Marine Genetic Resources: Experiences in Commercialization

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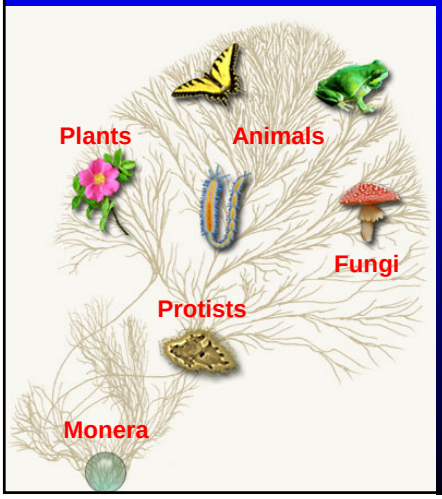
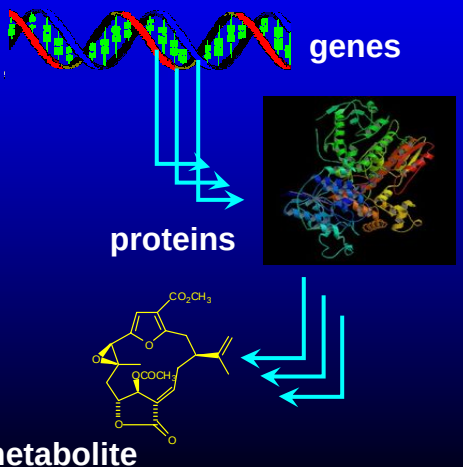
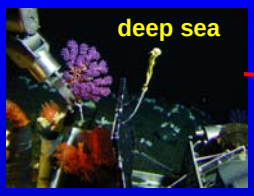
Background

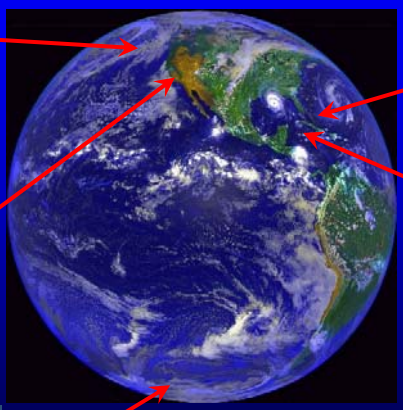
Marine Genetic Resources: "genetic material of actual or potential value". [Convention on Biological Diversity]





Ocean Habitat Diversity

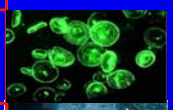


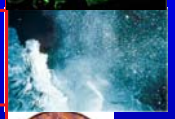


- predation
- competition
- pathogenesis
- temperature
- pressure
- light
- nutrients

Marine Biotech Products

Product	Application	Original Source
Fluorescent Probes Green Fluorescent Protein (GFP)	Reporter gene assays	Jellyfish: *Aequora victoria*
Novel Enzymes Deep Vent DNA Polymerase®□	Polymerase chain reaction (PCR)	Bacterium: *Thermococcus litoralis*
Nutritional Supplements Formulaid®□	θ3 Fatty acids in infant formula	Marine microalga: *Crypthecodinium cohnii*
Cosmetic Additives Resilience® (Pseudopterosin)	Antiinflammatory	Gorgonian: *Pseudopterogorgia elisabethae*



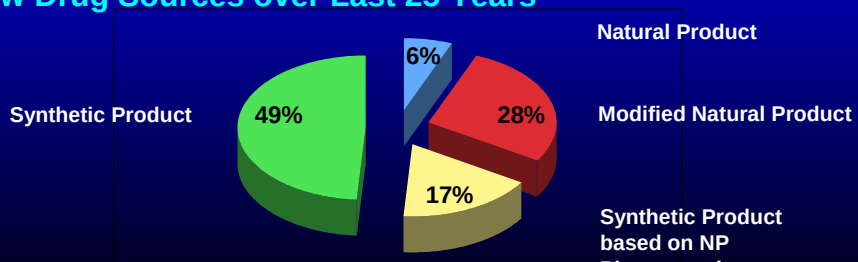


Other active research areas:
- biomaterials (artificial bone from corals; stents from sea urchins; silica chips from diatoms; fiberoptic cables from sponges)
- agrochemicals (insecticides and weed killers from sponges)
- antifoulants (ship paints from soft corals)

Marine Pharmaceuticals

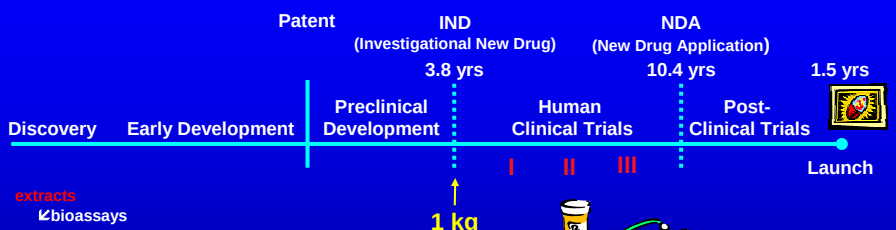
Product	Application	Original Source
Pharmaceuticals Acyclovir® (Ara-A) Cytosar-U® (Ara-C)	Antiviral drug Anticancer drug	**Sponge:** **Cryptotheca crypta*
Pharmaceuticals Prialt®□ (conotoxin)	Analgesic	**Cone snail:** *Conus magnus*

