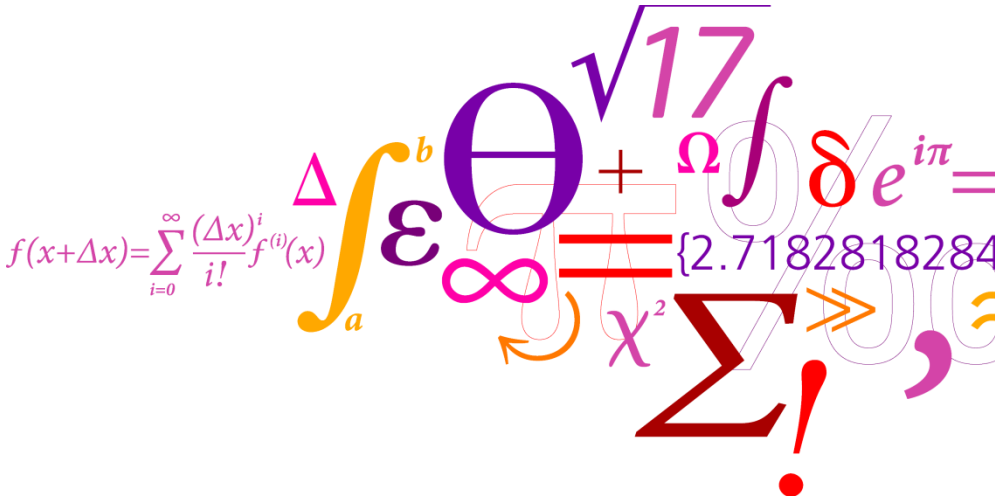
Blue Biotechnology

Torger Børresen, Ph.D.
Forskningschef
Afdeling for Fødevareindustriel Forskning
DTU Fødevareinstituttet
Søltofts Plads, Bygning 221, DTU
DK-2800 Lyngby



Oversigt

- **Hvad er Blue Biotechnology og hvad er så interessant ved det?**
- **Rapporter og udredninger**
- **Europæisk samarbejde**
- **Konferencer og netværksdannelser**

The Earth

- **72 % of surface is water**
- **> 90 % of the biosphere is water**
- **So why is this planet called EARTH?**

Challenges

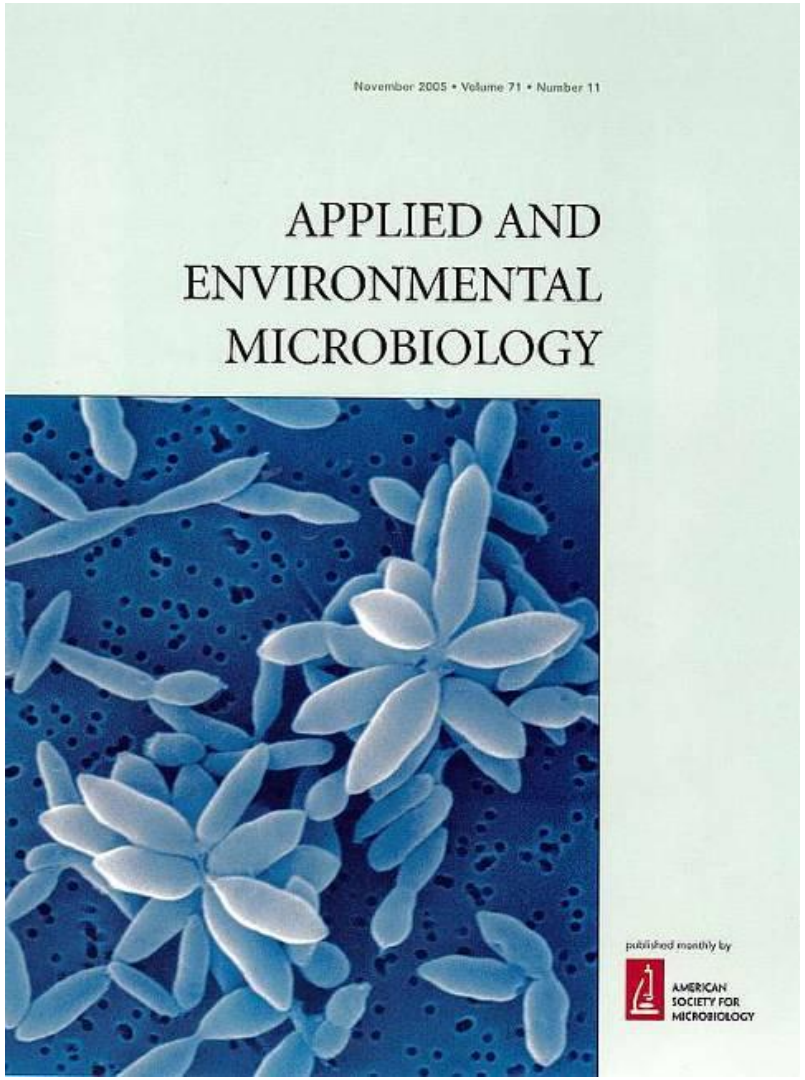
- Less than 1% of marine microorganisms can be cultured
- Lack of knowledge about the micro- and macrobiota composition in most ocean areas
- Development of polycultural systems for growing organisms in the aquatic environment in order to master the environmental conditions
- Future food supplies will be requested from the aquatic environment
  - Finfish
  - Crustaceans
  - Algae
  - More 'exotic' foods

Mikrobiologi

'Havets stjernebakterier' *Roseobacter*

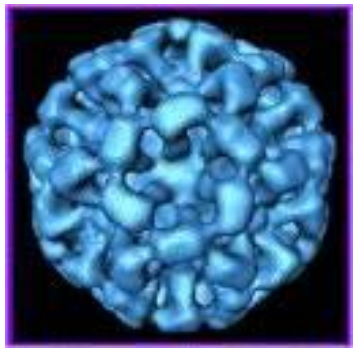
- Først identificeret i pighvaropdræt i Portugal
- Senere isoleret fra prøver taget på Galathea-togt

