermostat

Vers l'espace Énergie solaire Énergie solaire L'énergie piégée augmente l'effet de serre Augmentation Vers l'atmosphère des gaz à effet de serre Restitution d'énergie plus 10000 Stockage d'énergie supplémentaire stockée dans l'océan www.ocean-climate.org www.ocean-climate.org dans l'océan

AVANT LE DÉVELOPPEMENT INDUSTRIEL

SITUATION ACTUELLE

Augmentation de l'effet de serre



Pompe à carbone physique

Around 25% of the CO2 gener activities has been absor cean since the start of the ind



pump



Pompe à carbone biologique







Photosynthetic bacteria and protists generated the oxygen on Earth



The Plankton

THE INVISIBLE MULTITUDE

✓ BASIS OF THE OCEANIC FOOD WEB

SEQUESTER ATMOSPHERIC CO₂ IN THE OCEAN

GENERATE THE OXYGEN WE BREATHE

THE MOST IMPORTANT BIOLOGICAL CARBON PUMP ON THE PLANET

✓ AFFECT AND ARE AFFECTED BY CLIMATE CHANGE

>90% of the biomass in the ocean





0.1-100/litre



E.Reynaud, UCD, Dublin





E.Reynaud, UCD, [

Bacteria/Archaea:

0.1-1 billion/litre

TARA Ocean













Ocean Life Affects and is Affected by Climate

- SEQUESTRATION OF CO2
 SNOWBALL EARTH EVENTS
 GENERATION OF CLOUD-GENERATING DMSP AND OTHER AEROSOLS
- CHANGES IN ABUNDANCE AND SPECIES DIVERSITY
 SPECIES MIGRATIONS
 DESTABILIZATION OF FOOD CHAINS
 EVOLUTION AND EXTINCTION

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Human impact on the oceans

Halpern et al. Science 2011

Ocean acidification

Ocean pCO2 + pH measurements

Bermuda Atlantic Time Series, http://www.seafriends.org

Sea surface pCO₂ and pH at Station ALOHA

Hawaii Ocean Time series, Dave Karl, UHawaii

Lowered pH could alter Calcification of Marine Organisms

Coralline algae (http://tidechase.blogspot.com)

Radiolarians (http://www.astrographics.com)

Pteropod Limacina helicina - NÔAA

Pteropod (http://noaa.gov)

Coral (http://www.aboututila.com)

An ocean under pressure

Conséquences de l'augmentation du CO2 sur les écosystèmes marins

The ocean is changing

Future vulnerability of marine biodiversity compared with contemporary and past changes

ARTICLES

PUBLISHED CHUNE: 1 JUNE 2015 | DOI: 10.0038/WORMATCHO

Grégory Beaugrand^{12*}, Martin Edwards²³, Virginie Raybaud⁴⁵, Eric Goberville¹² and Richard R. Kirby^{3,6+}

Summary of talk

The ocean that protects us

La beean under threat

The ocean and human health

Exploration of marine microbes

The ocean and human health

2, removal of CO2, temperature

- - Consumption of c
 - Swimming in pollu
 - Exposure to toxin
 - Source of new drug
 - Disease transmission

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The ocean and human health

Indirect effects:

• Generation of O2, removal of CO2, temperature regulation

V Direct effects:

- One half of the world's population lives within 100km of the coast
- Consumption of contaminated seafood
- Swimming in polluted water
- Exposure to toxins from harmul algal blooms
- Source of new drugs for medicine
- Disease transmission

Terra satellite image of a dust plume crossing the Mediterranean sea. Sand and dust from North Africa and the Sahara has blown north towards Italy in a large plume. This image was taken on 16 July 2003 by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS).

Atmospheric sample taken during a dust event in Mali, Africa, showing heavy growth of bacteria and fungi. The volume of air filtered was ~75 litres.

Photo Dale Griffin Microbiology Today (Nov 2005) p 182.

