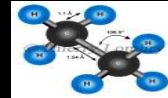
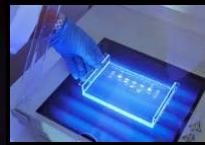


Marine Genetic Resources: Technical Challenges & Values



S. Arnaud-Haond



Marine Genetic Resources: Technical Challenges Values

New York, May 2nd

The marine realm

70% of the biosphere, in three dimensions

34 of the 36 phylum described so far (17 are terrestrial)



Human look to the Ocean: A changing perspective?

•Up to the XVIIIe : a source of danger since Antiquity and the Bible times, supported by piracy. Very few « seamens », mostly looking for ressources



•XVIII and XIXe : After the first circumnavigations and mapping, commercial shipping



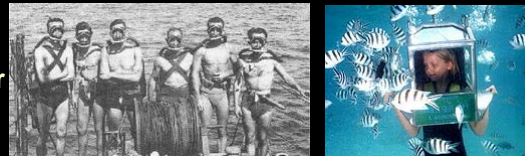
•Late XIX: first scaphanders



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Human look to the Ocean: A changing perspective?

•1949: Gagan&Cousteau:



•First autonomous scaphander

•During the XXe : first scientific circumnavigations (Challenger)



•Pushing the limits: Technical challenges



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A deep investment

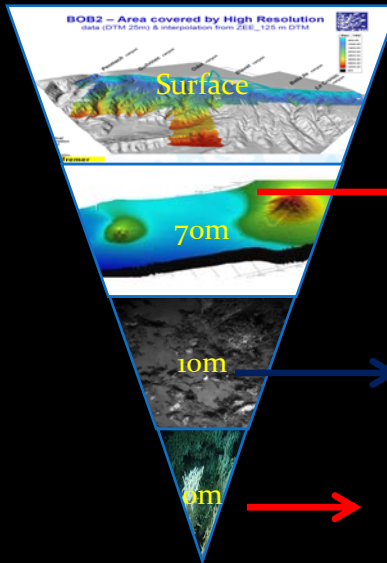


Getting deeper and deeper as we face technological challenges: the challenger deep, 2012: <10.000mt


High price for developing machines (several millions \$) and for oceanographic cruises (several 10.000\$ a day)




A deep investment



Multi beam 

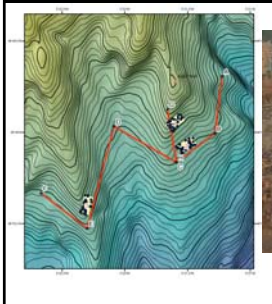
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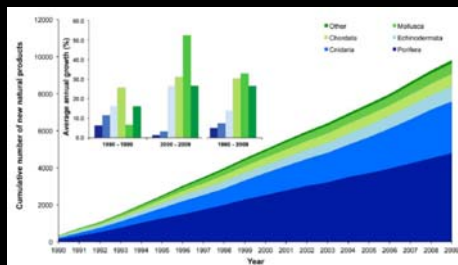


Sampling

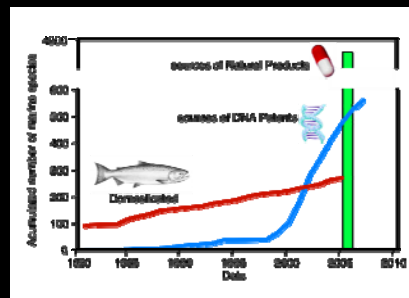


Same profile with Marine Biotechnologies: On the edge of a revolution?