Professor Lone Gram



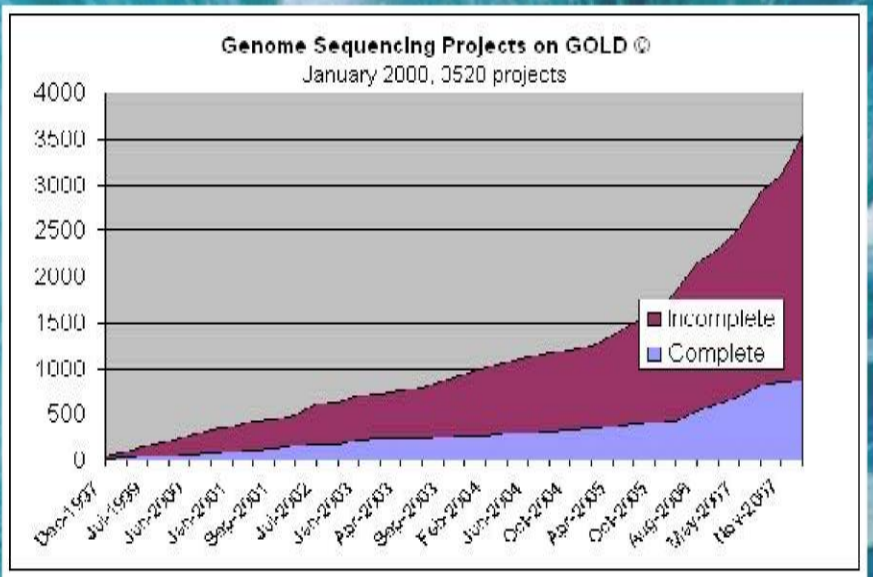
The new promises – blue biotechnology

- Bioprospecting
- Metagenomics
- Use of -omics technology
- Functional genomics
- New applications



The genome tsunami…

- The number of sequenced organisms grows exponentially



Seaweed - utilisation

Traditional utilisation

- Fertilizer
- Condiment with other food (in Far East)
- Extraction of gums for food and non-food use

New use

- Antioxidants
- Minerals and minor components

Antioxidanter

- Nyt projekt startede forår 2009 vedrørende antioxidanter i tang
- Post doc Sabeena Farvin

- Seniorforsker Charlotte Jacobsen

Gums as food ingredients

Polysaccharides from seaweed are all negatively charged molecules

Examples:

- Alginate
- Agar
- Carragenans

Excellent for use as thickeners

And for water binding agents

Chitin (from crustaceans)

Positively charged molecules

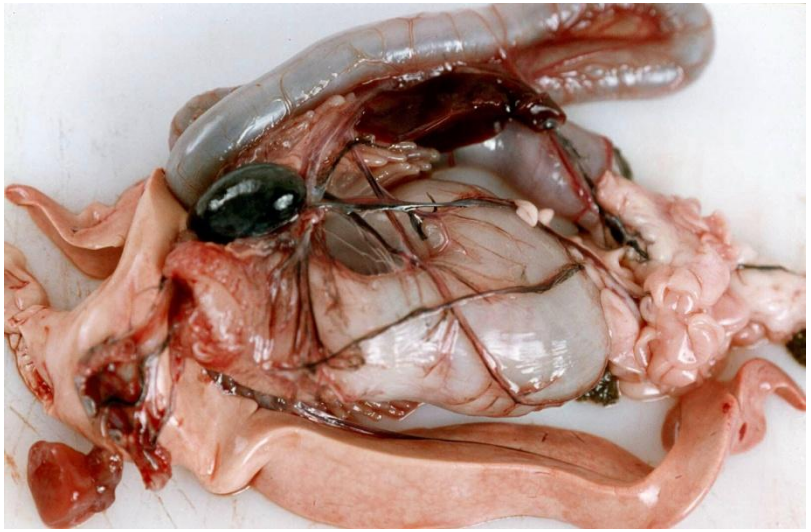
Headline in Seafood International, May 2001

There's gold in marine waste

- **Erik Hempel: In Norway a value estimate of $ 110 million produced in year 2000**
- **Report from conference 'By-products from the fisheries industry beyond 2000'**

Udnyttelse af biprodukter

- Enzymer fra fiskeindvolde
- Collagen fra fiskeskind og benfraktion
- Fiskeolier til fødevarebrug
- Proteinhydrolysater fra afskær i filetindustrien
- Basiske proteiner fra fiskemælk
- Chitin fra rejeskaller



New potentials

PROCESSING

by **Fiona Proffitt**

A surprising use of fish waste

Skincare products command a large market, estimated in 2000 at US$6.6 billion in the United States, US$1.1 billion in the United Kingdom, and US$1.6 billion in France. Consumer demand for natural products in this lucrative market continues to grow. Cosmeceuticals (cosmetic products intended to have therapeutic effects on the body) are widely reported to be the fastest growing sector of the cosmetics industry, with a market value forecast of approximately US$5 billion by 2007.

More and more consumers want natural skincare products that are enhanced with biologically active compounds ('bioactives') - whether they be antioxidants that reduce the signs of ageing, or natural UV protectors that can penetrate skin cells. 'By-catch' and 'waste' products from the aquaculture and fishing industries – including fish organs, skin, and eyes – are just as likely to contain these

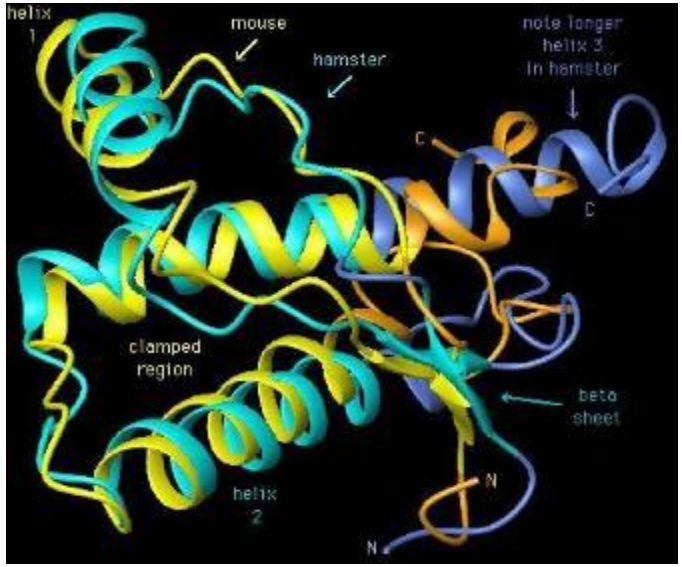
Fiona Proffitt

The development of health-giving products based on active marine compounds provides one promising avenue for adding value to seafood products. Scientists from New Zealand's National Institute of Water and Atmospheric Research (NIWA) have been working with the seafood industry to lead the way in this exciting new area.

