Marine Biotechnology opportunities and challenges – Are we realizing the vision and strategy for Europe?

SUBMARINER Blue Biotechnology Cooperation Event:
New Strategies and Future Perspectives
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Jan-Bart Calewaert
Marine Board-ESF
E-mail: jbcalewaert@esf.org

Marine Board-ESF?

Mission

The Marine Board provides a pan-European platform for its member organisations to develop common priorities, to advance marine research, and to bridge the gap between science and policy in order to meet future marine science challenges and opportunities.
33 Members from 20 Countries (April 2012)

Belgium  Italy
Croatia  Netherlands
Cyprus  Norway
Denmark  Poland
Estonia  Portugal
Finland  Romania
France  Spain
Germany  Sweden
Greece  Turkey
Ireland  United Kingdom

Marine Board offices - InnovOcean site - Ostend, Belgium
How to reach our objectives?

The Marine Board delivers its strategic vision and science foresight through high-level publications and statements, targeted both at the research community and policymakers.

Some new & ongoing activities 2012

- **Working Groups**:
  - Marine Microbial Diversity
    - launch at the EMD on 22 May 2012 & available from www.marineboard.eu from 01/06/2012
  - Oceans and Human Health
  - Valuation of Marine Ecosystem Goods and Services
- **Science Policy Briefing on Marine biodiversity**
- **Navigating the Future IV** (Publication late 2012)
  - key challenges and opportunities for marine science in next decade
Outline

I. Exploring the marine environment
II. Marine biotech contributions to the grand challenges
III. Major marine biotech science policy developments
IV. A new vision and strategy for Europe
V. From MARINEBIOTECH CSA to ERA-NET?
VI. Other key developments

I. Exploring the Marine Environment
Importance of the oceans
70% of Earth’s surface
97% of biosphere volume
80% of species on Earth
2/3 of the value of all natural services provided by the planet

A largely invisible world

Pelagibacter ubique

Benefits delivered by marine ecosystem services

• Oceans deliver huge amount of **food products**, are increasingly providing **sustainable sources of energy**

• Oceans are responsible for **regulating the climate system** and **buffer large amounts of carbon dioxide** released by man

• Maritime activities are of growing importance to **secure our economic recovery and creation of jobs**
Rationale for exploring the marine environment

- Life in the oceans is ancient, over 3.5 billion years old

- Diversity of life in the oceans is high (but still largely unknown)

- Adaptations to marine environmental conditions are diverse and often unique

- Genetic basis for adaptations is now increasingly understood

- New tools for exploring the marine environment exist (from metagenomics to satellite observation)
II. Marine biotech contributions

**OECD - definition of biotechnology**

"The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" [1].

+ list of biotechnology techniques functions as an interpretative guideline to the single definition.

→ High-tech and molecular tools to distinguish biotech from more traditional ‘production’ activities using organisms (agriculture and aquaculture, etc.)

[1]http://www.oecd.org/document/42/0,3343,en_2649_34537_1933994_1_1_1_37437,00.html
Marine Biotechnology

... explores and uses marine bioresources as the target or source of biotechnical applications.

This for the production of knowledge, goods and services. The developments can, positively or negatively, affect the natural environment, therefore it is necessary to consider sustainable use and social acceptance for the use of the marine environment. (definition by CSA MarineBiotech - Adapted from OECD)

Marine biotechnology contributions

Fulfill the Europe 2020 Strategy

Realize The EU Bioeconomy strategy:
«Innovating for Sustainable growth: A bioeconomy for Europe»

Address the grand challenges of the 21st century

• the protection and management of the marine environment
• securing human health and well-being
• sustainable alternative sources of energy
• sustainable supply of high quality and healthy food
• industrial products and processes
Yondells® (trabectedin)

1. Health

Contributions from Adrianna Ianora (SZN) and Fernando de la Calle (Pharmamar)

Other applications for natural products
Neutraceuticals and Cosmeceuticals

- as nutritional supplements including color additives and antioxidants
- vitamins, oils, and cofactors which enhance general well-being
- The carotenoid market alone was projected to reach 77,000 million Euro by 2010
2. Improve aquaculture production

Marine aquaculture is one of the fastest growing sectors in "agriculture"
- areas closed to commercial fishing
- increased demand to supply food and high quality wholesome products

In 2007 the EU-27 production of aquaculture increased to nearly 1,306 thousand tonnes (+ 6.3%) with Iceland and Norway increasing their aquaculture production by 56%.