- 1.2 % of patented genes reported in GenBank database with a marine origin, but the increase is exponential



(from Costa-Leal et al., 2012 - pLoSONE)

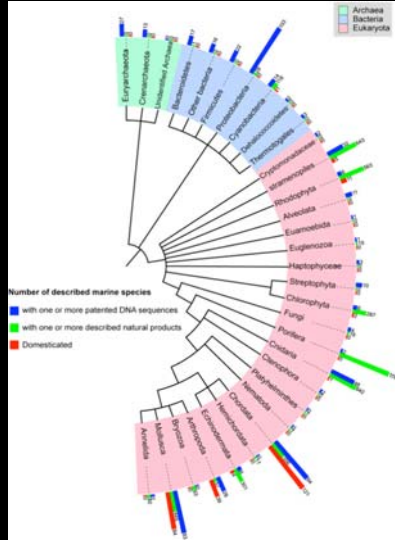


(from Arrieta et al., 2010 – PNAS, and Blunt et al., 2006 – Nat Prod Rep)

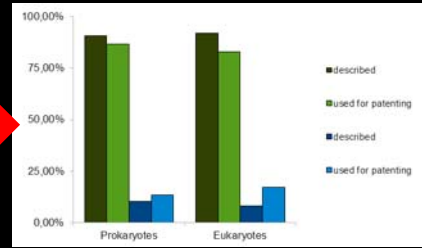
- The use of natural products has also increased dramatically during the last decades



The Marine Reservoir: far the eldest but hardly tackled yet

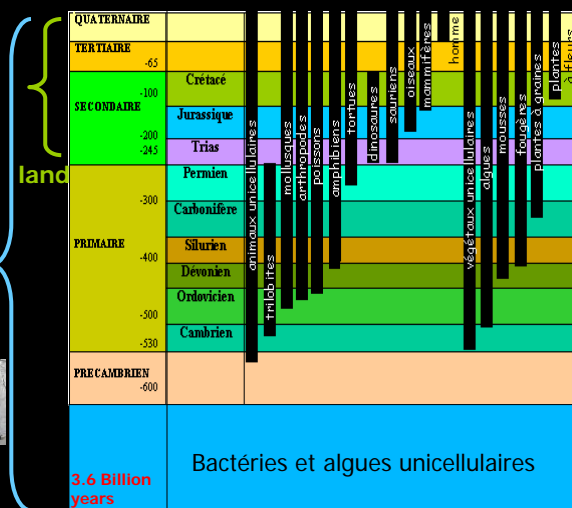
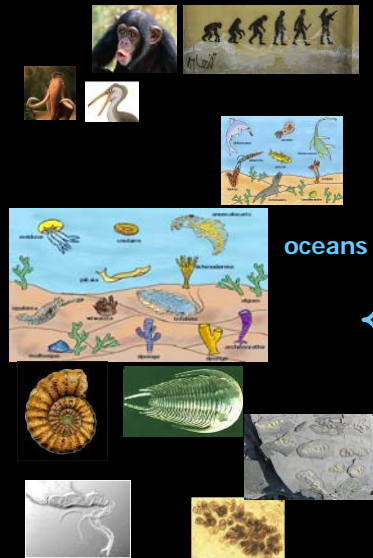


(from Arrieta et al., PNAS 2010)



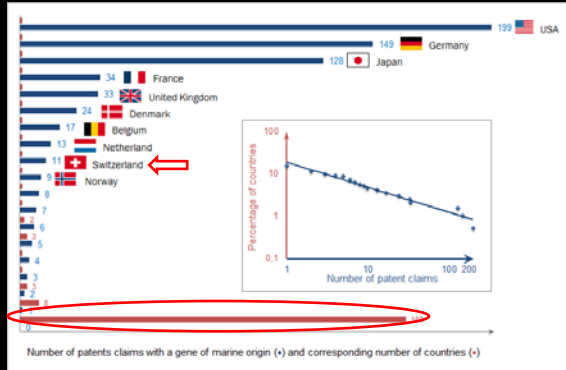
Yield of marine biodiversity *versus* terrestrial one:
 150% for eucaryotes
 210% for procaryote
 3.6 billion years evolution in the marine realm

Evolution of Life : from Oceans to Land



The unbalanced ownership of patents claims

- 10 countries own 90% patent claims, 3 own 70
- A typical power law distribution of wealth
- **The rich gets richer** effect: oceanographic means or molecular skills?



