

# Basics of Marine Genetic Resources

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## Agenda

- **Definition of Marine Genetic Resources**
  - Marine Genetic Resources (MGRs)
  - Biological Resources
  - Genetic Material
- **Derivatives and Products of MGRs**
  - Major Classes of Macromolecules
  - Major Classes of small Molecules
- **Distribution of MGRs**
  - Areas within National Jurisdiction and Beyond National Jurisdiction
  - Endemism, Migration and Colonization

## Definitions

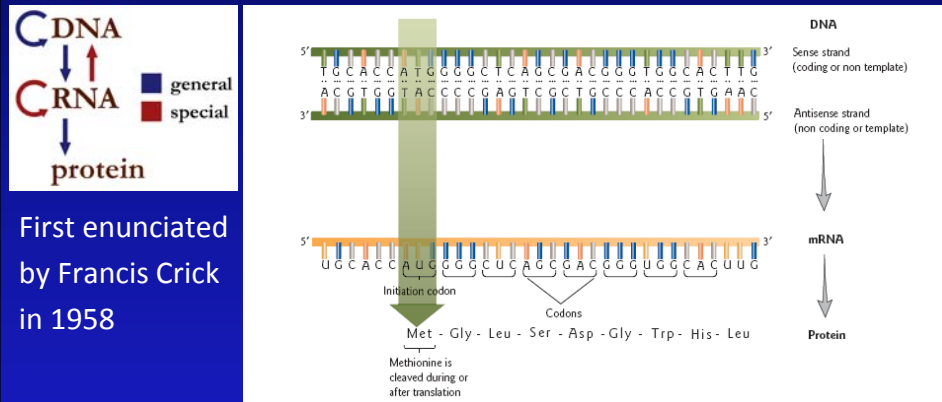
Article 2 of the Convention on Biological Diversity (CBD) (1992):

- **Biological resources:** genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity
- **Genetic material:** any material of plant, animal, microbial or other origin containing functional units of heredity
- **Genetic resources:** genetic material of actual or potential values

## Genome

- The **genome** is the complete set of sequences in the genetic material of an organism. It is the entirety of an organism's hereditary information, including the sequence of each chromosome plus any DNA in organelles.
- It consists of a long sequence of **nucleic acid** that provides the *information* need to construct the organism.

# The Central Dogma of Molecular Biology



First enunciated  
by Francis Crick  
in 1958

The Genetic code is the collection of codons that corresponds to each amino acid and to translation signals.

## Derivatives and Products of MGRs

- **Major Classes of Macromolecules**
  - RNAs
  - Proteins
  - Polysaccharides
- **Major Classes of Small Molecules**
  - Lipids
  - Small peptides
  - Oligosaccharides and Monosaccharides
  - Metabolites: Small chemical compounds

## The Major Constituents of Organisms Are Macromolecules

Molecular components of an <i>E. coli</i> cell		
	Percentage of total weight of cell	Approximate number of different molecular species
Water	70	1
Proteins	15	3,000
DNA	1	1
RNA	6	>3,000
polysaccharides	3	5
Lipids	2	20
Monomeric subunits and intermediates	2	500
Inorganic ions	1	20

## Major Types of RNA

1. Ribosomal RNA (rRNA), component of the ribosome
2. Transfer RNA (tRNA)
3. Messenger RNA (mRNA)
4. Small nuclear RNA (snRNA), involved in pre-mRNA splicing,
5. Small nucleolar RNA (snoRNA), involved in rRNA processing
6. microRNAs, regulators of gene expression, chromatin structure etc.
7. Long noncoding RNAs
8. Viral RNA

## Major Types of Peptides

- **Structural Polypeptides:**  
*Collagen, Cytoskeleton Proteins, Membrane Proteins, Ribosomal Proteins, etc.*
- **Enzymes:**  
*Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases*
- **Small peptides:**  
*Antimicrobial peptides, Toxins, neuropeptides, etc.*

## Antimicrobial Peptides from Marine Invertebrates

- **Amphipathic alpha helix:**  
*Styelin, Clavanin, Clavaspirin, Dicynthaurin*
- **Beta sheet**  
*Penaeidins 1 to 3, Tachyplesin I to III, Big defensin, Polyphemusin I and II, Defensins A and B, Mytilin A and B, Mytimicin, Myticin A and B, Defensins 1 and 2, Mytilin B, C, D, and G1*
- **Others:**  
*Plicatamide, Halocidin, Halocyamines, Lv1 to 6, Ls1 to 3, Penaeidin 4, Crustin Cm-1, Callinectin*

*Tincu and Taylor (2004) Antimicrob. Agents Chemother. 48 (10): 3645-3654.*

## Major Types of Marine Lipids

- **Omega-3 polyunsaturated Fatty Acids**

Eicosapentaenoic Acid (EPA),

Docosapentaenoic Acid (DPA)

Docosahexaenoic Acid (DHA)

Alpha-linolenic acid (ALA)

- **Sterol Esters:**

cholesterol and desmosterol/brassicasterol,

beta-sitosterol, etc.

