MARINE BOARD

2nd Marine Board Forum Brussels September 16th 2010

”Towards a European Network of Marine *Observatories*
For Monitoring and *Research* ”

From Time Series to Genomes

Challenges and Opportunities for Marine Research Stations

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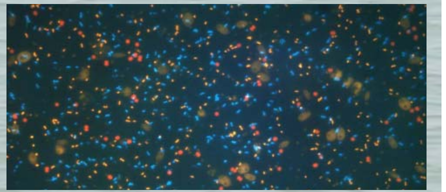
Marine laboratories are unique and essential for marine research (in partnership with vessels, satellites, remote systems etc.)

- Providing access to marine ecosystems including valuable (historical) time-series data



- Providing access to marine models for Biomedicine, ecotoxicology, biodiversity, gene discovery

- Providing logistics for ex situ experiments, including modern equipment for biology

- Providing logistics for hosting and catering

Marine Laboratories <u>are</u>:

- ideal places to study organisms in their habitat and in the lab
- great places for the public to see research happening, and to increase ocean literacy. Marine labs are "windows on the ocean"
- able to host large numbers of students at all stages during the year, often in all seasons (classes, field trips, tours, internships)
- accessible to researchers on a regular basis, short to long term
- places for graduate students to begin independent research
- home to experts in taxonomy, ecology, biology, chemistry, geology
- places to teach small intensive undergraduate/graduate classes

Marine Laboratories ***Are:***

-excellent for research at molecular to ecosystem levels

- ideal for long-term ecological research, real time data collection, land/ocean margin research, climate/ocean change effects

- places to do research and teach ocean geology, chemistry, physics, engineering etc.

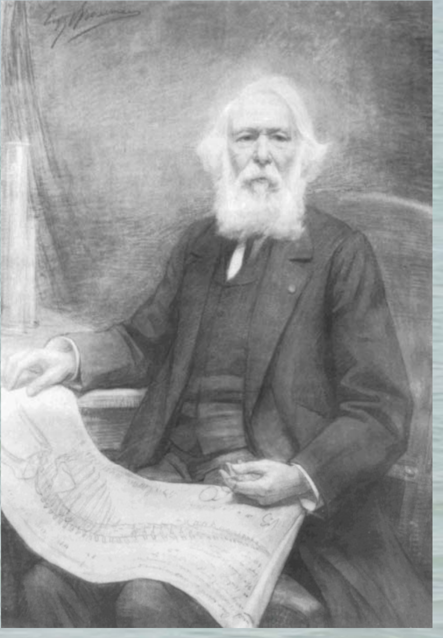
- inexpensive test-beds for new ocean instrumentation

- land base stations for OOS, buoys and cabled arrays, submersibles

-support bases for research vessels, boats, diving research support

- places to integrate social science and natural science research and education

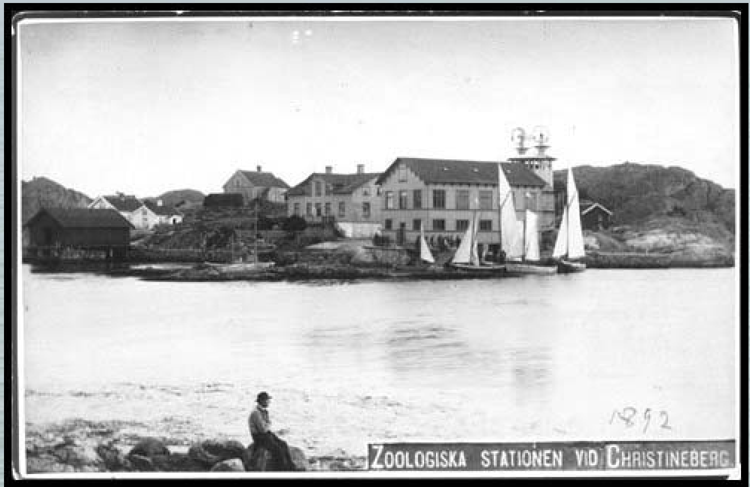
The world's first marine station at Ostend : the 'Dune laboratory' in the oyster farm of Valcke-Deknuyt



Founded by Professor Pierre-Joseph van Beneden (1809-1894)

“For his marine research, Pierre-Joseph found a source of inspiration in Sweden and England. At that time in Kristineberg, Sven Lovén and other Swedish marine scientists joined a colony of naturalists to carry out marine research in what would later (1877) become a research station. “

Since the 1800's.........



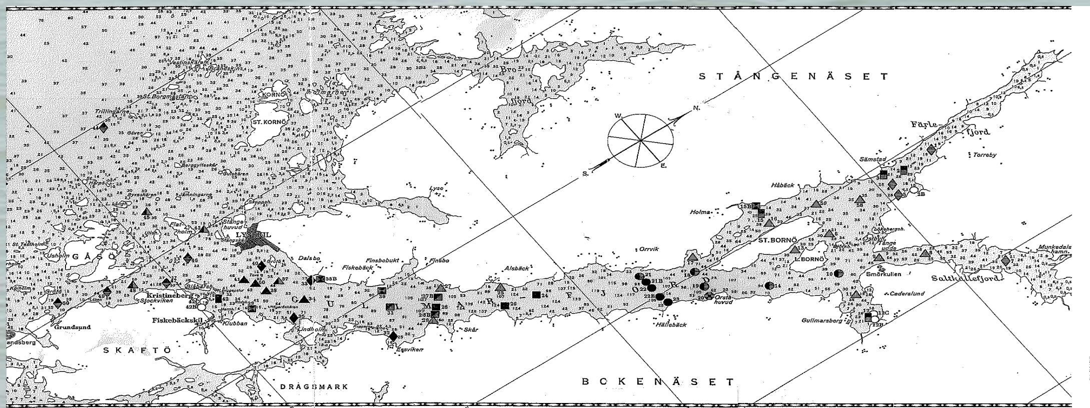
Species:	Stations (Italicized figures denote large number of individuals):
Artacama proboscidea . . .	5.
Ascidia obliqua	6, 20 III.
Ascidiella aspersa	6, 16, 20 II, 32, 33 B, 55, 59.
Astacilla longicornis . . .	41.
Astarte elliptica	43.
» *montagui*	43, 56.
Asterias rubens	2 B, 33 B, 42 B, 42 C, 56.
Athanas nitescens	12 B.
Bathyporeia pelagica . . .	57.
Bittium reticulatum	2 B, 4, 12 B, 30, 39, 42 B.
Brada villosa	4, 5, 20 II, 29, 38, 40, 41, 42, 43, 51, 53, 60.
Brissopsis lyrifera	5, 6, 8, 9, 13, 24, 27, 28, 29, 31, 32, 37, 38, 40, 41, **43**, 45, 48, **53**, 54, 55; 58, **60**, 61, 62.
Calocaris mac'andreae . . .	7, 8, 10, 11, 41.
Capitella capitata	42 C.
Carcinus moenas	42 C.
Cardium fasciatum	5, 12 B, 12 C, 15 B, 42 B, 61.
» *minimum*	1, 3, 4, 5, 13, 17, 19, 25, 26, 29, 31, 33, 34, 40, 46, 48, 53, **54**, 55, 58, 62.
Castalia punctata	**10**, 14, **18**, 20 III, **21**, 21 B, 22, 24, 27 B, 28 B.
Ceratocephale lovéni	10, 18, 19, 21, 22, 23, **24**, 26, 27 B.
Chaetozone setosa	6, 7, 9, **10**, 11, **14**, **18**, **19**, 21, 21 B, 22, 23, 26, 27, 27 B, 31, 50, 53, 54, 55, 58, 59, 62.
Cheirocratus intermedius . .	54.
» *sundewalli* . .	30, 37, 56.
Cheraphilus nanus	25, 54.
Chondractinia digitata . . .	21.
Ciona intestinalis	2 B, 12 B.
Cirratulus longisetis	46, 52.
Corbula gibba	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12 B, 12 C, 13, 15 B, 16, 17, 27, 30, 32, 33, 39, 40, 41, **42**, 43, 45, **48**, 52, 55, 58, 60, 61.
Corella parallelogramma . .	16, 20 II, 35, 57.
Crangon allmanni	49.
Cucumaria elongata	43.
Cultellus pellucidus	**2**, 5, 12 C, 15, 44, 46, 50, 53, 54, 57, 61, 62.
Cylichna cylindracea	4, 5, 40, 42, 48, 54, 55, 62.
Cylicolaimus acuticaudatum	56.
Cyprina islandica	1, 5, 37, 42, 53, 55.
Dentalium entalis	20 II, 29, 33, 37, 41, 43, 44, 46, 48, 50, 52,

Table 21. *B. ch. + Mal.*

Station	Depth	Date	S ‰	T°	O_2 ccm/L
G. 34	60	21/6 1923	34,84	6,40	—
» 38	48	26/6 »	34,24	6,40	—
» »	»	27/10 1925	33,40	12,22	—
» 41	52	29/6 1923	34,65	6,38	—
» »	»	27/10 1925	33,70	11,40	—
» 60	48	17/9 1923	32,52	12,30	5,17
» »	»	27/10 1925	33,40	12,32	—

Table 22. *B. ch. + T.*

Station	Depth	Date	S ‰	T°	O_2 ccm/L
G. 37	39	20/6 1923	32,88	6,60	—
» 43	66	» »	34,48	6,40	—
» »	»	31/8 »	34,14	7,69	4,54
» »	»	20/11 1924	33,80	10,30	—
» 45	38	26/6 1923	32,15	7,78	
» 48	45	» »	33,06	6,70	
» »	»	20/11 1924	33,36	11,00	
» »	»	21/8 1926	30,40	14,46	
» 53	51	3/7 1923	32,72	8,00	
» 54	56	» »	34,33	7,10	
» 55	41	» »	31,70	9,65	
» 62	50	18/8 1926	33,80	11,40	



[1] According to PALMQUIST's earlier figures.