(from Arnaud-Haond, Arrieta and Duarte, Science 2011)

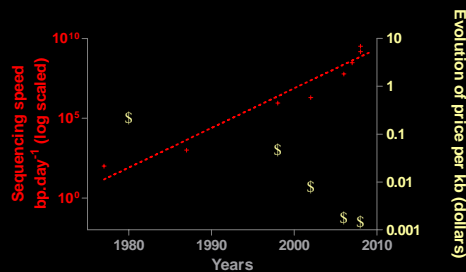
Yet the Areas Beyond National Jurisdiction were excluded from the Nagoya Protocol for CBD on Access and Benefit Sharing in November 2010

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Take-off of molecular biology

Nowadays GRs encompass most natural products due to the evolution of Genomics techniques following (a 'worse than') Moore's law.

Genetic resources are more commonly used than harvested or cultured, at least for marine Organisms

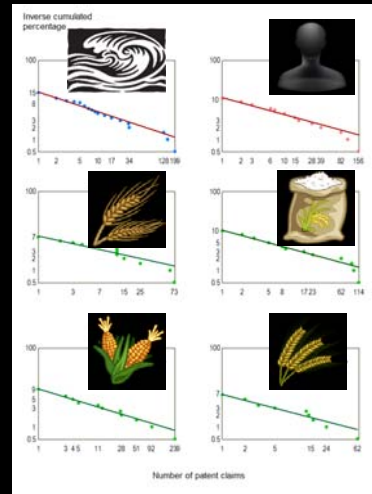


Credits: AlBiotech

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The unbalanced ownership of patents claims

- Same pattern and similar set of countries for patent claims associated to
 - Human sequences
 - Sequences from the 4 crops most cultivated and consumed in the world: wheat, rice, maize, barley.
- A disequilibrium therefore mostly linked to access to molecular technology



(from Arnaud-Haond, Arrieta and Duarte, 2011)

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Anything happening in ABJN???

- Discovery of hydrothermal vents (first deep sea ecosystems) in 1977, first cruises for biological material few years after.
 - 35 years ago,
 - no harvesting capacity comparable to shallow water
 - take off only expected with molecular biology, therefore only 20 years ago the minimum time needed to complete applied research
- Despite this Marjo Vierros will show you how many molecules can already be traced back to an ABJN origin, and this is only the beginning.
- In 2010 a full issue of Environmental Technology was dedicated to Biotechnologies at seeps and vents
- One example: Ultrathin Valley industry (hydrothermal bacteria with an amylase gene used biofuel production): 150 millions \$. Year as of 2009

1977: Discovery of hydrothermal vents and of the first sequencing technology

1990: automated sequencing

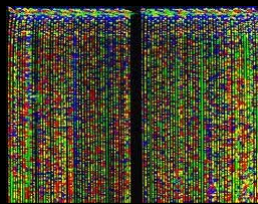
1996: high throughput sequencing

..... 2015?

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Access Sharing

Involves oceanographic tools, but also and possibly more importantly molecular technologies

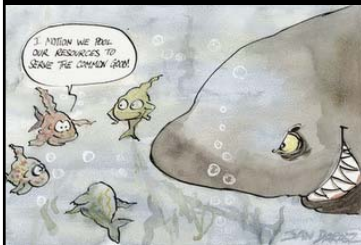


=> A need for Capacity building

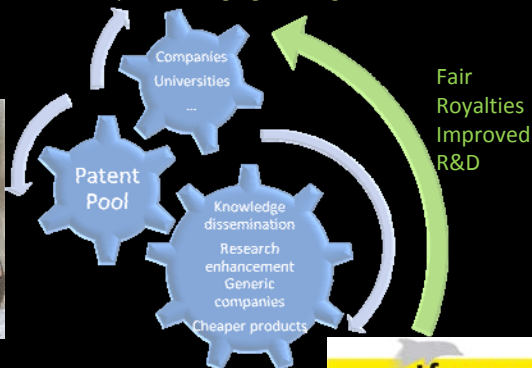
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Patent Pool: funds to encourage capacity building?