3. Probing the marine environment

Biotechnology has contributed to marine research in many ways:
1. Bioremediation after major oil spills
2. Monitoring toxic blooms
3. Restoration of certain habitats
4. Identifying the country of origin of endangered species (forensic biotech)
4. Energy

Alternatives to fossil fuels may be photosynthetically generated biomass:

1. Microalgae (e.g. Chlorella) are renewable and there is no damage to the environment. Unfortunately, biomass is not economically competitive with current sources of energy.

2. Biomass can be converted by bacteria and microalgae to fuels such as methane and biodiesel.

3. Biotechnology may make biomass more viable by enhancing photosynthesis to produce more of a fuel, or modifying biomass to favor fuel production.

5. Marine Biotech contribution to innovative products in support to the grand challenges

1. Proteins and enzymes (notably extremophiles)
   - Large range of applications: white biotech, feed, energy, environment, etc.
   - Need for improved high throughput direct screening from crude sample

2. Biopolymers (EPS, PHA, etc.)
   - Large range of applications: cosmetics, health, bioremediation, etc.

3. Biomaterials
   - Novel field of research
Bioprospecting efforts increase

Marine natural products & genes of commercial interest

The applications of genes of marine organisms patented thus far range widely:
- pharmacology and human health (55%),
- agriculture or aquaculture (26%),
- food (17%),
- cosmetics (7%) industry
- an emerging and growing number of applications in the fields of ecotoxicology, bioremediation, and biofuel production
III. Marine biotech science policy developments

Key Science Policy docs/events

- **2001** ESF Marine Board Position Paper
  - Recognised underexploited benefits of marine biotechnology in Europe
  - Called for European initiative to mobilise scattered human capital & refocus dispersed infrastructure
- **2006** EC background paper no. 10 on Marine Biotechnology
- **2007** “The Bremen meeting”. MB experts meet, hosted by German presidency
- **2008** “Blue Book”. EC-US task force on Biotech (marine genomics), Monaco
- **2008** EC launched “European Strategy for Marine and Maritime Research”
- **2009** CWG-MB advocates integrated Marine Biotech R&D in Eur
- **2010** Updated Position Paper from ESF’s Marine Board
2009 KBBE-net Collaborative Working Group on Marine Biotechnology

First real attempt to jointly map national research priorities of European countries to identify Areas of common interest

- Biodiscovery / Bioprospecting
- Reference marine organisms and systems
- Molecular aquaculture
- Marine biomass production, use and transformation
- R & D tools (model organisms, reference sequences, bioinformatics, databases and biobanks, HTS technologies, IPR)

Marine Biotechnology Working Group 2009-2010 - Objectives

- provide a **strategic assessment** of the current scientific understanding of marine biotechnology relevant to European and member states policies
- identify the **priorities for further research** needed in this field
- formulate **recommendations** for future policies

*Chaired by: Joel Querellou (Ifremer)*

11 experts from various disciplines: Torger Barresen (Dk), Catherine Boyen (Fr), Alan Dobson (Ir), Manfred Höfle (G), Adrianna Ianora (It), Marcel Jaspars (UK), Anake Kijjoa (Pt), Jan Olafsen (N), Joel Querellou (Fr), George Rigos (Gr), René Wijffels (Nl)
IV. A new vision and strategy for European marine biotech

Vision for the future

By 2020 European Union will develop and apply advanced tools, platforms and infrastructures and support to Marine Biotechnology to provide a significant contribution to addressing key societal challenges of the next decades in the areas of food and energy security, the development of novel drugs and treatments for human health and the sustainable use and management of the seas and oceans.

Naive if not supported by an appropriate strategy and a strong implementation plan and constant support of all key players.
Farming Bacteria for Food

This species of yeti crab “farms” colonies of bacteria on its claws.

To help them grow, it waves its pincers over methane and sulfide vents, fertilizing the bacteria and making them good enough to eat.