## Major Types of Saccharides

- **Polysaccharides:**

Alginate, Chitosan, Exopolysaccharides (EPS),

Agar/Agarose and Carrageenans, Glycogen , etc.

- **Oligosaccharides:**

Alginate Oligosaccharides (AOs), Chitosan Oligosaccharides (COs),

Fucoidan Oligosaccharides (FOs), Trehalose, etc.

- **Monosaccharides:**

Glucose, Galactose, Fucose, Mannose, Rhamnose, Xylose,

Arabinose, Ribose, etc.

## Rapid Advancing of the Knowledge of Marine Genetic Resources

- **New technology of Marine Bioprospecting**

ROVs (Remotely Operated Vehicles)

AUVs (Autonomous Underwater Vehicles)

Manned Submersible

- **New Biotechnologies**

Genomics

Micro-Array

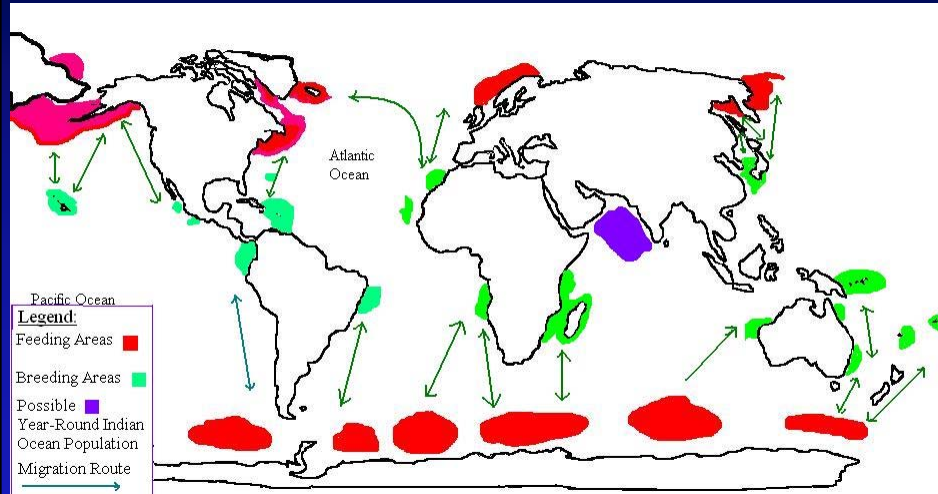
Proteomics

Metabolomics

## Endemic Species Around Hydrothermal Vent



## Biogeography of the Humpback Whale



Map recreated by John Schaumburg 2005. Information from (Winn & Winn 1985)

## Long-distance Migration of leatherback turtles

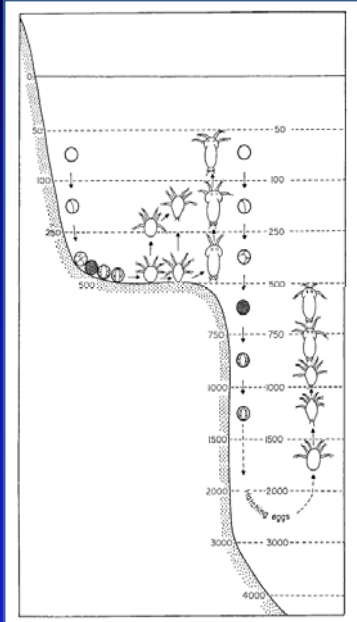


*Dermochelys coriacea*

Paolo Luschi Long-Distance Animal Migrations in the Oceanic Environment: Orientation and Navigation Correlates. ISRN Zoology 2013



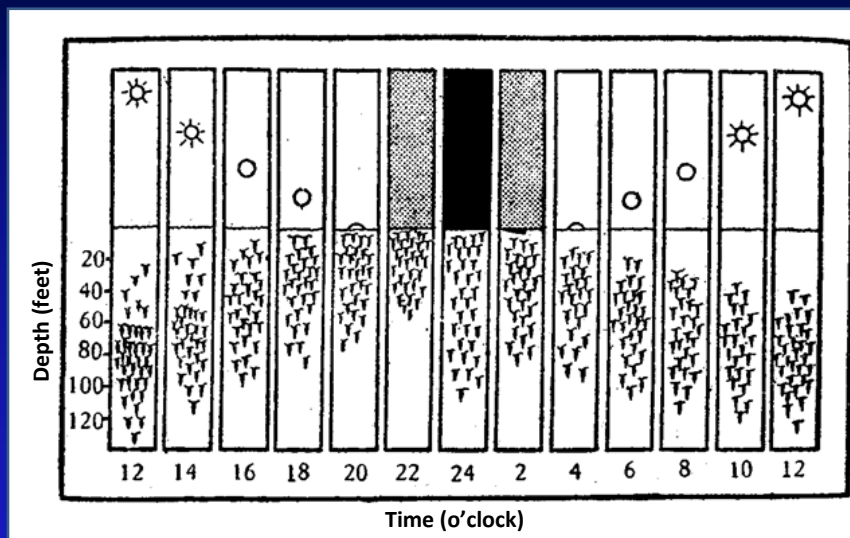
## Developmental Ascent of *Euphausia superba*