New Drug Sources over Last 25 Years*



*after Newman & Cragg 2007: JNP 70:461

Drug Discovery Timeline



extracts
↙bioassays
..... active extracts
..... lead compounds
..... lead candidates

Numbers
100,000 ⇨ 1 clinical trials
costly: 0.5-1B $$$/drug

I = what dosage is safe/how treatment should be given

II = evaluate effectiveness/look for side effects

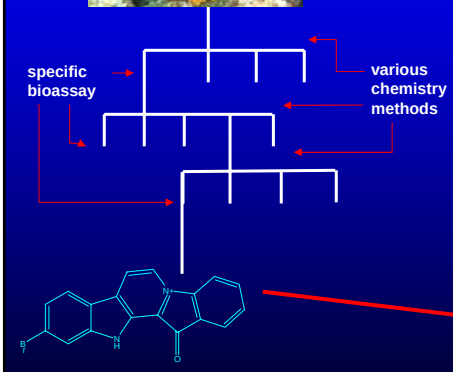
III = compare new treatment to current/standard treatment

Academics → (funding: NIH, WHO, NOAA, etc.)

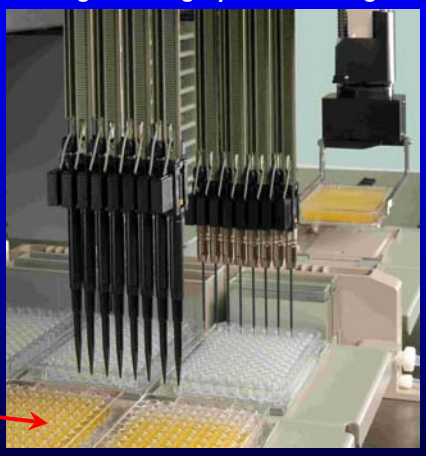
Pharmaceutical Industry →

Laboratory Approaches

Bioassay-guided fractionation



High Through-put Screening



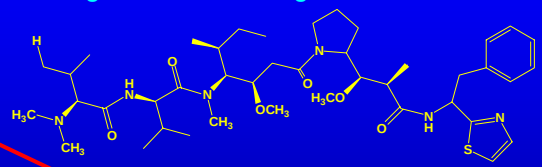
Chemistry-driven (slow & costly)

Biology-driven (fast, but sample-limited!!!)

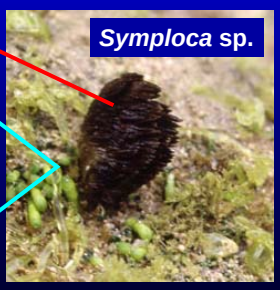
Supply Concerns

Dolabella auricularia

1600 kg sea hare ⇨ 10 mg Dolastatin 10



diet-derived bioaccumulation



Symploca sp.

Current Supply Options:
- total synthesis
- harvest *Symploca*
- culture *Symploca*
- heterologous gene expression

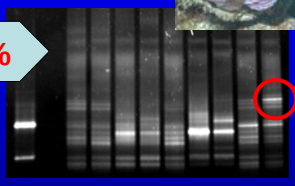
Lesson: increased biological knowledge results in environmental protection [rare species & habitat]

Sourcing Microbial Diversity

SW contains 10^6 to 10^9 microbe cells/ml; sponges can have 50% cells by weight

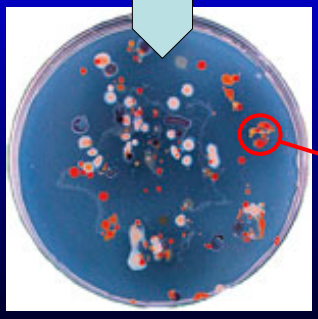
99%

1%



E coli heterologous expression system

Molecular techniques



Marine microbial diversity

Microbial fermentation

Research Partnerships

Direct Benefit Sharing: IP Compensation

Research → Public Sector → Private Sector → Utility

Diffuse Benefit Sharing: Societal Opportunities

Our Partnership Model:

Baker et al 1995; J Nat Prod 58:1325
Rosenthal 1999; Pharm Biol 37:6

- capacity enhancement [scientists & infrastructure]
- research collaborations and shared results/IP
- technology transfer and education opportunities
- access to information relevant to biodiversity
- priority research and economic contributions

Conclusions

- Marine genetic resources have tremendous potential for a variety of biotechnology applications:
  - public health -food security -environmental remediation
- There are direct [= shared IP] and diffuse [= use] benefits of marine genetic resources for society
- Commercialization of these resources requires significant Research & Development [= $$$], and even then marketable products are rare
- In all countries there needs to be increased support for fundamental research and partnerships that move information from the laboratories into products that help people live better, healthier and more productive lives

Recommendations

- Increase research on the biosynthetic capabilities of marine organisms using innovative techniques, and apply this fundamental knowledge to help detect important Marine Natural Products
- Development of technologies that foster sustainable resources rather than overharvesting
- Better tools for marine biotechnology used in solving environmental problems
- Greater emphasis for research efforts that seek to commercialize marine bioproducts