[2] The organisms indeed also precipitate carbonates from the sea-water, but this process in water rich in CO_2 goes on more slowly than the dissolution (cf. KROGH, 1904, p. 397). Why the skeletons of living animals are not dissolved depends upon their being protected by covering membranes. Where, for instance, the periostracum has been injured in molluscs one can, in water rich in CO_2, prove corrosion. (KROGH, p. 387).

Kristinebergs zoologiska station 1877—1927. N:r 4. Pl. 1.

Fig. 1. Fig. 2.

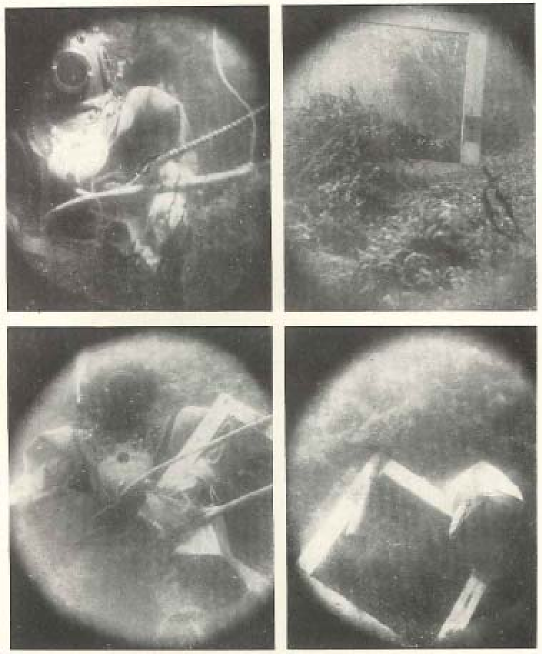


Fig. 3. Fig. 4.

Fig. 2. The author descending into the sea.

Fig. 6. Inspecting the cloth-bag.

http://uw-observatory.loven.gu.se

Fig. 4. Lowering the submarine camera.

Fig. 5. Working in shallow water.

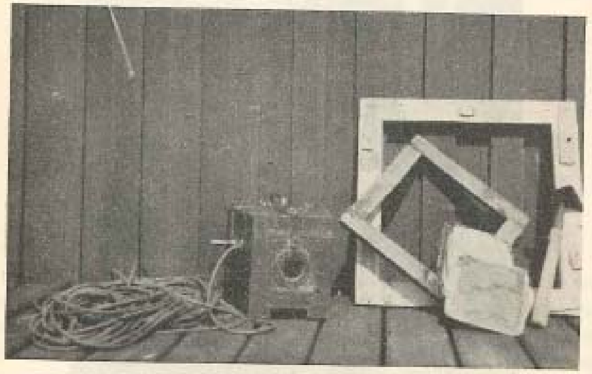
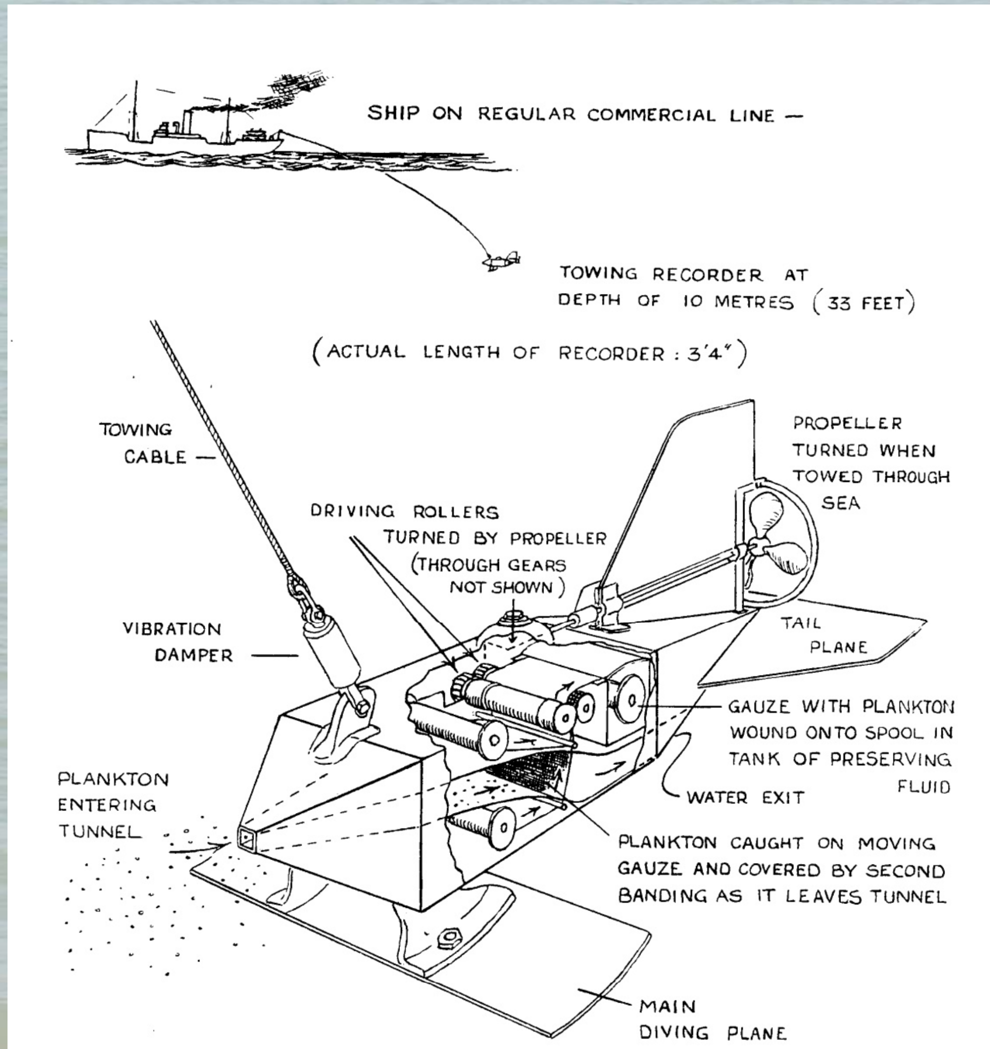


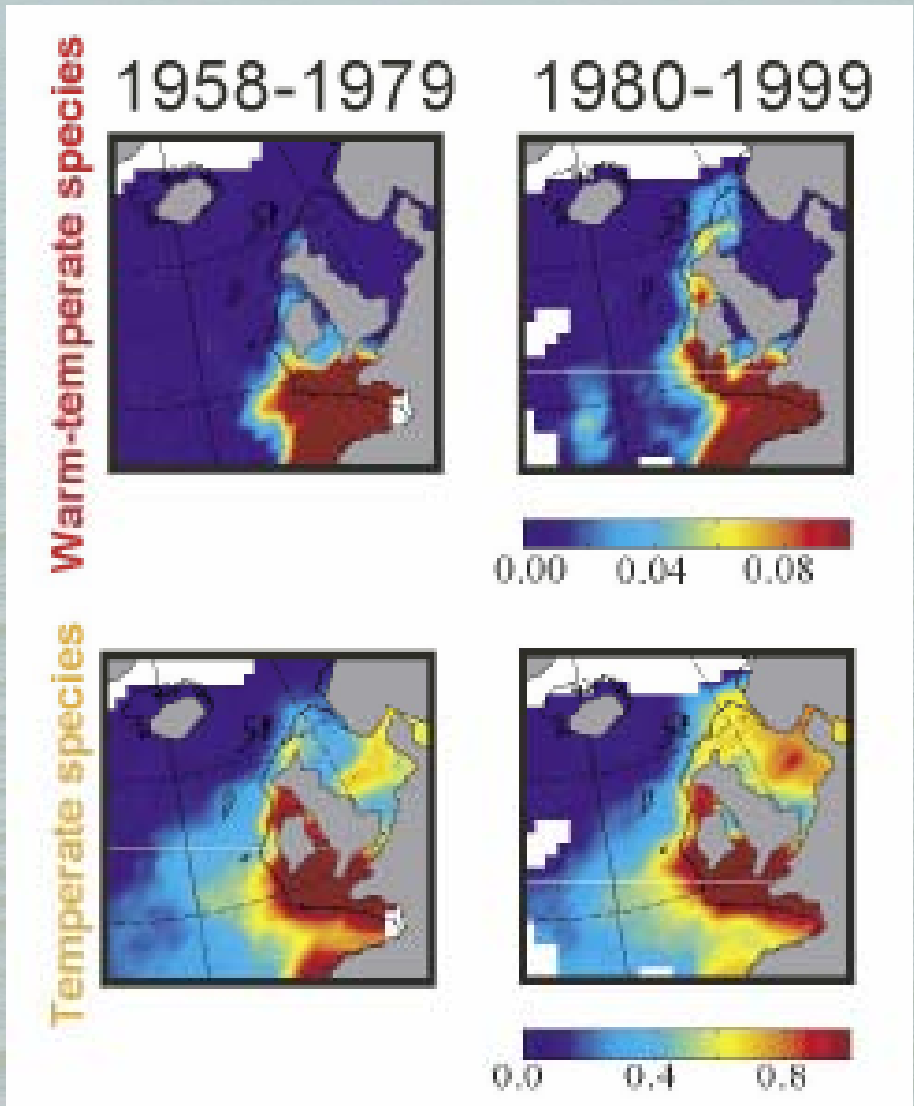
Fig. 3. Our equipement. The frames ($^1/_{10}$ and $^1/_4$ of a sq.M.), the triangular iron-scraper, the cloth-bag and the box for submarine photography with its circuit.