Mark Brown, Wired UK
Challenges – MB PP15

- Access to resources (especially) very deep specimens
- Increased understanding of physiology of marine species
- Culturing marine microorganisms
- Sustainable aquaculture of algae, fish, and shellfish for food, fuels and high value products and processes
- New policies for the protection of marine genetic resources
- Address legal and policy barriers in the biodiscovery pipeline (ABS, IP, ...)

PP15 High level opportunities

Some of the main opportunities for Europe are in
- Pooling resources (infrastructures, human capital, ...)
- Exchanging knowledge and best practices
- Avoiding duplication of efforts through better coordination of activities (aligning at various levels)
- Improving the science-policy and science-industry interface
Recommendations – MB PP15

I. Create a strong identity and communication strategy to raise the profile and awareness of European marine biotechnology research

II. Stimulate the development of research strategies and programmes for Marine Biotechnology research and align these at the national, regional and pan-European level.

III. Improve technology transfer pathways, strengthen the basis for proactive interaction between academic research and industry

IV. Improve training and education to support marine biotechnology in Europe to provide both research and industry with skilled people

Strategy – how to achieve the goals?

- Improve coordination of European Marine Biotechnology RTDI to strengthen integration
- Profile marine biotechnology landscape in Europe in international context
- Create a central European portal www.marinebiotech.eu
- Improve policies in property rights and IP
- Develop collaborative industry-academia research programmes

+ SEE ALL RECOMMENDED ACTIONS - download the position paper at www.marineboard.eu
V. Coordination of European Marine Biotechnology RTDI – towards an ERA-NET?
What is an ERA-NET?

- EC-funded project
- Eligible partners: funding organisations only

Aim:
- Coordination of national + regional research programs
- Funding of transnational research projects

Why an ERA-NET Marine Biotechnology?

- Develop and strengthen the coordination of national and regional RTDI programmes.

- Reduce fragmentation and duplication and pave the way for common programmes and cooperation.

- Efficient use of national and regional funding by developing joint transnational calls and avoiding double funding.

- Provide a framework for actors implementing public research programmes to coordinate their activities.

- Progress towards the vision of a European Research Area (ERA).

www.marinebiotech.eu
CSA MarineBiotech - Aim

- Mobilisation funding agencies and key stakeholders within marine biotechnology
- Gaining better understanding of the marine biotechnology landscape in Europe and beyond
- Sketching the contours of future cooperation between funding agencies in the area of marine biotechnology
- Developing a vision of strategic marine biotechnology RTDI that is shared by the interested funding agencies and stakeholders.

**Duration**
October 2011 – April 2013 (18 month)

**Coordinator & Manager**
Steinar Bergseth, RCN (Norway) & Meredith Lloyd-Evans, BioBridge Ltd. (UK)

**Budget**: 1 Mio €

www.marinebiotech.eu
CSA MarineBiotech - Partners

Belgium - Flanders Marine Institute (VLIZ)
  - Marine Board - ESF

Denmark - Technical University of Denmark (DTU)

France - Centre National de la Recherche Scientifique Roscoff (CNRS)
  - French Institute for Exploration of the Sea (IFREMER)

Germany - North Germany Life Science Agency (Norgenta)

Italy - National Research Council (CNR)

Norway - Research Council Norway (RCN)

Portugal - Ministry of Science, Technology and Higher education (FCT) FCT

Turkey - The Scientific and Technological Research Council of Turkey (TÜBİTAK)

UK - Biobridge Ltd.

www.marinebiotech.eu

Project Structure

CSA (Coordinating) in Marine Biotechnology - MARINEBIOTECH

Work Package 1 - Coordination & Management

Work Package 2 - Mobilization & Engagement of Funding Agencies and Stakeholders

Work Package 3 - Mapping the Marine Biotechnology RTDI Landscape

Work Package 4 - Scoping the Future ERA-NET

Work Package 5 - Communication & Dissemination

Marine Biotechnology ERA-NET
Mapping components in a nutshell

- **Inventory of European** Marine Biotechnology RTDI Strategies, Programmes and Initiatives
  *Task Leader: Marine Board-ESF*

- **A Global** Perspective: High-level analysis of key trends and developments in global marine biotechnology RTDI
  *Task Leader: BioBridge*