INFOFISH *International,* Number 6, 2007, 44-47

Application categories

- **Proteins**
  - collagens
  - protamines, histones
  - enzymes
  - peptides
- **Lipids**
  - ω-3 fatty acids
- **Carbohydrates**
  - chitin, chitosan
- **Non-protein nitrogen compounds**



SEAFOODplus

Project Leader
Gudjon Thorkelson,
Matis, IS

- **Project PROPEPHEALTH**
  - **Bioactive properties:**
    - **Antibacterial, antiviral**
    - **Antioxidant**
    - **Blood pressure regulation** (angiotensin-I-converting enzyme)
    - **Anticancer effect**
    - **Stimulation of protein synthesis**
    - **Secretion of digestive enzyme**

www.seafoodplus.org

Fish protein hydrolysate preparation

3 SME'S → 7 SPECIES → More than 20 hydrolysates

DANISH FISH PROTEIN

- Cod (*G. morhua*)
- Plaice (*P. platessa*)
- Salmon (*S. salar*)

primex

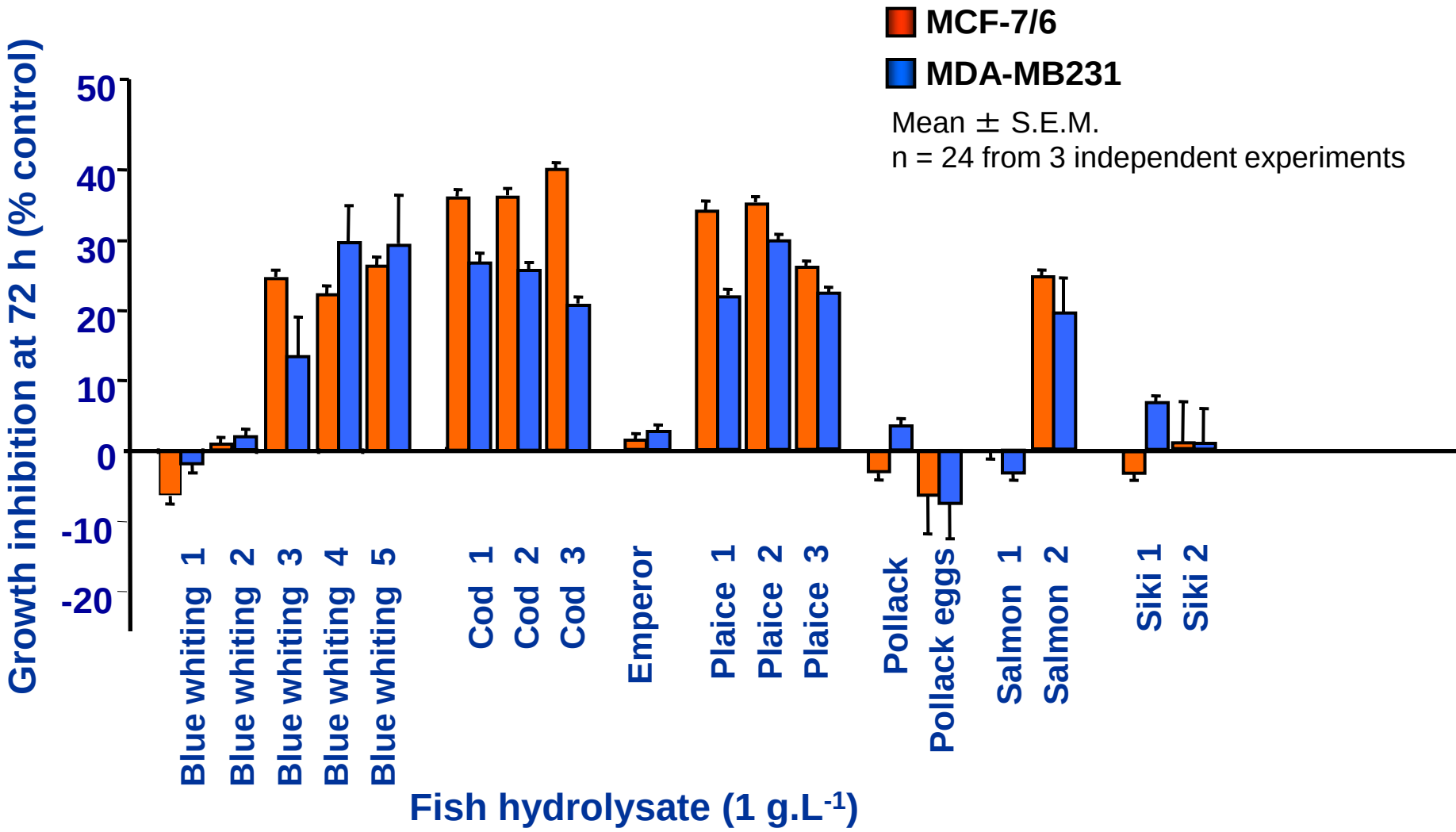
- Blue whiting (*M. poutassou*)
- Salmon (*S. salar*)

- Red bream (*B. decadactylus*)
- Saithe (*P. virens*)
- Dogfish (*C. squamosus*)

Each sample in triplicate

To control reproducibility

Antiproliferative activity of fish hydrolysates on cancer cell lines



The critical question:

Can hydrolysate peptide fractions have a consistent composition in all batches?

- Important parameters:
  - Raw material composition / freshness
  - Enzyme(s) used
  - Process parameters selected
  - Fractionation procedures

- 'A consistent quality can be obtained, but it is like making cheese, beer or other foods where each producer standardize the conditions – it is an organic process'

  - *Greta Jakobsen, Marinova*

Adding taurine increases the health value of seafood products

No one seriously doubts that seafood products are healthy, valuable foods. Nearly everybody knows that they contain Omega 3 fatty acids (EPA 20:5, DHA 22:6), numerous vitamins, plus minerals and trace elements. In contrast, hardly anyone knows that seafood also contains other important substances: taurine, for example, whose significance was for a long time disputed. New findings from the SEAFOODplus project have now revealed, however, just how important taurine is for our health.