Antarctic krill (*Euphausia superba*)

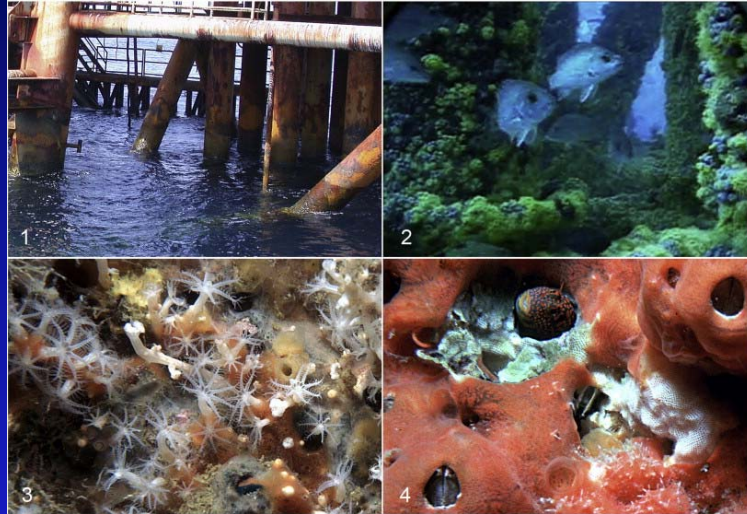
Development of sinking eggs of *Euphausia superba* in shelf and oceanic water showing how hatching in the shallower conditions gives rise to occurrences of nauplii and metanauplii unusually close to the surface. (After Marr, 1962)

## Diurnal vertical migration of zooplankton



Advances in Marine Biology Volume 7 (1969)  
Sir Frederick S. Russell & Sir Maurice Yonge

## Fouling on Gulf of Mexico oil platforms



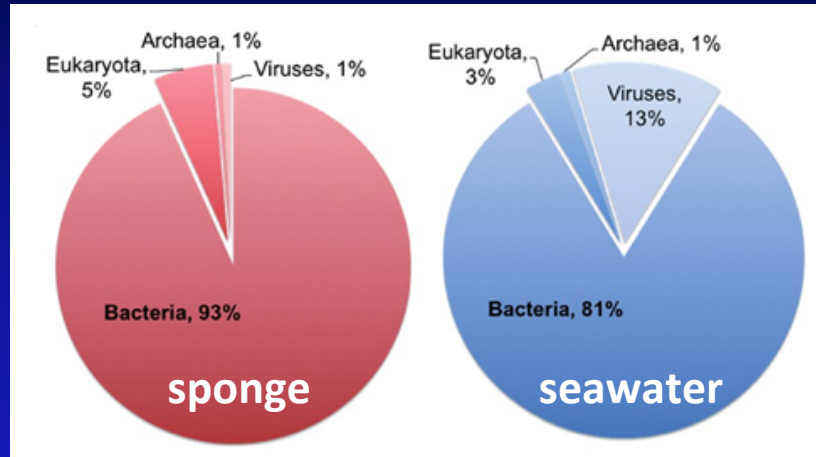
Gupta and Smith (2013) *Marine Micropaleontology*

## Impact of Migration and Colonization on MGRs

- **New Habitat**
- **New Genetic Diversity**
- **New Chemical Diversity**



## Metagenomes from Sponge and Seawater



Distribution of sponge and seawater taxonomic hits at the Domain hierarchical level, with sponge and seawater.

Trindade-Silva AE, Rua C, Silva GGZ, Dutilh BE, et al. (2012) Taxonomic and Functional Microbial Signatures of the Endemic Marine Sponge *Arenosclera brasiliensis*. PLoS ONE 7(7): e39905. doi:10.1371/journal.pone.0039905



## Marine Biosphere Maintains a Previously Undetected, Persistent Microbial Seed Bank

Comparison of a deep bacterial community characterization from one site in the English Channel (L4-DeepSeq) with 356 datasets from the International Census of Marine Microbes (ICoMM). Increasing sequencing depth uncovers greater phylogenetic overlap with the global ICoMM data.

Gibbons SM, Caporaso JG, Pirrung M, Field D, Knight R, Gilbert JA. (2013) Evidence for a persistent microbial seed bank throughout the global ocean. *Proceedings of the National Academy of Sciences, USA*, 110(12):4651–5.

## Common and distinction of MGRs in different regions

From both scientific and practical points of view :

MGRs from areas beyond national jurisdiction may share high similarity with that from areas within national jurisdiction.

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