Monitoring plankton with the CPR Survey

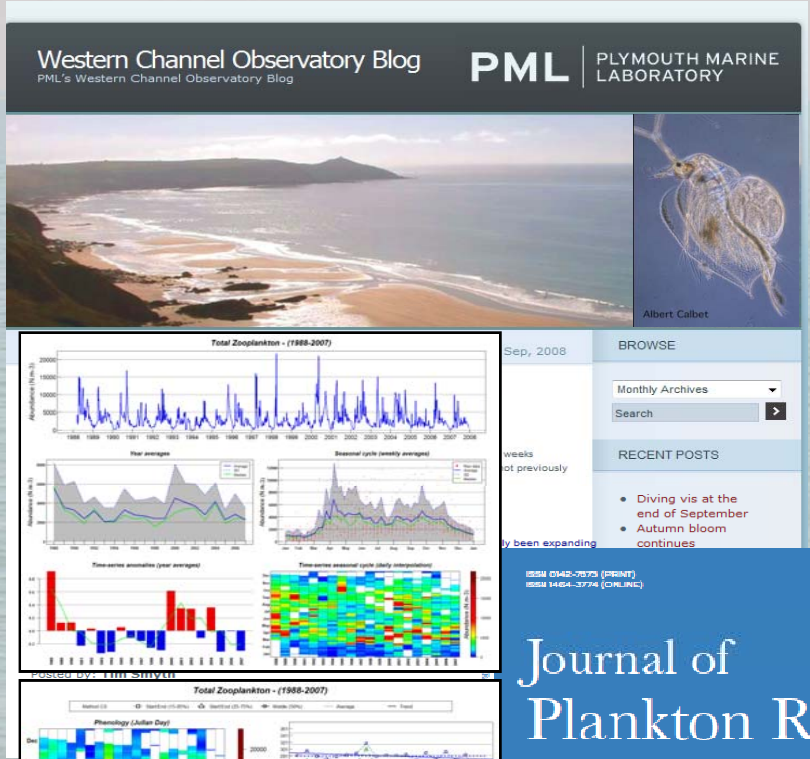
1930s

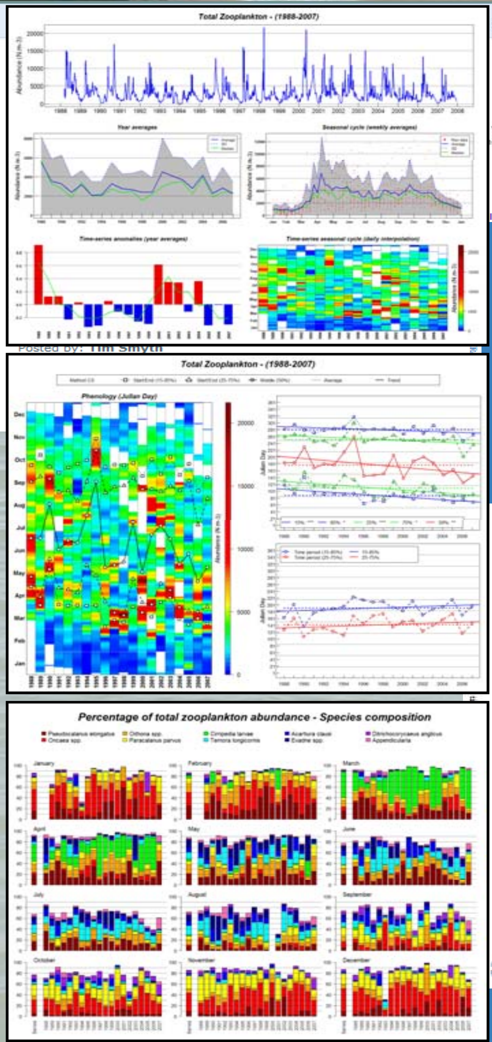


Northwards shifts in plankton: today



Beaugrand et 2003 *Science* 296: 1692



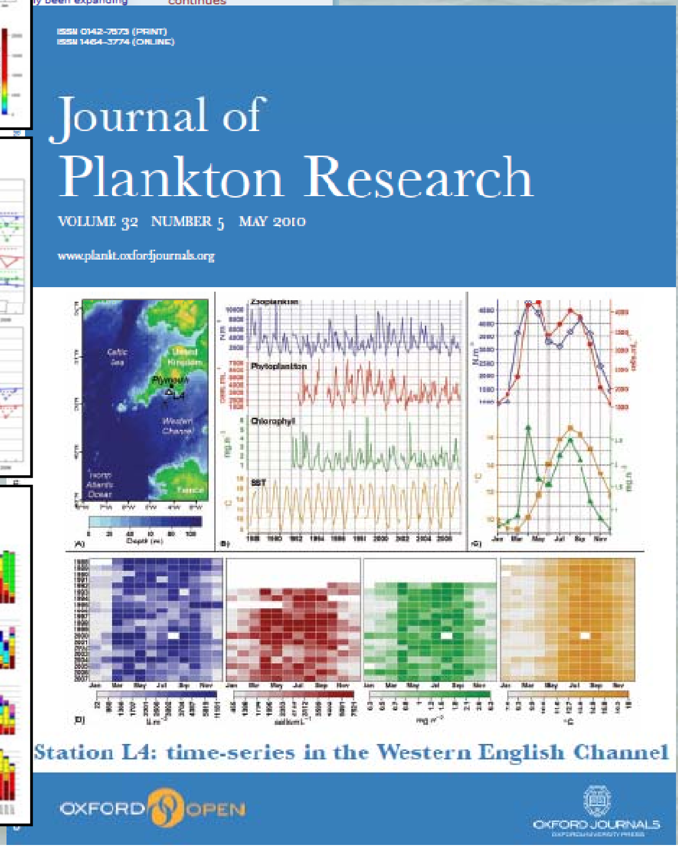


Western Channel Observatory

Incorporates long-term stations E1 and L4
Some data going back many decades

Weekly sampling at L4 for ~20 years
Physico-chemical variables
Nutrients
Pigments
Cell-counts
Phytoplankton
Microzooplankton
Zooplankton

http://www.westernchannelobservatory.org.uk/l4/

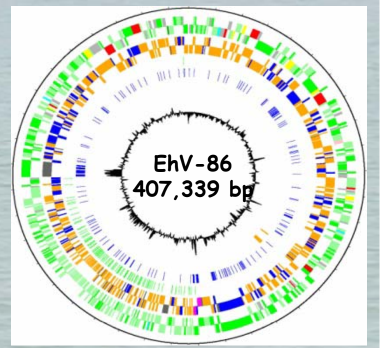


Recent JPR special issue celebrating 20 years sampling at L4.
10 papers describing WCO, biological control of pCO2, effects of high CO2 on fixed N, phytoplankton, zooplankton and meroplankton community dynamics, sardine eggs, fish phenology, zooplankton grazing and predation

WCO now includes:
In-situ data buoys at E1 and L4, collecting data in real-time;
Multi-scale benthic surveys and meroplankton investigations to link pelagic and benthic dynamics;
Detailed in-house links to satellite observations and ecosystem models;
Links to operational forecasting