The Case of Cholera

MASSOCIATION AFFAIRS

Global Climate and Infectious Disease: The Cholera Paradigm^{*}

Rita R. Colwell

SCIENCE • VOL. 274 • 20 DECEMBER 1996

Vibrio cholerae

Environmental Signatures Related To Cholera Epidemics

Monitoring the Temporal Patterns of Cholera Transmission Risk

Ames Research Center

Cholera in the Bay of Bengal - Bangladesh

Sea Surface Temperature March 1994

Sea Surface Height Anomaly March 1994

Correlation of Cholera and Chlorophyll Anomalies

Correlation of Cholera and Zooplankton Anomalies

Model for the Transmission of Vibrio Cholerae from the Environment to Humans

Physical & Chemical Characteristics of Water

- temperature
- sunlight
- rainfall
- pH
- dissolved oxygen
- salinity & nutrients

Fecal shedding

returns *V. cholerae* to the water

Biological Characteristics

- algae bloom
- phytoplankton bloom

Zooplankton bloom

(enters into non-culturable state)

V. Cholerae

viable but non-culturable state in the water column & attached to particulates. Commensal or symbiotic relationships

Transmission of V. cholerae

to humans via ingested water containing colonized copepods or other vectors.

Source: Dr. Rita Colwell

Incidence Proportion by Coverage Rate

Source: Dr. Abul Hussam

त्रता के SONO किल्हान के FILTER

ET MILLIN

Schematic Diagram of SONO - FILTER

Model SF-TWIN, Patent 1003935, 2002

Spec and appearance may change for improvement

Arsenic Filter Based on Composite Iron Matrix Flow: 20-60 liters per hour As(Total) < 10 ppb (CL 95%) As(III) < 2 ppb (CL 99.9%) Life: 5 years minimum Maintenance: very low Cost: US \$35.00 -\$40.00 Waster: Completely nontoxic

Government approved and ETVAM program verified

Bangladesh

An ocean under pressure

Conséquences de l'augmentation du CO2 sur les écosystèmes marins

Increased risk of floods, potentially displacing tens of millions of people, due to sea level rise and heavy rainfall events, especially in small island states and low-lying deltaic areas.

Bangladesh is projected to lose about 17% of its land area with a sea level rise of one meter - very difficult to adapt due to lack of adaptive capacity

Summary of talk

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he ocean under threat

The manufacture health Exploration of marine microbes

Co-directed by Etienne Bourgois and Eric Karsenti

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TARA OCEANS 2009 - 2012

THE TARA OCEANS POLAR CIRCLE EXPEDITION MAY – DECEMBER 2013

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Tara Oceans studies plankton at PLANETARY SCALE

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Science May 22 2015

TARA OCLANS

Eukarvotic plankton diversity in the sunlit ocean

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Structure and function of the lobal ocean microbiome

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Patterns and ecological drivers of ocean viral communities

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Determinants of community structure in the global plankton Interactome

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OCEANS

Plankton diversity

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Environmental characteristics of Agulhas rings affect interocean plankton transport

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Addition rings provide the principal room for ocura maturata. structure from the lacks Facilie to the Atlantic Issis. Their influence on alphal serves circulation is well known, but their role in plankton transport is largely nearestored. We show that, although the course becomencie structure of stashtan communitine is continuous across the Agailtan choice point, South Atlantic plantice depends to almost compared with Indian Ocean searce populations. Nucleiing and in sits excepting of a young Aprilian ring indicate that strang vertical realing drives complex vitragen civilian, oblights: concentrative restal where and improvement of through the start and the second planting starts of the starts of The ownikar local sectorsment inside Antilias class may nevthe a tobative method is a contributing to the limited dispersal of bulies Generofunktors populations into the Albertic.

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All Tara Oceans data are public

40 million genes

Largest-ever DNA sequencing effort for ocean science.

Genetic sequences collected could represent tens of thousands of new species and ecosystem interactions.

Considering the size of the world's ocean, there is much, much more to discover.

11,535 gigabytes

Size of the *Tara* datasets in the European Nucleotide Archive as of May 2015. This represents 12,581 gigabases roughly equivalent to 135 fully sequenced human genomes.

Unlimited

Potential to discover new knowledge about life in the world's ocean.

Tara data: www.ebi.ac.uk/services/tara-oceans-data

Ocean Microbial Reference Gene Catalog

Assessment of global viral communities

5,476 Viral communities. Only 39 previously known

Viral populations are regionally dominant, but widespread

Data supports seed-bank hypothesis for viral ecology

Brum, Ignacio-Espinoza, Roux, et al. Science (2015)

A new world of marine protists

Saturation at around 130,000 taxa

More than 10 times higher than the number of formally described marine eukaryotic plankton

Around one third cannot be assigned to any known taxonomic group

Scale bar 10µm

Sebastien COLIN, CNRS, Station Biologique de Roscoff, C.deVargas 's group

Merci !