- **Analysis** of the European Marine Biotechnology RTDI Landscape
  *Task Leader: Marine Board-ESF*
Examples of national strategic documents with an identifiable focus on marine biotech

- **Ireland 2007**: [http://www.marine.ie/home/SeaChange.htm](http://www.marine.ie/home/SeaChange.htm)
    Marine Biotechnology, Marine Technology, Marine Functional Food and Renewable Ocean Energy

- **Norway 2009**
  - “A strategy for Marine Bioprospecting – a source of new and viable wealth creation”
    Encourage use of marine resources, biobanks, international collaboration, innovation – develop value chain

- **Denmark 2010**
  - “The Ocean – a underutilised resource”
    Better use of marine biomass, healthy diet, bioprospecting for new biological principles and compounds, biofilms

Sea [www.marinebiotech.eu](http://www.marinebiotech.eu) for regular updates, strategic documents and analysis reports

Global outlook

- No obvious National Strategies for Marine Biotechnology
- A few specific national programmes in Mbiotech or industrial applications
- Globally, algal bioenergy support stands out, mainly due to very strong US focus on R&D and investment
- Marine bioactives and molecular aquaculture also important
- Economic development support does exist (equivalent to ERDF and regional or national programmes in EU) – combinations of direct grant, loan, loan guarantee, matched-funding, tax-benefits

Report should be available by summer 2012 at [www.marinebiotech.eu](http://www.marinebiotech.eu)
Some first observations

- **USA:** a focus on algal bioenergy; a new national Bioeconomy plan with opportunity to establish MBt as strategic element; several world-recognised MBt institutes – CoMB, Scripps etc
- **Japan:** rather less prominent than 10-20 years ago
- **India:** an intention to establish a National MBt Institute – funding voted end-2011; €12M joint biofuels programme UK BBSRC and India’s Department of Biotechnology – includes algae
- **Brazil:** BIOMAR – Marine Biotechnology Action – established 2005 by Ministry of Science and Innovation to fund MBt projects; RedeAlgas; many research activities in bioactives and in bioenergy but difficult to see cohesion

Other international and regional initiatives

- **Census of Marine Life 2000-2010:** Established by Alfred P Sloan Foundation
- **Regional Oceanographic data and information exchange networks:** established under the aegis of UNESCO’s IODE
- **Pan American Marine Biotechnology Association:** – HQ Canada
Regional interest – e.g. CIESM

- 22-state organisation headquartered in Monaco
- Non-European members include Egypt, Israel, Morocco, Syria, Tunisia, Turkey, [Algeria]
- Covers all aspects of marine science and research - no specific focus on marine biotechnology – except:
- Decision of CIESM Board 2010 to ‘unite in protecting the economic interests of the Mediterranean against the risk of massive exploitation of their marine genetic resources by foreign companies’ (F Briand, DG CIESM)
- Blue Biotech meeting La Spezia 12 April 2011
- ‘Blog’ forum on Blue Biotech at http://www.ciesmseaforum.org/category/blue-biotech/
- Next congress 2013

CSA MarineBiotech - Time schedule

For the mapping and scoping we need your input!
VI. What else is on the horizon?

Improving coordination (1)

The problem of Europe

- National priorities still largely dominate
- 15% European level funding and **85% at national level**

→ One way to address this is to set up a long-term framework for research at EU level and increase the added value of MS/AC investments in RTD = **Joint Programming Initiatives** to tackle challenges too big to for individual countries to handle
Improving coordination (2)

  - A coordinating and integrating platform for marine and maritime research driven by governments

  - Merger of former marine NoEs MGE, Marbef and Euroceans
  - From genes to ecosystems: bringing the marine sciences into the multi-disciplinary perspectives of the 21st Century

- **Other ERA-NETs and European Technology Platforms (ETPs) related to KBBE**
  - EATIP, SusChem, biofuels TP, ...?
  - BiodiveERSA, MATERA, INNER, ERA-PG, SPLASH, BONUS, Nanosci, EMIDA, ERASysBio, SEAS-ERA, BioEnergy...
  - ERA-IB2 → Towards a European Research Area in Industrial Biotechnology

Improving coordination (3)