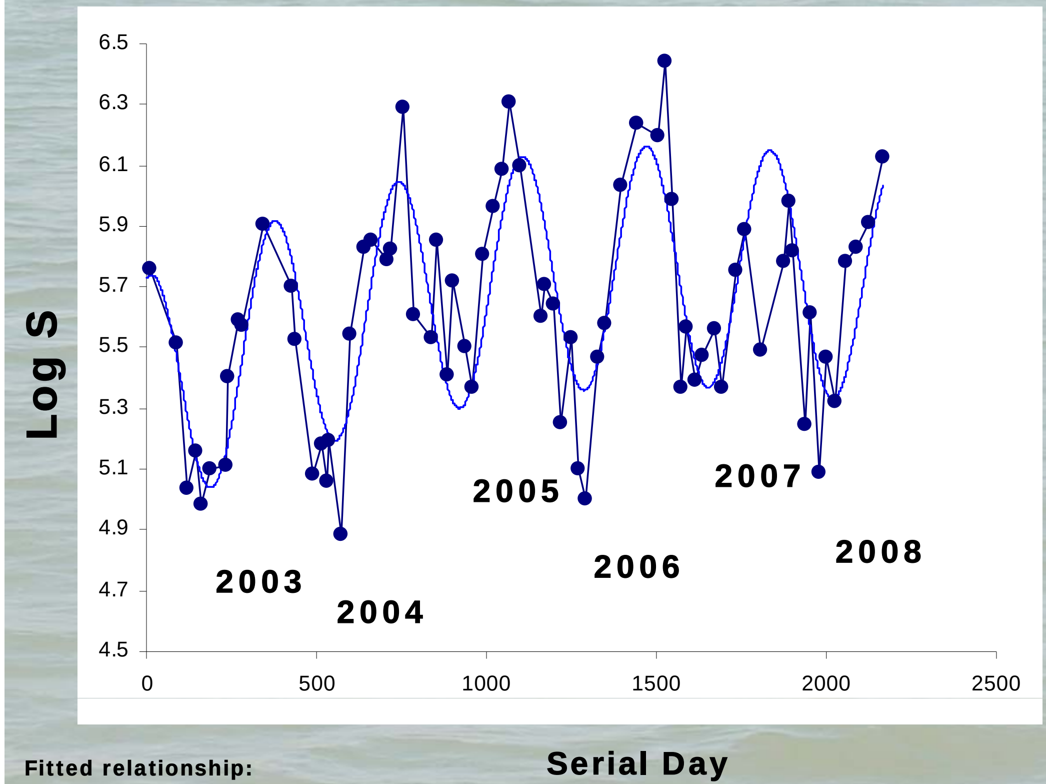
Genomic studies at L4

Comprehensive time-series data
Ongoing genetic studies at L4 on viruses, archaea, bacteria and plankton
Weekly sampling and preservation of environmental DNA samples
'the most sequenced body of water on the planet"
>80 Million reads:metagenomic and metatranscriptomic
>20 billion base pairs of data!!

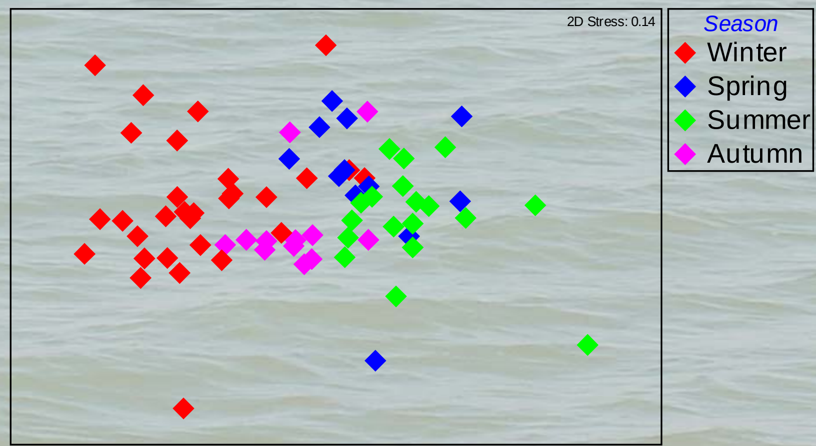


Example

Analysis of ~monthly samples over 7 years
>20 million 16S rDNA V6 tags → 454 pyrosequencing, Illumina runs



Robust seasonal cycle in bacterioplankton diversity and community structure
Diversity peaks in mid-winter
Cycle correlates with day-length
Evidence of longer-term change



Fitted relationship:
$\text{Log S} = 5.34 + 5.5.10^{-4}\text{Day} - 1.8.10^{-7}\text{Day}^2 + 0.396\text{DX1} + 0.02\text{DX2}$
Where DX1 and DX2 are cos and sin descriptors of annual cycle
Relationship describes ~70% of total variation in log S

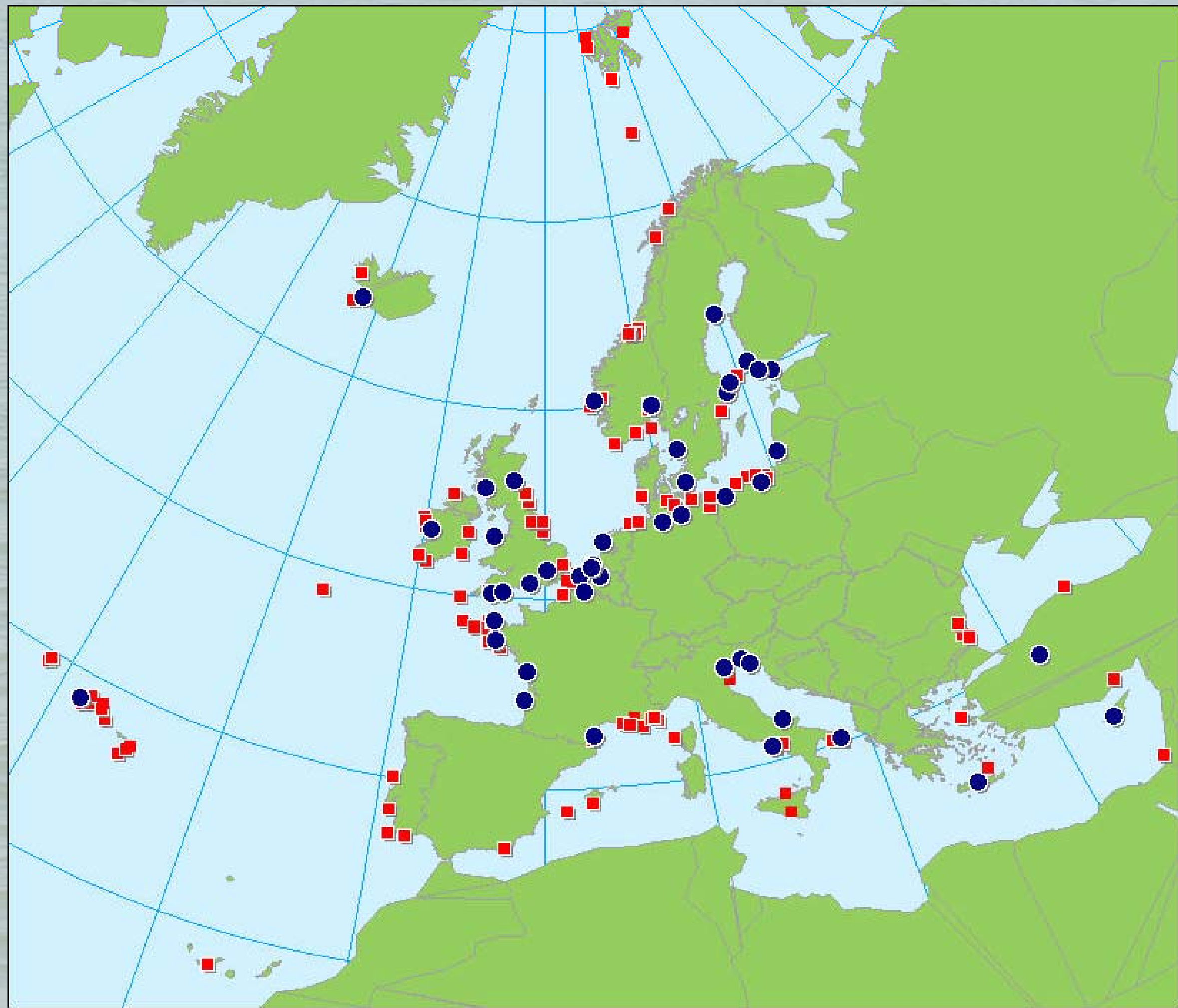
CONTACTS: Paul Somerfield, Tim Smyth, Claudia Halsband-Lenk

Europe is well served by Marine Research Stations

http://www.marbef.org/data/sites.php

MARS members
(Blue dots)
http://www.marsnetwork.org

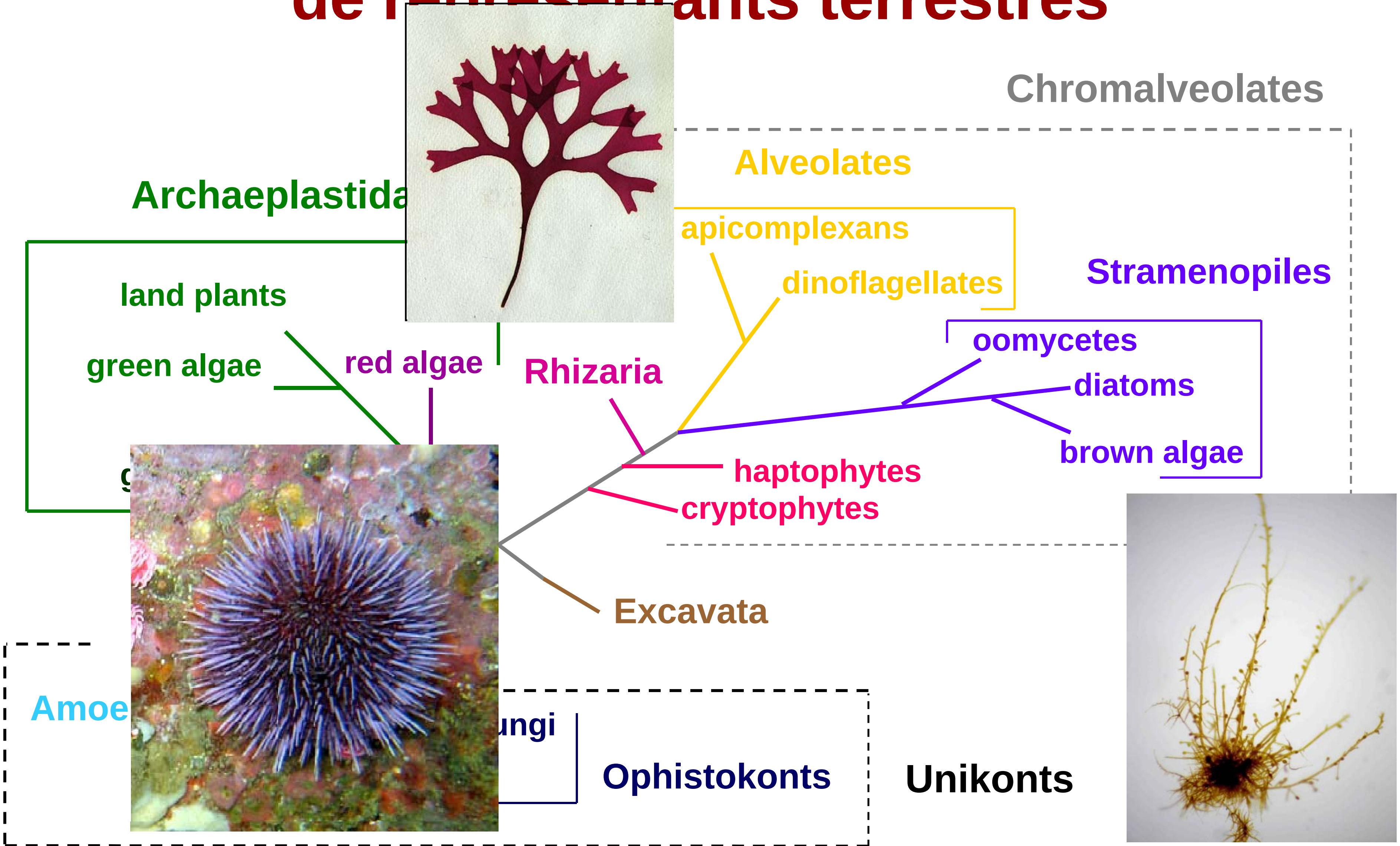
BIOMARE
Reference and Focal sites
(Red dots)
http://www.biomareweb.org