The body of an adult contains about 70 g of the amino acid taurine. It is mainly found in the muscles and the brain, in the heart and in the blood. White blood cells, too, have high concentrations of taurine. It is particularly important for the development of the brain, the retina of the eye, and the liver of the newly born.

It is only a few years since scientists began re-evaluating the

In the face of the immense significance of taurine it is not surprising that various SEAFOODplus subprojects involve taurine. The first results were presented at the 3rd open conference in Tromsø.

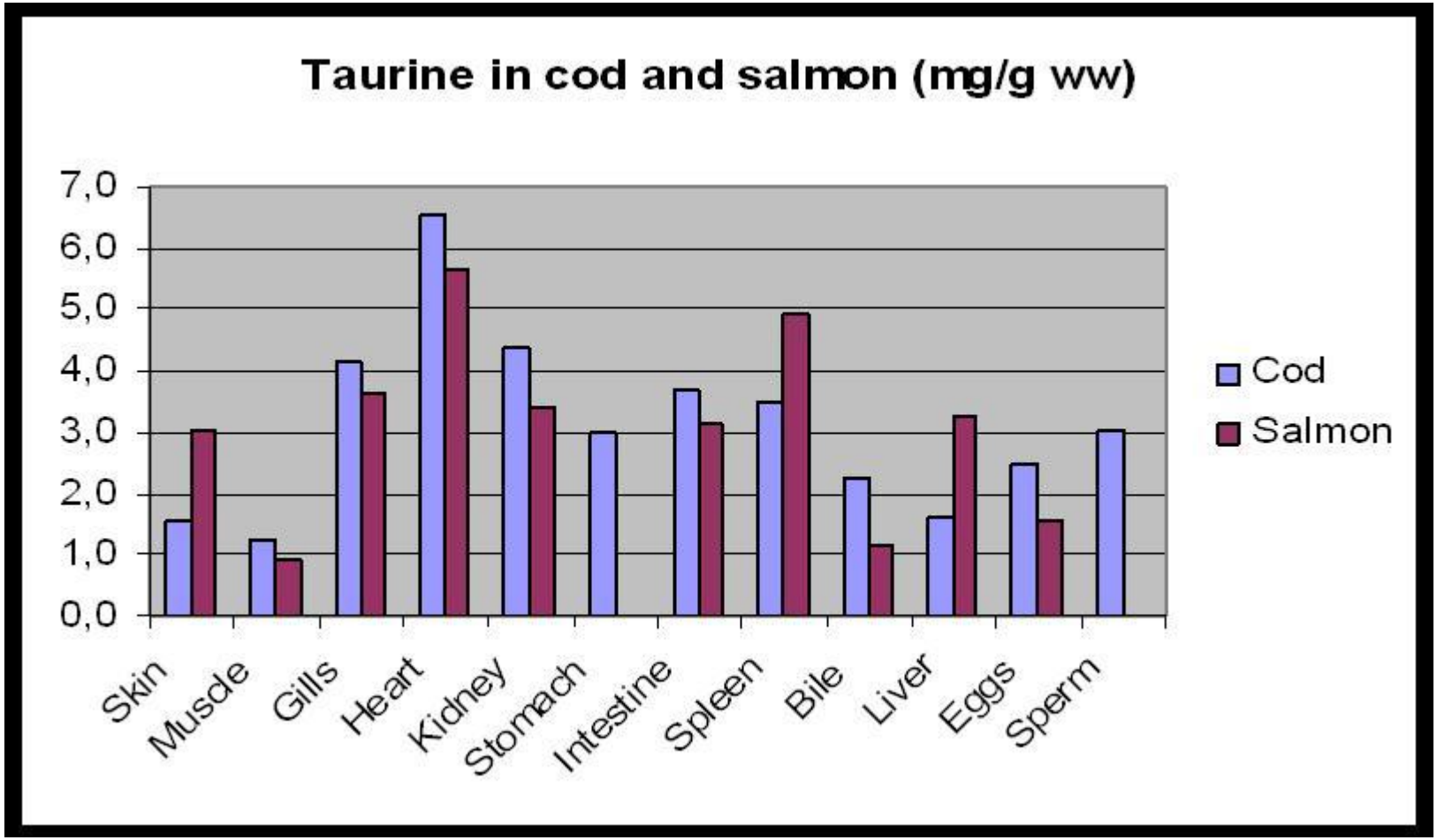
Reduction of serum cholesterol

Edel O. Elvevoll (University of Tromsø) presented the results of a study on the influence of processing on the nutritional and health value of seafood which she had conducted together with Bjarne Østerud and other scientists. Due to the general trend towards

hand processing can contribute

From EUROFISH Magazine

Taurine as functional component



Elvevoll et al. 2006

"Havet – en uudnyttet ressource"

novozymes Rethink Tomorrow — Nikolaj Blom

DANISCO First you add knowledge... — Markus Klinger

DANISH FISH PROTEIN — Greta Jakobsen

Dansk Akvakultur — Karl Iver Dahl-Madsen

DI Fødevarer DI Fødevarer DI — **DANSK FISK**

Christian Eskelund-Hansen

HEMPEL

CHR. HANSEN Improving food & health

LEO Pharma

DANSKBIOTEK

Pharma Nord

"Havet – en uudnyttet ressource"

DANSKBIOTEK

DANSK BIOTEK (The Danish Association of Biotechnology Industries) works to improve conditions for biotechnological research and production in Denmark, and to further the common interests of members, nationally and internationally.

DANSK BIOTEK represents the biotechnological industry within drug development, industry and foods (red, white and green biotechnology) and spans all areas of research, development and production.

Blue?