**JPI Oceans goals**

1. **Foster enabling cross-cutting marine technologies**
2. **Foster the marine bio-economy**
3. Maximize the development of marine renewable energies
4. **Knowledge and technologies to conquer the deep-sea frontier**
5. Understand and mitigate impacts and pressures on the marine environment to reach Good Environmental Status (GES) - MSFD
6. **Improve understanding of marine ecosystems and processes**
7. Address the impact of CC on coastal areas and maritime activities
8. **Infrastructure for integrated data and information base enabling industrial development and supporting maritime governance**
9. Develop a research to policy mechanism, in particular to support of the MSFD and Marine Spatial Planning (MSP)
10. Foster the inter-disciplinary human capacities that are necessary to the JPI goals
Improving availability and access to research infrastructures - examples

- Coordination and access to Research Vessels – FP7 EUROFLEETS - [http://www.eurofleets.eu/np4/home.html](http://www.eurofleets.eu/np4/home.html)
- Access to bioinformatics infrastructure – ELIXIR (ESFRI) aims to construct and operate a sustainable infrastructure for biological information in Europe to support life science research and its translation to medicine and the environment, the bio-industries and society [http://www.elixir-europe.org/](http://www.elixir-europe.org/)

Tackling research priorities and challenges – selected examples

- Cultivation challenges
  - FP7 MaCuMBA – Marine Microorganisms: Cultivation Methods for Improving their Biotechnological Applications
- Legal and policy barriers
  - NEW FP7 BlueGenics, SeaBioTech and PharmaSea
- Biodiscovery bottlenecks
  - NEW FP7 BlueGenics, SeaBioTech and PharmaSea
Global interest - OECD
Organisation for Economic Cooperation and Development

new policy work to ensure the translation of new scientific and technological advances into economic prosperity in an environmentally sustainable manner

- Multi-national working party on marine biotech initiated by Norway 2010 within the Working Group on Biotechnology
- 11 members - 9 individual countries, the EU & OECD BIAC
- Scoping Paper 2011 – now working document
  - 5 broad [starting] areas: molecular aquaculture, algal biofuels, bioremediation, biodiscovery, biosensors

Marine Biotech & OECD

- Provide forum to discuss potential of marine biotechnology to provide solutions to the grand challenges
- Discuss impact and potential of new science and technology within the field of marine biotechnology
- Identify barrier to development of marine biotechnology
- Consider the role of government in creating an enabling environment for marine biotechnology
- Determine areas in which the OECD can provide further policy insight and expertise
- Provide guidance for further work on marine biotechnology at the OECD
Conclusions (1) – are we realising the vision and strategy?

Notable progress

- European coordination efforts ongoing → CSA, ERA-NET, marine biotech portal, euromarine, JPI Oceans
- Key research priorities are being addressed
  - Cultivation challenges, e.g. microorganisms
  - Legal and policy barriers
  - Biodiscovery challenges
- Infrastructures are being developed or improved
  - Research fleets
  - Marine model organisms
  - Omics platforms
- International recognition and driving forces (e.g. OECD initiative)
- Identity and visibility has greatly improved

Conclusions (2) – are we realising the vision and strategy?

Many challenges remain

- Buy-in from funders and governments
- Aligning the various interests, strategies and programmes at various levels
- Positioning of bluebiotech in the complicated and dynamic landscape: projects, infrastructures, JPI Oceans, other ERA-NETs, etc.
- Techtransfer and industry/academic collaborative approaches – developing markets and businesses
- Education and training remains a challenge
Conclusions (3)
Take home messages

• Science policy process is often slow and frustrating for scientists BUT is a CRITICAL process
• Scientists must engage, invest time and effort even if the results are delayed and indirect
• After many years of push&pull, the marine biotech process is picking up speed in Europe and beyond (ERA-NET, OECD, etc.)
• Baltic region is in an excellent position to contribute AND benefit from these developments BUT
  – Should get its act together and be ready to jump on the train - once in motion, it will not wait
  – Use the development of the Mbiotech strategy to position itself as a model region to obtain maximum benefits
  – Take an open approach linking with the pan-European processes

Acknowledgements

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Thank you for your attention and future contributions!

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**Marine Board**

[Image of Marine Board logos]

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