BIOMARE sites are now *marine sites* for Life-Watch in the ESFRI programme
MARS sites founding members of EMBRC and EcoBOS programmes


What is unique about the Marine
Environment?

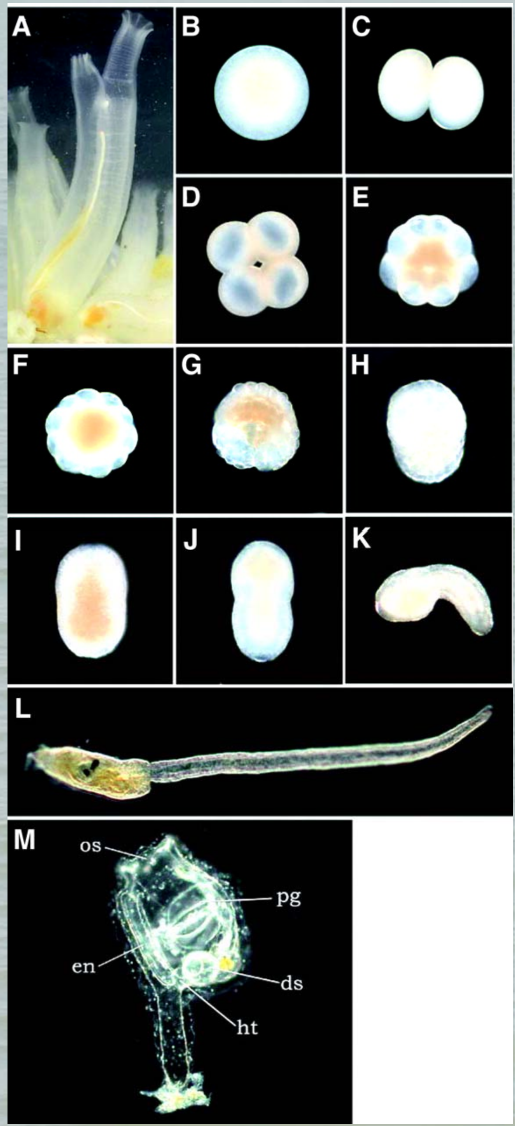
De très grandes lignées évolutives n'ont pas de représentants terrestres



Les organismes marins reviennent au centre de la biologie évolutive

Genomics

13 December 2002
Science
Vol. 298 No. 5601
Pages 2079–2270 $10
American Association for the Advancement of Science



A
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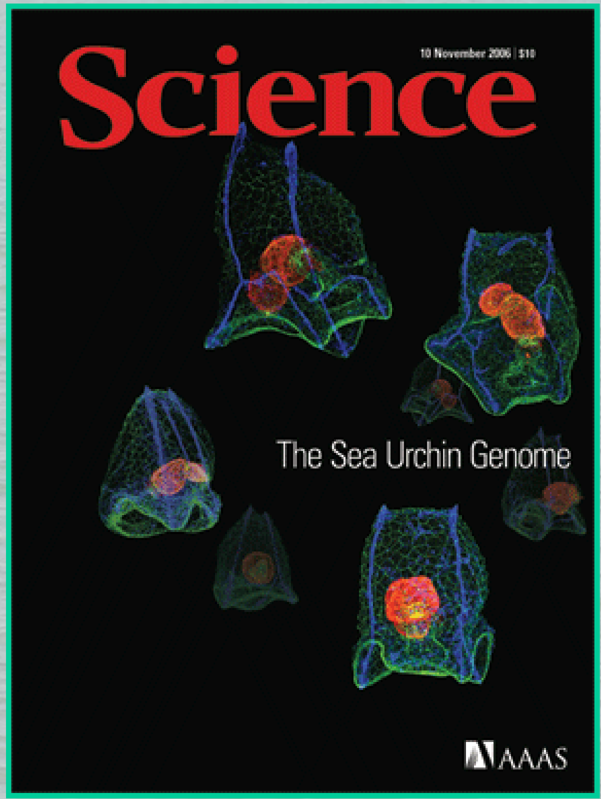
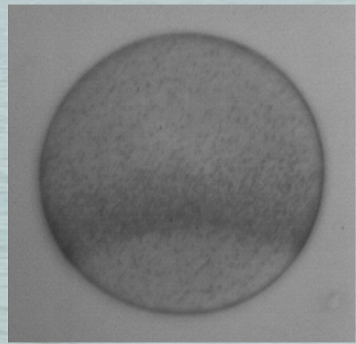


Science
10 November 2006 | $10
The Sea Urchin Genome
AAAS

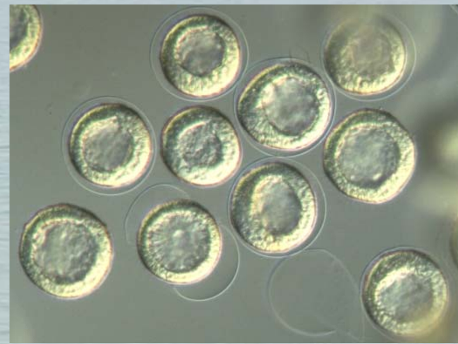
The Sea Urchin as a Model System for Analysis of Development

Large numbers of gametes > 10^7 eggs per female

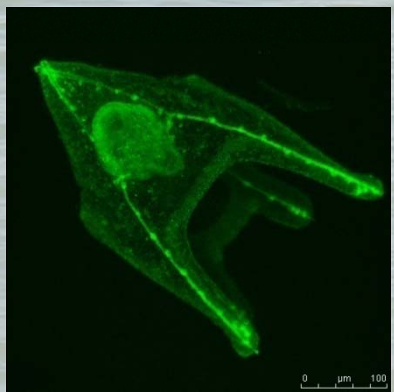
External fertilization
In vitro fertilization yield 100%



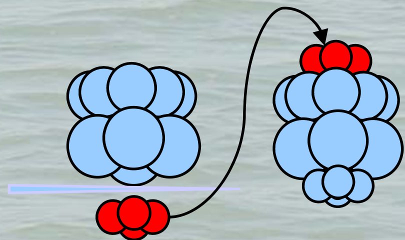
Egg can be oriented through a subequatorial pigmented band
(Mediterranean *P. lividus* only)



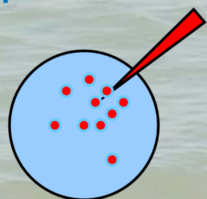
Rapid, synchronous development



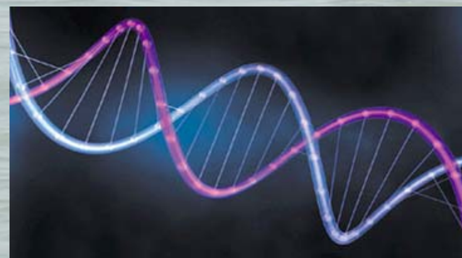
Embryo
optically clear
simple structure



Physically manipulable(cell transplantation/isolation)