Havet

- en uudnyttet ressource

En vidensyntese om danske muligheder indenfor marin bioteknologi og anden udnyttelse af havets ressourcer

Fødevareministeriet maj 2010

Ministeriet for Fødevarer, Landbrug og Fiskeri

Indholdsfortegnelse

1 Sammenfatninger og udviklingstemaer 4
2 Baggrund, arbejdsmetode og afgrænsninger 6
2.1 Baggrund 6
2.2 Arbejdsmetode 7
2.3 Afgrænsninger 7
3 Introduktion 9
4 Anvendelsesorienterede perspektiver 13
4.1 Kommercielle muligheder 13
4.1.1 Bioprospektering / Biodiscovery 13
4.1.2 Forbedret produktion af marine organismer 18
4.1.3 Fremstilling af nye produkter, især indenfor fødevarer 21
5 Økonomisk perspektivering og sektorpåvirkning 30
6 Forsknings- og udviklingsklynger 32
7 Danske muligheder 36
7.1 Perspektiver og muligheder 36
7.2 De udvalgte temaer 40
7.2.1 Udnyttelse af havets biomasse 40
7.2.2 Dyrkning af råvarer i havet 45
7.2.3 Sundhedsfremmende kost 47
7.2.4 Opdagelse af nye stoffer, materialer og biologiske aktiviteter 50
7.2.5 Ekstraktion af værdifulde biokemiske stoffer 53
7.2.6 Biofilm – fra skibe over fødevareindustrien til menneskets indre 54
7.3 Den nødvendige infrastruktur og anvendelse af evt. bevillinger 58
8 Anbefalinger fra en europæisk arbejdsgruppe 59
9 Bilag 61
9.1 Kontaktgruppens sammensætning 61
9.2 Kort præsentation af udvalgte danske forskningsmiljøer og forskere samt innovative erhvervsvirksomheder 63
9.3 FN's havretskonvention 81
9.4 FN's konvention om biologisk diversitet 84
9.5 Liste over anvendte ord og begreber 85

Information til læseren:

- *Bilag 9.5 indeholder en liste med definitioner og forklaringer på en række af de anvendte forkortelser og faglige termer.*

Havet - en uudnyttet ressource

En vidensyntese om danske muligheder indenfor marin bioteknologi og anden udnyttelse af havets ressourcer

ISBN 978-87-7083-777-4

Udgiver:
Ministeriet for Fødevarer, Landbrug og Fiskeri

Slotsholmsgade 12
1216 København K
Tlf: 3392 3301
E-mail: fvm@fvm.dk

Fødevareministeriet 2010

De seks temaer

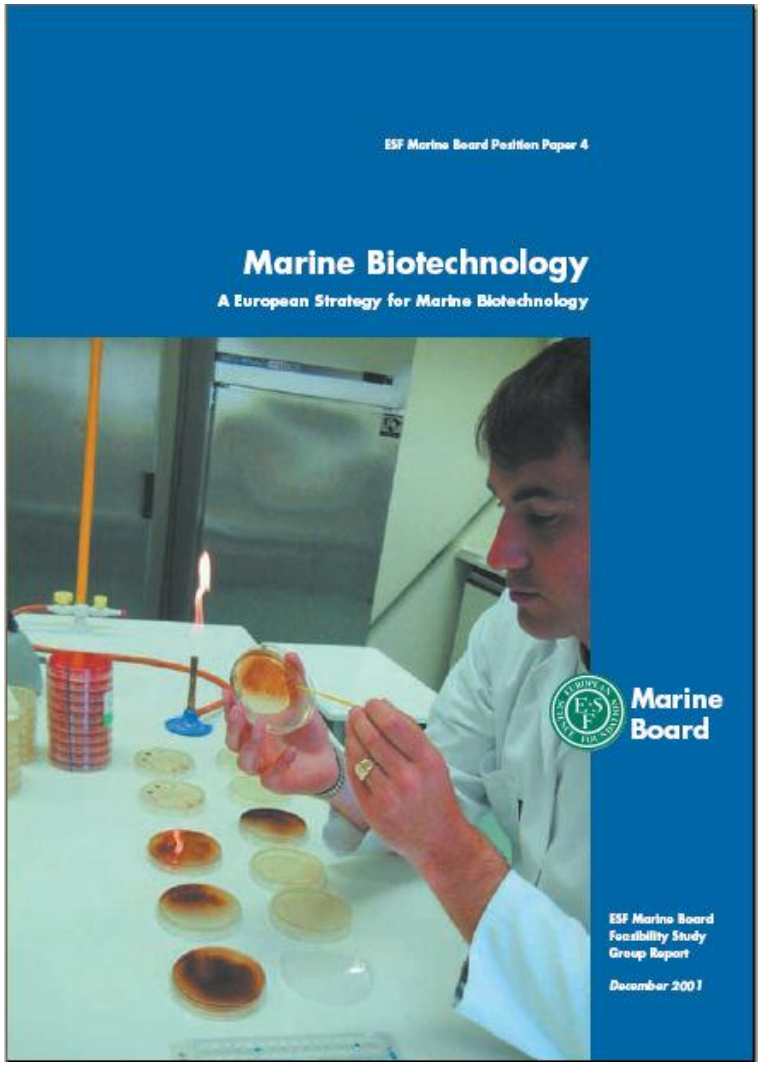
- Udnyttelse af havets biomasse
- Dyrkning af råvarer i og fra havet
- Sundhedsfremmende kost
- Opdagelse af nye stoffer, materialer og biologiske aktiviteter
- Ekstraktion af værdifulde biokemiske stoffer
- Biofilm – fra skibe over fødevareindustrien til menneskets indre

KBBE-net Scoping Paper

KBBE-net Scoping Paper – summary of recommendations

- **Marine bioprospecting/biodiscovery**
- **Robust biotechnology based R&D tools**
- **Molecular aquaculture**
- **Biomass production for bioenergy and fine chemicals**

