Bioprospecting from Marine Genetic Resources from Areas Beyond National Jurisdiction

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Chair of the Advisory Panel of Policy and Legal Experts – aiming to provide clear recommendations and ready-to-use solutions to address critical policy and legal barriers which impede the access and sustainable use of MGR for European biotechnological research, development and commercialisation
Term has no meaning to biologists and is not defined in UNCLOS but is taken to mean the Nagoya Equivalent:

“Marine genetic material” means any material of plant, animal, microbial or other origin, **found in the marine environment**, containing functional units of heredity;

“Marine genetic resources” means **marine** genetic material of actual or potential value

Diversity of habitat is assumed to translate to biological diversity
Marine Species Diversity

<table>
<thead>
<tr>
<th>Animal Diversity</th>
<th>Microbial Diversity</th>
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<tbody>
<tr>
<td>Of the major divisions of animal life ~20 have no representatives on land</td>
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<tr>
<td>There is no clear estimate of marine microbial diversity or its economic value</td>
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Phylum:
- Porifera
- Placozoa
- Cnidaria
- Ctenophora
- Platyhelminthes
- Gnathostomulida
- Nemertea
- Nematoda
- Rotifera
- Gastrotricha
- Kinorhyncha
- Loricifera
- Tardigrada
- Priapula
- Mollusca
- Kamptozoa
- Pogonophora
- Sipuncula
- Echiura
- Annelida
- Onychophora
- Crustacea
- Chelicerata
- Uniramia
- Chaetognatha
- Phoronida
- Brachiopoda
- Bryozoa
- Echinodermata
- Hemichordata
- Urochordata
- Cephalochordata
- Vertebrata

Phylum:
- Marine
- Terrestrial

Species estimate (Log)
Biological Diversity = Chemical Diversity

Small Molecules

Biomolecules
The Marine Bioprospecting Process

**Bioprospecting** is the discovery of compounds and associated ideas from genetic resources to develop novel biomedicines, biomedical research tools, antifoulants, catalysts, nutraceuticals, cosmeceuticals, etc. Unlike seabed mining, marine genetic resources are not mined.

**Why use marine genetic resources?**

Offers advantage over comparable terrestrial resource:

- Superior performance
- Better economics

Unprecedented activity in particular application:

- Enzymes: new reactivity/new biotransformation
- Small molecules: novel chemical structures & new mechanism of action
- Materials: new properties
Sampling in ABNJ

MGR

Chemistry

Product

Bioassay

Elements of good practice already exist at all stages of the marine biodiscovery pipeline
Non-Pharma MGR Derived Products on the Market

Vent Polymerase – for DNA amplification
Origin: Vent bacterium (Naples, Italy)
Production: Recombinant
Owner: New England Biolabs

Fuelzyme – Enzyme used in biodiesel production
Origin: Deep sea bacterium (location unknown)
Production: Recombinant
Owner: Verenium (BASF)

Cosmetic screening infra-red rays
Origin: Vent bacterium (location unknown)
Production: Bacterial culture
Owner: Sederma (Croda)

Anti biofilm agents
Origin: Red seaweed
Production: Chemical Synthesis
Owner: XXXXX
MGR Derived Pharmaceutical Products on the Market

All from EEZ apart from 1 (high seas) – All prior to CBD coming into force
None rely on harvesting natural source except fish oils
None from ABNJ – mainly reef derived

7 successful compounds came from 28,000 known marine compounds

Mainly anti-cancer with a few analgesics and antivirals

Mainly start-ups at early stage with large pharma at late stage

http://marinepharmacology.midwestern.edu/
Before Getting to Preclinical Trials:

>110,000 screening events
>700 active dereplicated extracts
Active, non toxic, novel chemistry

At 30 Months:
13,689 Strains
>14,000 Active Extracts
>80 Active Compounds
1 Drug Lead

PHARMASEA
Real Benefit Scenario

- **Cost in 2014 to bring drug to market US$2,558 M** - >70%
- **Clinical trials**
- **Typical industry royalties on natural products developed into drugs is 1-3%**
- **Halaven (Eisai), derived from a Japanese sponge makes US$200 M per year – in principle yielding US$ 2-6 M pa.**
- **Currently 7 approved marine drugs – total royalties would be US$ 10-50 M.**
- **Blockbuster drug (> US$ 1 Bn pa income) would yield US$10-30 M pa**
- **Currently 7 approved marine drugs come from ~28,000 discovered marine compounds (1 in 4000 chance) – none are ‘blockbusters’**
- **All examples were discovered pre-CBD – not clear if actual royalties are being paid**
- **Other markets – nutraceuticals/cosmeceuticals, lower risk, quicker to market, lower investment and lower returns.**

Monitoring Sample and Data Flows

Possible to track sample from origin to exploitation (needs better databases)

Modifications to DNA or compound may make it hard to trace MGR origin
An UNCLOS implementing agreement developed over the next few years would need to be flexible enough to deal with rapid scientific progress.
“The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013 under grant agreement n° 312184)”