Gene regulation/functioncan be tested by injection of
DNA, mRNA, or morpholinos

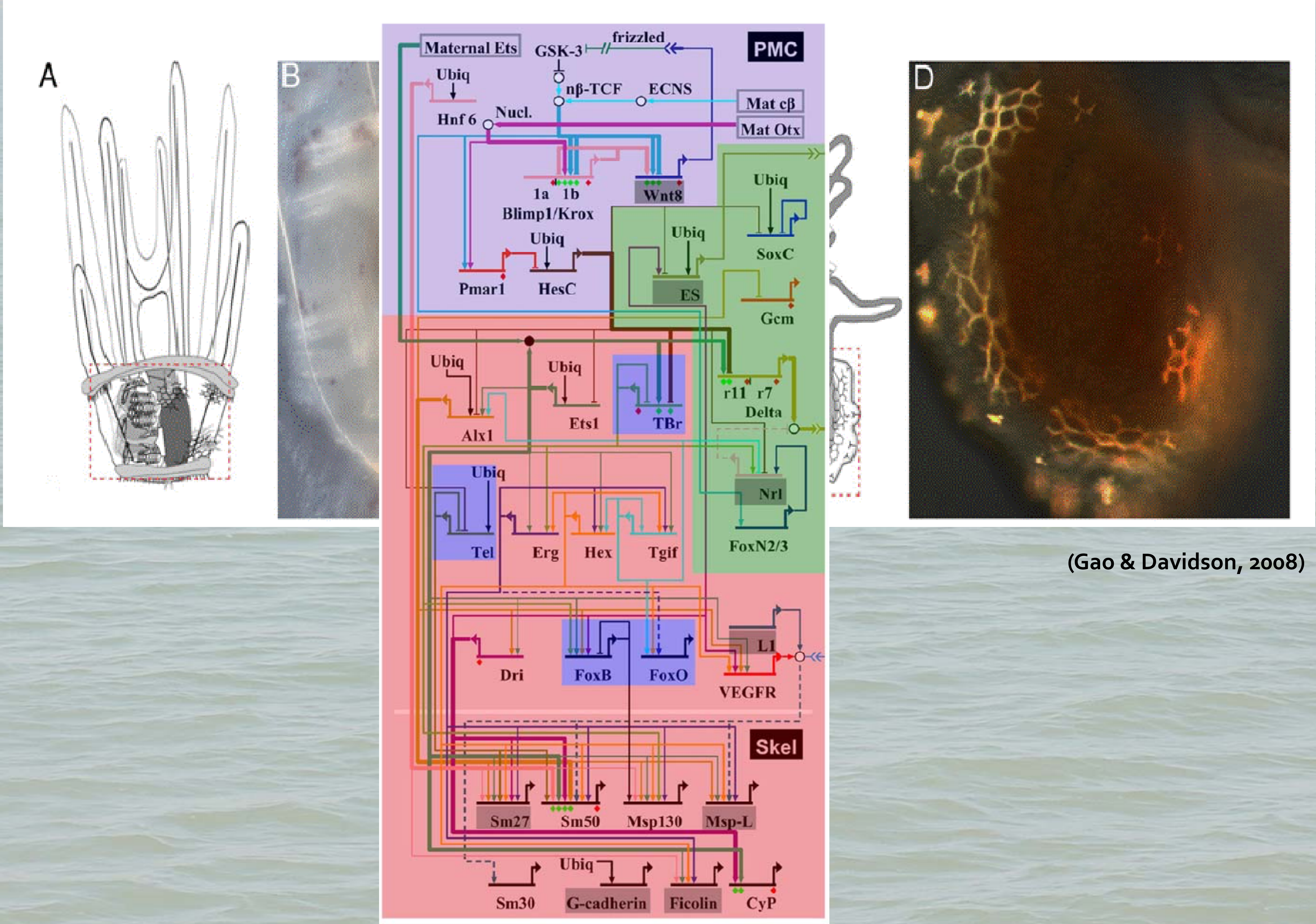


Resources for genomics

S. purpuratus **:**
Genome (800 Mb, 23000 gene models)
EST databases, arrayed libraries

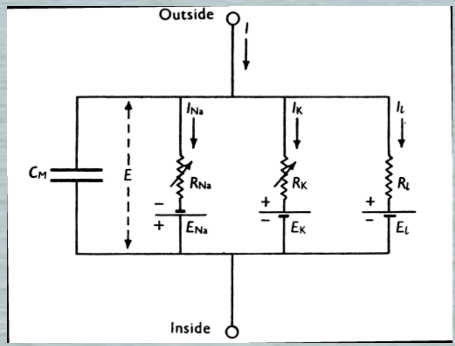
Many others soon…..

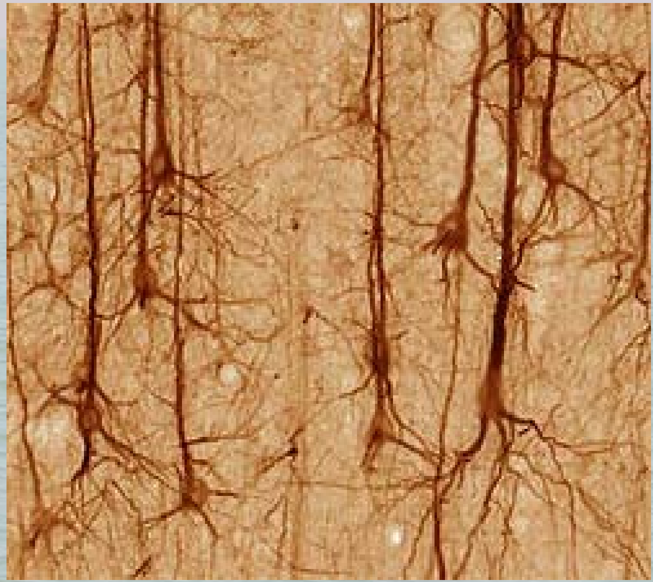
Ocean acidification and calcifying organisms

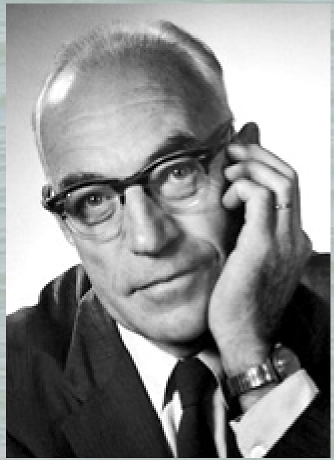


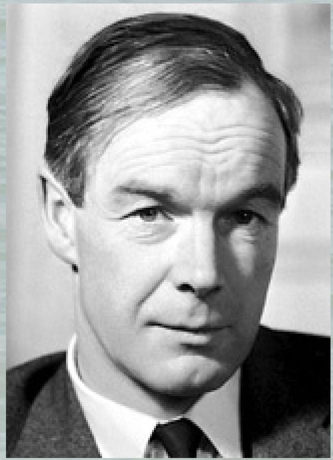
(Gao & Davidson, 2008)

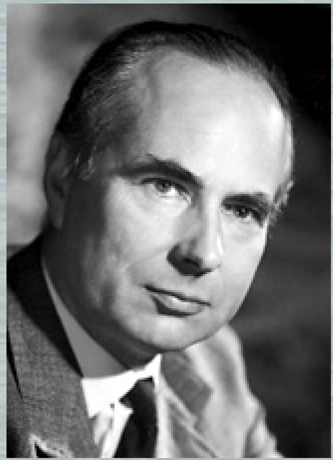
1963







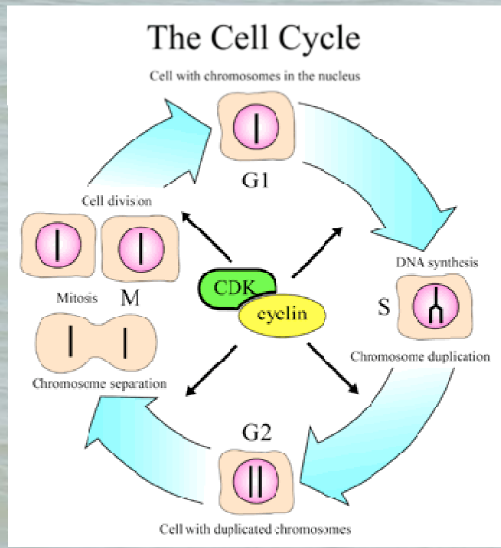


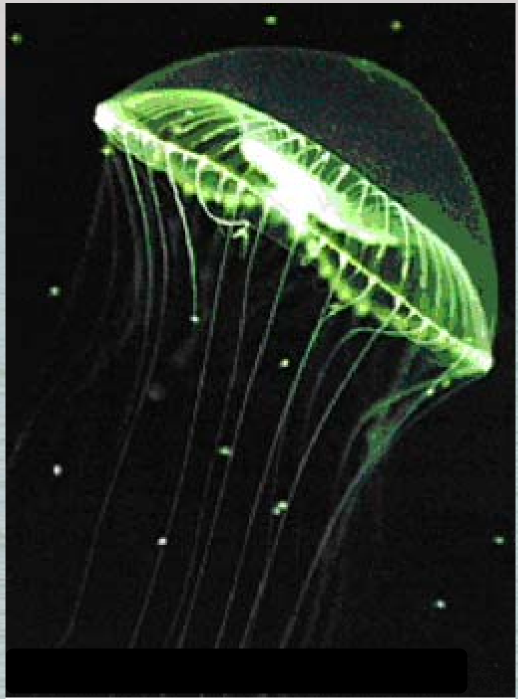


Sir John Carew Eccles; Alan Lloyd Hodgkin & Andrew Fielding Huxley

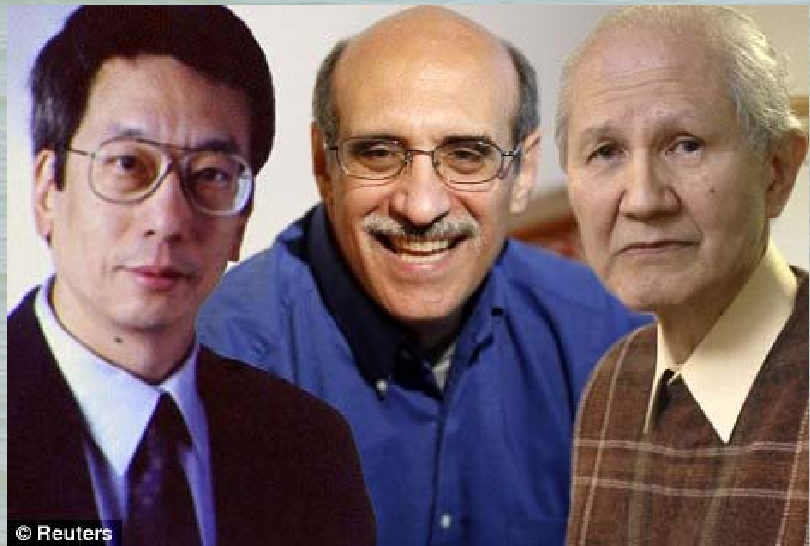
Leland H. Hartwell, Tim Hunt & Paul Nurse