Strategy Paper ESF Marine Biotechnology



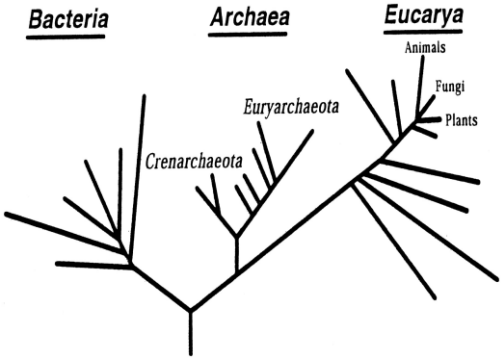
WORKING GROUP MEMBERS

Name	Organisation	Email
QUERELLOU, JOEL - CHAIR	FRENCH RESEARCH INSTITUTE FOR EXPLOITATION OF THE SEA (IFREMER), FRANCE	JOEL.QUERELLOU@IFREMER.FR
BØRRESEN, TORGER	NATIONAL INSTITUTE OF AQUATIC RESOURCES (DTU AQUA), DENMARK	TB@AQUA.DTU.DK
BOYEN, CATHERINE	CNRS STATION BIOLOGIQUE, FRANCE	BOYEN@SB-ROSCOFF.FR
DOBSON, ALAN TBC	ENVIRONMENTAL RESEARCH INSTITUTE - UCC, IRELAND	A.DOBSON@UCC.IE
HÖFLE, MANFRED	HELMHOLTZ CENTER OF INFECTION RESEARCH, GERMANY	MHO@GBF.DE
IANORA, ADRIANNA	ECOPHYSIOLOGY LABORATORY STAZIONE ZOOLOGICA "A. DOHRN" NAPLES, ITALY	IANORA@SZN.IT
KIJJOA, ANAKE	CIMAR - UNIVERSITY OF PORTO, PORTUGAL	ANKIJJOA@ICBAS.UP.PT
OLAFSEN, JAN	UNIVERSITY OF TROMSØ, NORWAY	JAN.OLAFSEN@UIT.NO
JASPARS, MARCEL (VIA VCR)	ABERDEEN UNIVERSITY, UK	M.JASPARS@ABDN.AC.UK
WIJFFELS, RENE	WAGENINGEN UNIVERSITY, NETHERLANDS	RENE.WIJFFELS@WUR.NL
RIGOS, GEORGE	HELLENIC CENTRE FOR MARINE RESEARCH (HCMR) - GREECE	GRIGOS@ATH.HCMR.GR

MARINE BOARD SECRETARIAT

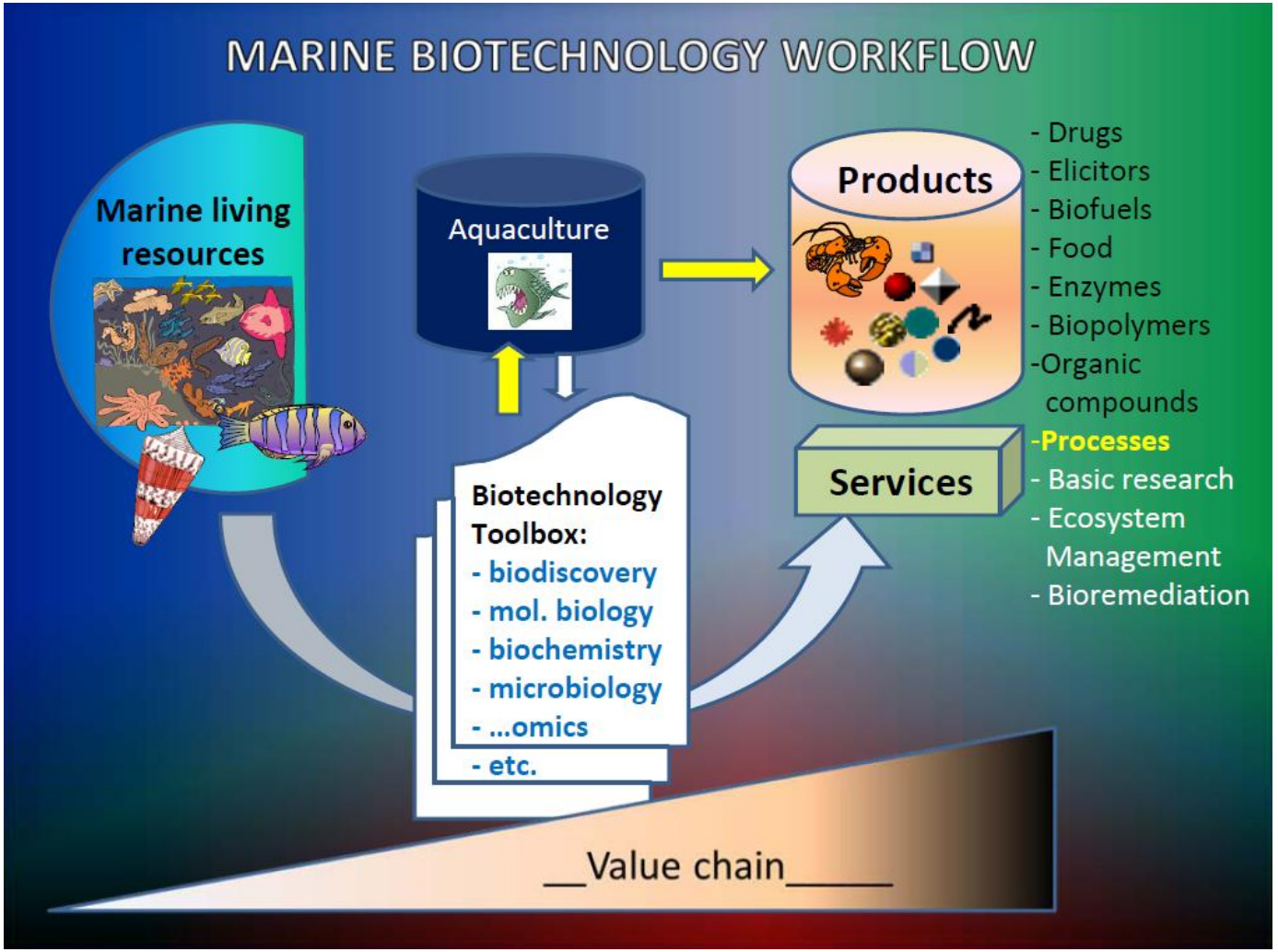
CALEWAERT, JAN-BART	MARINE BOARD	JBCALEWAERT@ESF.ORG
MCDONOUGH, NIALL	MARINE BOARD	NMCDONOUGH@ESF.ORG


EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE
MARINE BOARD
Position Paper 15
Marine Biotechnology:
A New Vision and Strategy for Europe
September 2010
www.esf.org/marineboard