- For Human Genes: UNESCO Common Heritage of the Human Kind, yet subject to patenting. Limited number of initiatives, but the UNITAIDS PATENT POOLS is an example.
- « A mechanism in which various patents held by different entities, such as companies, universities and research institutions are made available to others for production or further development, such as pediatric or fixed-dose formulations. The patent holders are paid a royalty by those using the patents, with the pool managing the negotiations, the licensing arrangements and payments ».



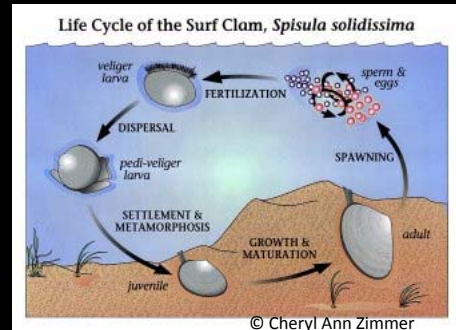
(from Spicy IP)



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Anything happening in ABJN???

- Another important point: a large amount of marine species are **widely distributed both outside and within NJs**
- Most marine invertebrates have complex life cycle, a large part of it in open water so **even the ones associated to shallow water have at some point their genome vehiculed by larvae in ABNJ**



Is it meaningful to maintain this 'legally driven' dichotomy that has few biological support??

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To summarize

- Technological challenges in two domains, oceanographic skills and molecular biology.
- Large costs for R&D but also benefits already made and forecasted
- Both are unequally distributed
- A situation that is unlikely to change unless incentives are offered to improve Capacity building & Access and Benefit Sharing
- The legal division of EEZ and ABJN will be tricky to apply to MGR
- Patent pools would be an option to promote both?

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Thanks!

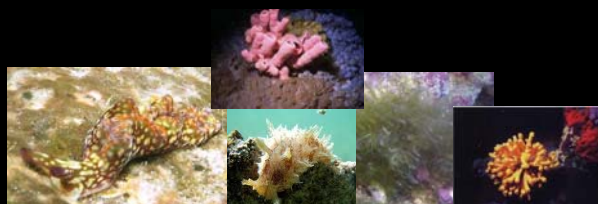
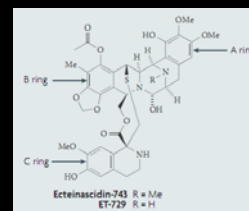


US President Lindon B. Johnson in 1966 "...the deep sea and the ocean bottoms are, and remain, the legacy of all human beings"

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Medicines

- Pain killers (*Conus*; ziconotide)
- Anti-cancer (tunicates): anti tumor toxins (already commercialized) or cellular division blockers (in test) : a market of about 1 billion\$. year
- Anti-herpes (237 millions \$. Year for Zovirax)
- AIDS Treatment -Retrovir (23 millions \$)
- Hydrothermal microbial polysaccharids with properties inducing tissus or bone regeneration
- Anticoagulants



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Biomedical and Molecular Biology

Bioluminescence used for cellular labelling
Enzymes TOTAL market: 50 billions\$. year
One billion\$. Year for applications to DNA extraction

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Cosmetics

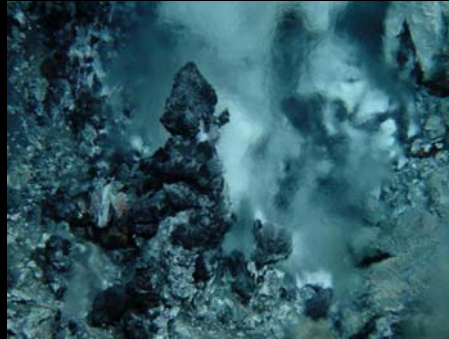
- In 2005 an estimated TOTAL market of 230 billion \$
- Marine organisms are rich in carotenoids, chlorophyll, antioxydant...
- Collagen