2001





2008

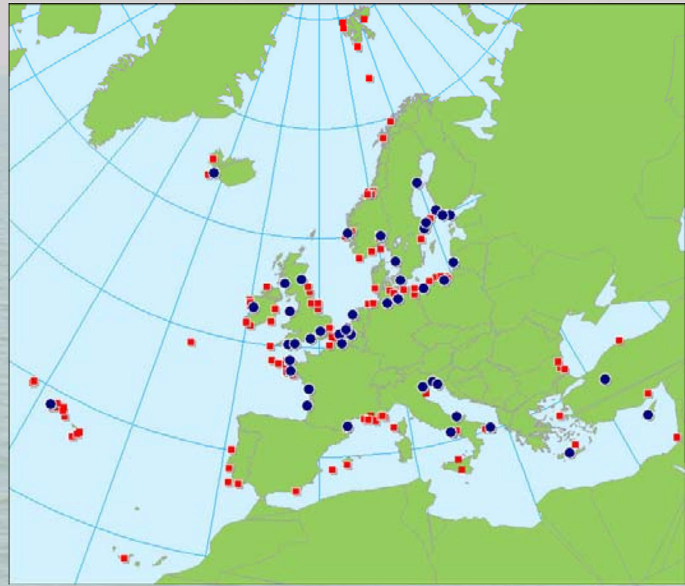


Roger Tsien, Martin Chalfie & Osamu Shimomura

What for the future?

Europe

> 60+ Labs/Insts



SZN, Italy

SLC, Sweden

SAMS, UK

MBA, UK

SOI, UK

SARS, Norway

CCMAR, Portugal

AWI, Germany

SBR, France

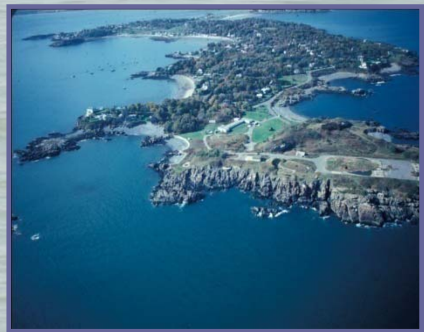
OOVS, France

OOBS, France

HMRC, Greece

USA > 120 labs/institutes

NAML
National Association
of
Marine Laboratories

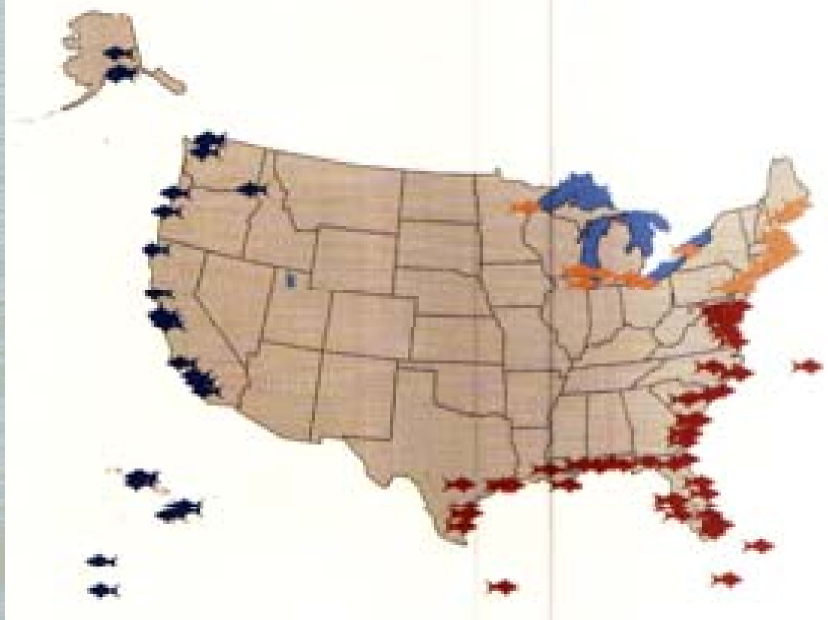


Regional Associations of NAML:

NEAMGLL, Northeastern Association of Marine and Great Lakes Laboratories, includes the Mid-Atlantic, New England, and the Great Lakes states;

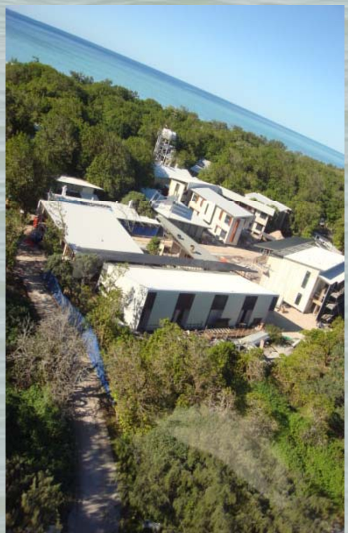
SAML, Southern Association of Marine Laboratories, includes coastal states from Maryland to Texas, and Bermuda, Puerto Rico, Panama and the Antarctic;

WAML, Western Association of Marine Laboratories, includes the states of the West Coast, Hawaii, Guam and Palau.



Australia Tropical Marine Network

- Affiliation of Six Research Stations belonging to three universities and the Australian Museum
- Based largely on the Great Barrier Reef
- Delivers co-operative education programs and Joint infrastructure developments



Japan > 150 (largely small) marine stations

Organization of Marine Stations in Japan

Hokkaido Honshu
Shikoku Kyushu
Okinawa

◆Marine Station - National University

Science

Graduate School of Science,
Field Science Center, University Institute (total 21)

Directors Congress

Agriculture/Fisheries

Graduate School of Agriculture/Fisheries,
Field Science Center, University Institute (total ~25)

Directors Congress

◆ Marine Station
- Prefectural or Private University (~10)

◆ JAMSTEC
(Japan Agency for Marine-Earth Science and Technology)

◆ Experimental Station
- Prefectural Fisheries Station (~100)

◆ Company; Corporation, etc

”WAMS”

The World Association of Marine Stations

A Network of Marine Stations and Institutes for the 21st Century

WAMS activities and mission

- Exchange programmes, (e.g. Global ERASMUS programme)
- Training and education,
- Capacity building
- "In kind" sharing of data and access to facilities,
- Joint development and harmonization of techniques and methods,
- Integrated research strategies.
- WAMS fellowships, (WAMS trust fund in cooperation with the IOC).

Particularly important activities for WAMS in its initial phase will be:

- Inventory of the WAMS membership marine sites
- Portal site for each marine station