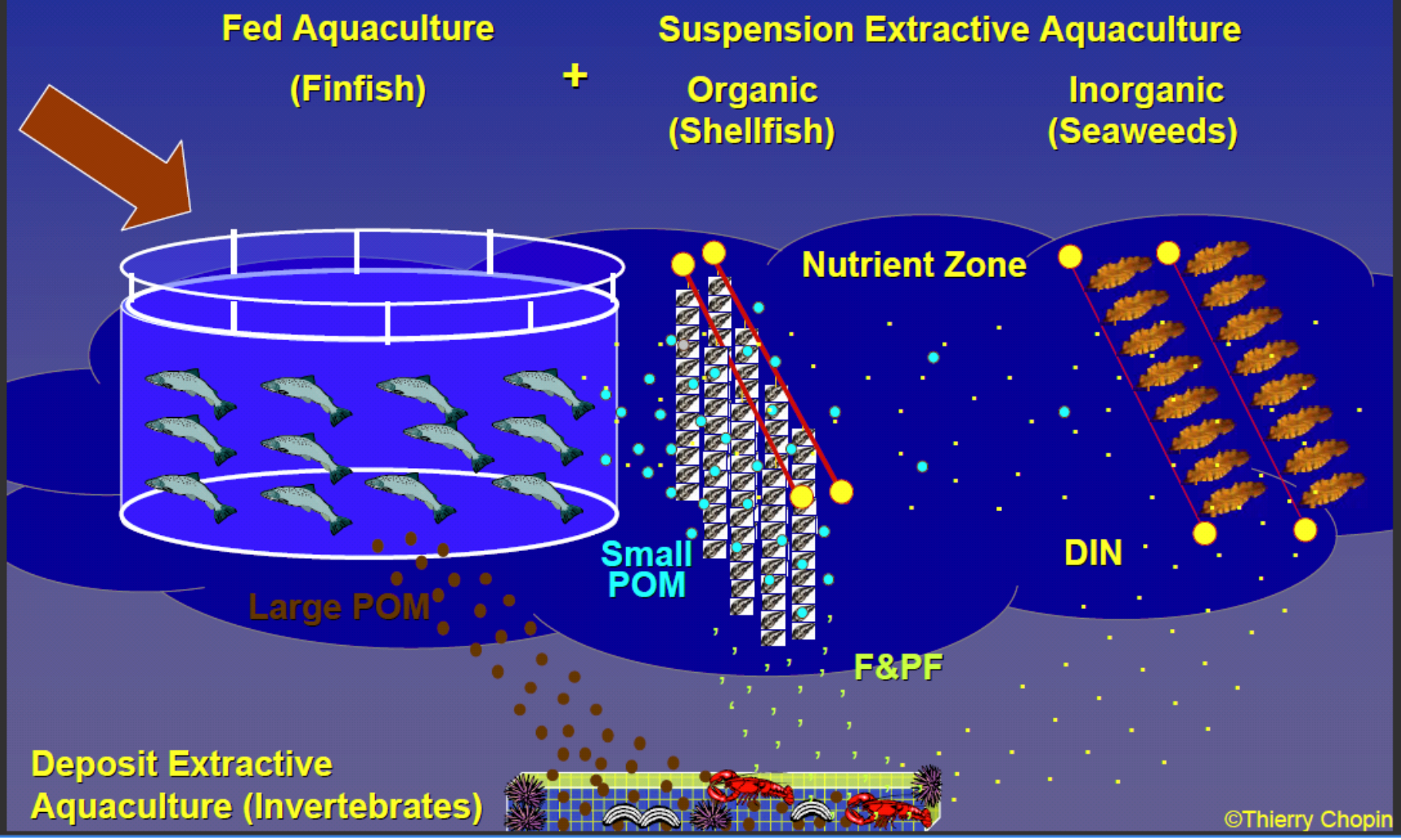

Bacteria
Archaea
Eucarya
Animals
Fungi
Plants
Euryarchaeota
Crenarchaeota

ESF Recommendations

- 1: Create a strong identity and communication strategy to raise the profile and awareness of European Marine Biotechnology research
- 2: Stimulate the development of research strategies and programmes for Marine Biotechnology research and align these at the national, regional and pan-European level
- 3: Significantly improve technology transfer pathways, strengthen the basis for proactive, mutually beneficial interaction and collaboration between academic research and industry and secure access and fair and equitable benefit sharing of marine genetic resources
- 4: Improve training and education to support Marine Biotechnology in Europe


MARINE BIOTECHNOLOGY WORKFLOW
Marine living resources
Aquaculture
Products
- Drugs
- Elicitors
- Biofuels
- Food
- Enzymes
- Biopolymers
-Organic compounds
Services
-Processes
- Basic research
- Ecosystem Management
- Bioremediation
Biotechnology Toolbox:
- biodiscovery
- mol. biology
- biochemistry
- microbiology
- ...omics
- etc.
__Value chain_____

Integrated Multi-Trophic Aquaculture (IMTA)



Ongoing strategy work

- Danish National investigation for exploitation of the resources of the oceans – blue biotechnology – finished September 2009
- Similar planning in the Nordic Innovation Centre
- KBBE-net in the EU established a working group on Marine Biotechnology – CWG-MB – Scoping paper delivered October 2009
- CSA applied for in January 2010
- An ERA-net may be established as part of the EU strategy on Marine Science – could be launched 2012 or 2013

FP7 Work programme 2011

KBBE.2011.3.2-01: Marine biotechnology ERA-NET preparatory action

Call: FP7-KBBE-2011-5

Cooperation between European research funding bodies in the area of Marine Biotechnology started in FP7 under the umbrella of the KBBE-NET high-level group. Building upon this group's conclusions, the overall aim of the CSA is to provide the basis for a successful forum for the exchange of information between Member States, and initiate the process of identifying research complementarities, thus creating a basis for developing future joint, transnational calls. The consortium should expand the partnership of the previous KBBE-NET Marine biotechnology working group to include more funding agencies of the different member states. In addition complementarities with other relevant European initiatives are sought, including establishing interactions with relevant ERA-NETs and ETPs. It is expected that the opportunity for future global initiatives in the area marine biotechnology will also be analysed.