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Bioremediation et Biofuel

- Bioremediation: Bacteria degrading contaminants, including some hydrocarbures
- Ultrathin Valley industry (hydrothermal bacteria used biofuel production): 150 millions \$. year

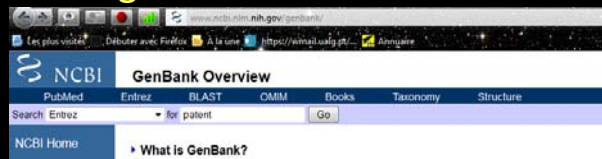


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Marine Biotechnologies

A numeric estimates based on patents associated to genes

- GenBank Patent Database
- Annotated by hand for marine sp.
- Origin of patents claims traced using Patentscope (World Intellectual Property Office database)

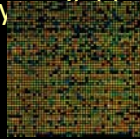


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A first question: The thin red line separating discovery from invention

Challenging Intellectual Property associated with genes?

- The novelty and non-obviousness requirement holds that, if a hypothetical person skilled in the relevant domain could re-create the invention as a predictable variation of the state of the art, the patent claim is obvious and not worthy of patent protection
 - genes cannot be patented per se but a list of potential applications is required
- YET, what is innovative today will be possible in most university labs next year and many processes/methods we screened in patent claims use the gene to perform exactly what it does in nature (synthesize a molecule / compound of interest), using molecular techniques widely



© Jingyue Ju

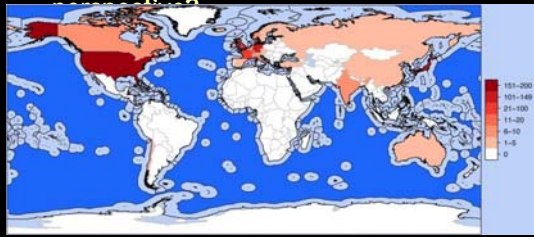


flickr/dsa_ges



A second problem for Access and Benefit Sharing: governance gap

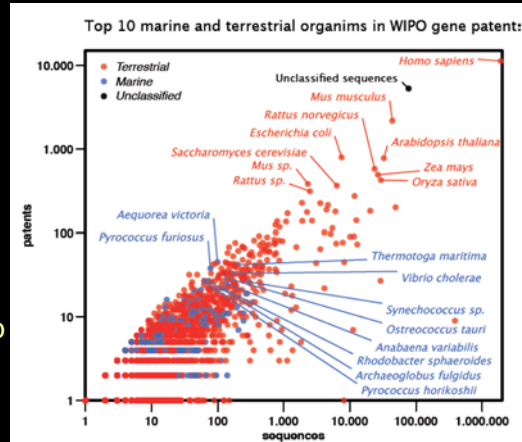
- Marine Genetic Resources may fall under a governance framework, or a governance gap:
 - EEZ: Exclusive Economic Zone, with sovereign rights, where CBD and Nagoya Protocol apply
 - 'The Area', more than 50% of the surface of Earth:
 - SeaBed
 - Water column
- For the moment being resources exploited on a 'first arrived first served' basis everywhere. Regulation through CBD is expected since Nagoya for EEZ, but for Areas Beyond National Jurisdiction, which





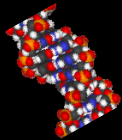
A third problem: gaps in the law on gene patenting

- Some are of unknown origin.
- Species name is not always mentioned
- Geographic location of collection OR distribution area of species is not a required criteria
- HOW to trace the compliance to CBD agreements and Nagoya Protocol
- HOW to apply a framework to MGR beyond national jurisdiction without such information?



(from Arnaud-Haond, Arrieta and Duarte, Science 2011)

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List of gaps

- What is patentable is nonobvious (TRIPS, general)
- Which information allows tracing the respect of international agreements (TRIPS → CBD, general)
- Should the status of MGRs be considered separately within EEZ and in Areas Beyond national Jurisdiction
- If so, what should be the status of MGRs in Areas Beyond National Jurisdiction, which Mechanism to ensure Access and benefit Sharing?

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