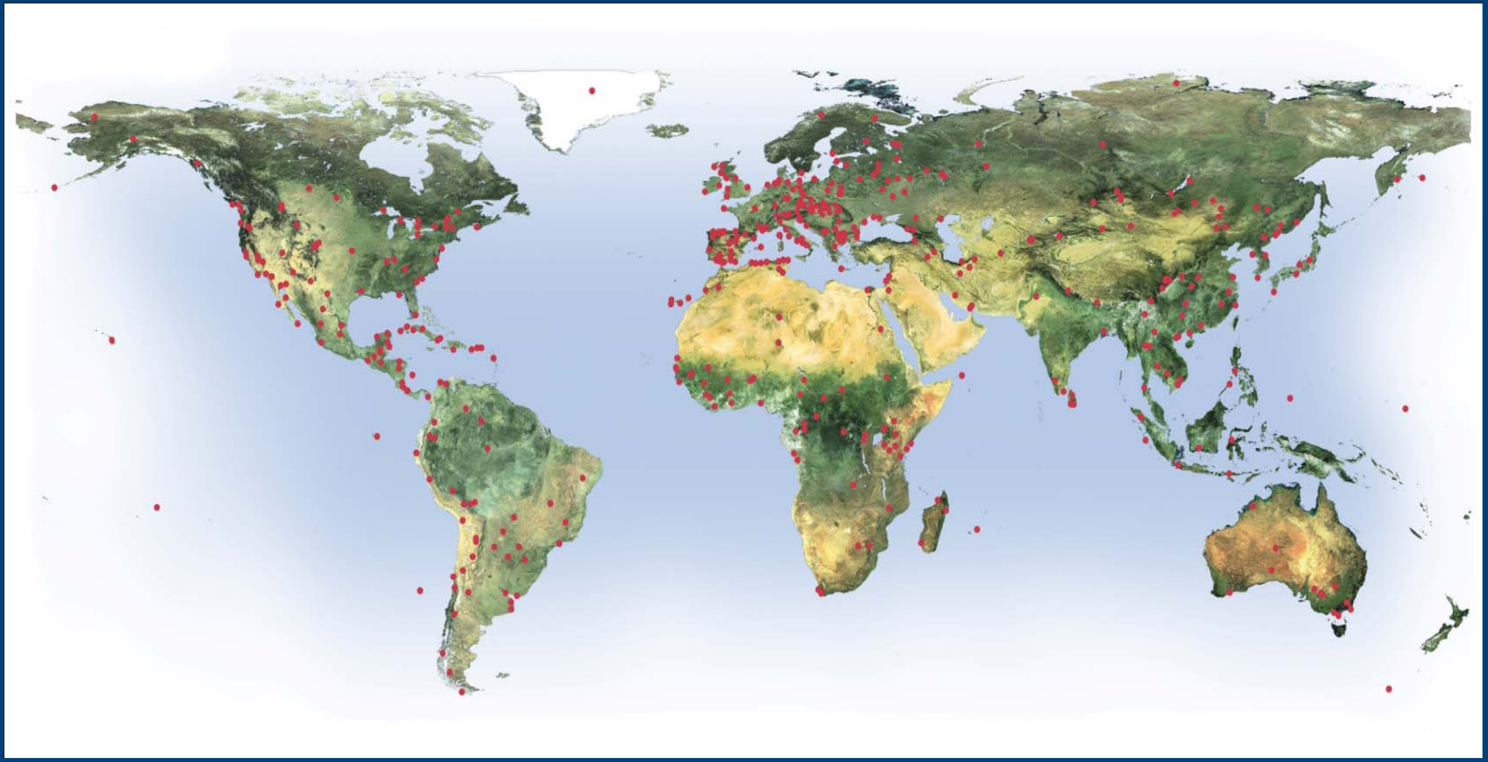
WAMS Steering Group:

- **MARS, The European Marine Network of Marine Institutes and Stations**
- **NAML, The National Association of Marine Laboratories USA,**
- **AMLC and CARICOMP The Association of Marine Laboratories of the Caribbean,**
- **JAMBIO, The Japanese Association for Marine Biology , Japan,**
- **PIMS, The Pacific Institutes of Marine Science,**
- **POGO**
- **Tropical Marine Network (Australia)**
- **GOOS – Africa (representing African Marine Laboratories)**
- **UNESCO IOC**
- **UNESCO MAB**

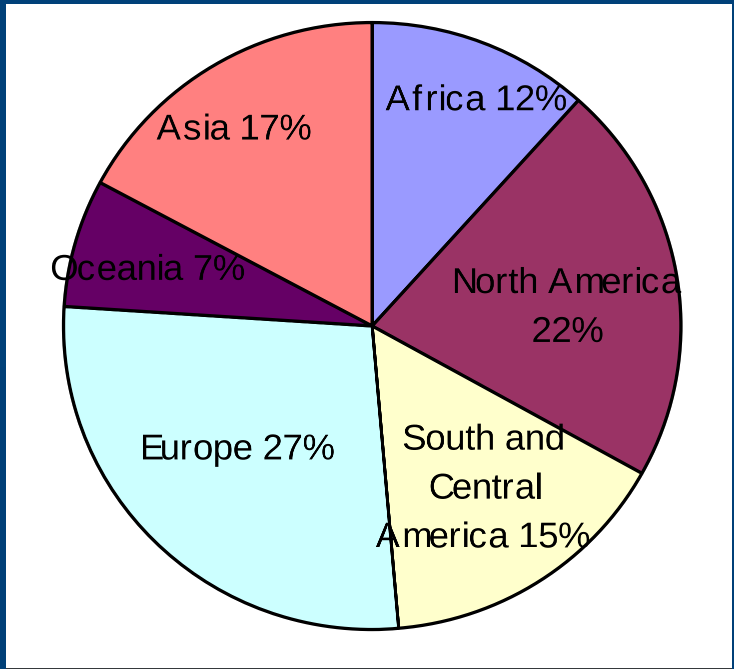
The scope of the activities within the WAMS stations will follow the theme:

“From genes to ecosystems”

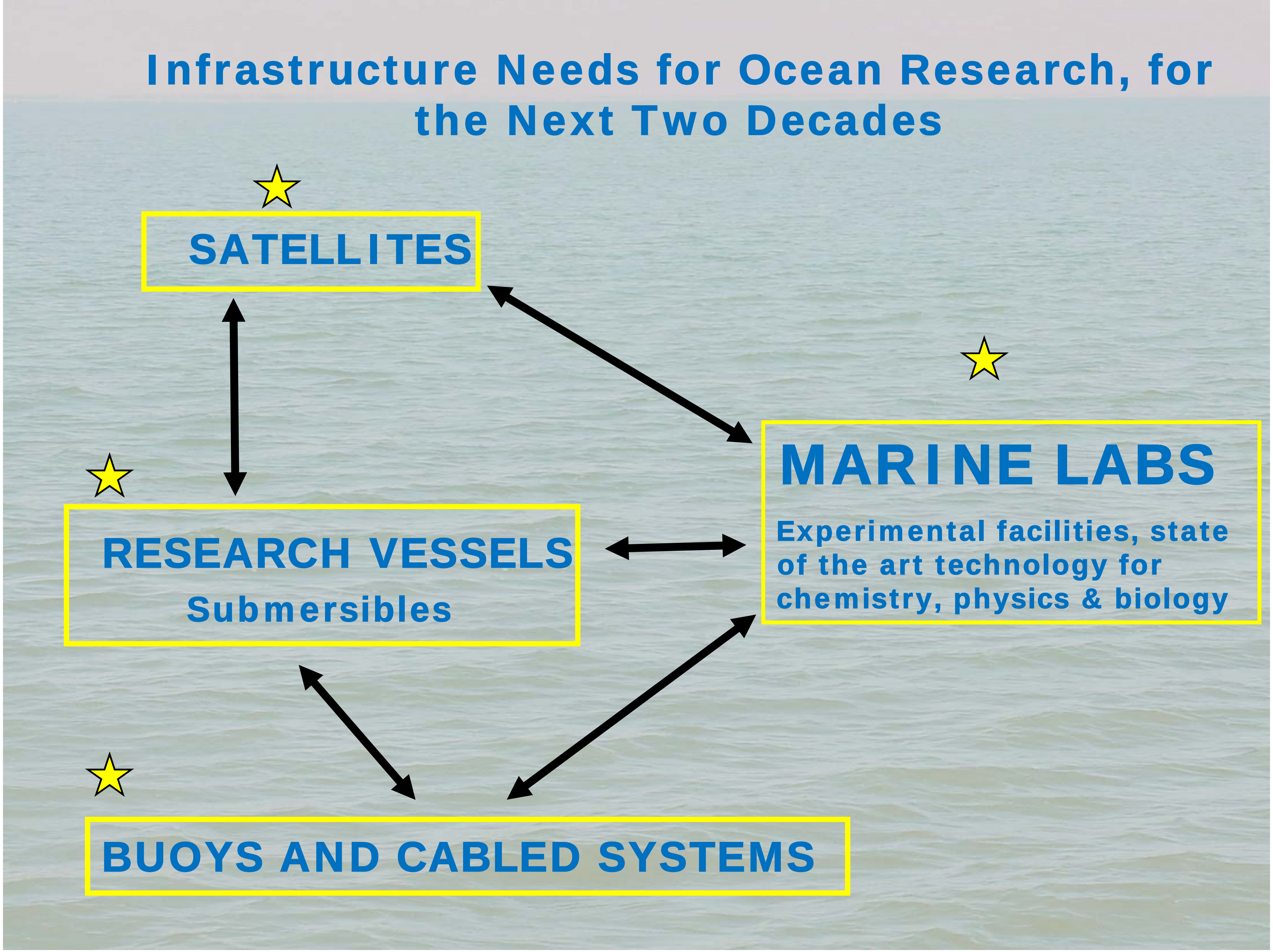
MARINE AND COASTAL BIOSPHERE RESERVES



- **The World Network of Biosphere Reserves : 551 sites in 107 countries (2009)**
- **More than 30% of those sites encompass a marine and/or coastal component**
- **Countries with different socioeconomic backgrounds and cultures**
- **Different marine ecosystems such as: mangrove, river deltas, marshland, island and deep ocean systems**



Distribution of Marine and Coastal Biosphere Reserves per Region


Infrastructure Needs for Ocean Research, for the Next Two Decades
SATELLITES
RESEARCH VESSELS
Submersibles
MARINE LABS
Experimental facilities, state of the art technology for chemistry, physics & biology
BUOYS AND CABLED SYSTEMS

The Time is right ....

... "Knowledge about marine biodiversity ………………is extensive owing to ….centuries of its study in many places and by a variety of enterprises. …….the innumerable academic institutions with shore facilities for study of the marine environment ....have provided foci of research and knowledge….." Fautin et al. (2010) PLoS ONE 5(8)

"Another point of consensus …………….is the inventory of threats to marine biodiversity. Indeed, most threats identified …..are true for the entire world." Birmingham Science News Examiner August 5th 2010