Funding scheme: Coordination and Support Action (coordinating action). The requested European Union contribution shall not exceed EUR 1 million.

Additional information: This topic is expected to contribute to the active participation of relevant partners from the enlarged European Union and Candidate countries.

Expected impacts: It is expected that this proposal will consolidate the basis for further coordination efforts in the area of Marine Biotechnology; seek for complementarities between national activities, and start pooling resources for funding and implementing future research activities in a synergistic manner.


EUROPABIO
The European Association for Bioindustries
MEMBERS ONLY
SUBSCRIBE LOST PASSWORD
WHERE THE BIOFUELS INDUSTRY MEETS TO DO BUSINESS
HOMEPAGE
ABOUT EUROPABIO
ABOUT BIOTECH
AROUND BIOTECH
EVENTS
MEDIA ROOM
USEFUL LINKS
Blue Biotechnology
EuropaBio Blue Biotech Working Group
"Rendez-vous de Concarneau"
30th - 31st August 2010
Concarneau, France
The European Association for Bioindustries
Blue Biotechnology
EuropaBio Home
EuropaBio Home
EuropaBio Home
EuropaBio Home
Subscribe to our RSS Feed
Watch us on Youtube
Follow us on Twitter
Join us on Facebook
EuropaBio's Blue Biotechnology Working Group (EBBWG) was created in 2010 through an initiative of the French Museum for Natural History, as a means to strengthen links and bridge the gap between Basic Research, Industry, SMEs and policymakers in a knowledge-based economy, to improve the competitiveness of European Bioindustry and to promote the growth of marine bioindustries in Europe.

Conference

The "Rendez-vous de Concarneau"

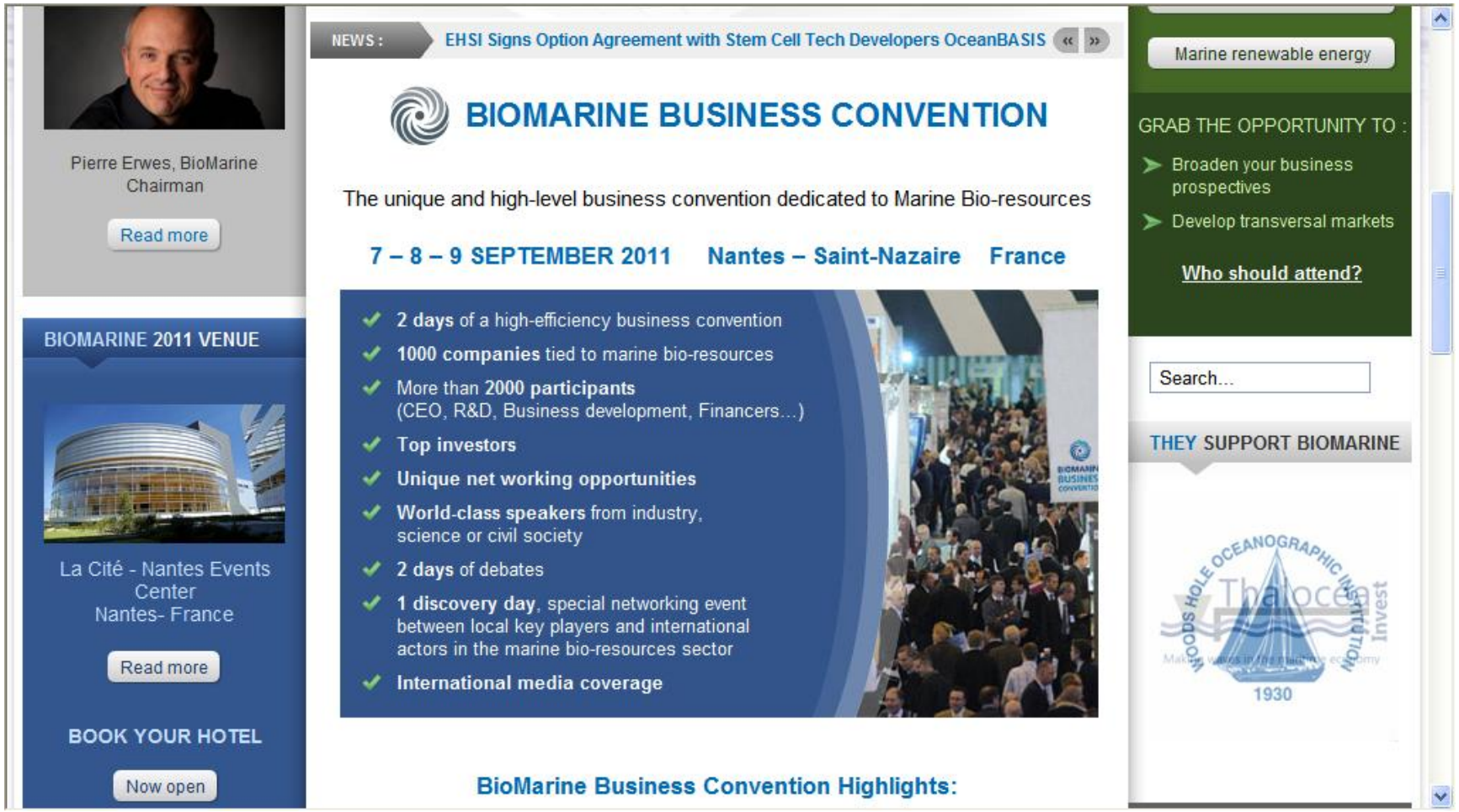
Where Industry meets Sciences in Marine Biotechnology

Purposes

- to promote relationships between Industry and University
- to promote tech transfer in European marine biotechnology

30-31 august 2011

Concarneau, Bretagne


Pierre Erwes, BioMarine
Chairman
Read more
BIOMARINE 2011 VENUE
La Cité - Nantes Events
Center
Nantes- France
Read more
BOOK YOUR HOTEL
Now open
NEWS :
EHSI Signs Option Agreement with Stem Cell Tech Developers OceanBASIS
BIOMARINE BUSINESS CONVENTION
The unique and high-level business convention dedicated to Marine Bio-resources
7 – 8 – 9 SEPTEMBER 2011 Nantes – Saint-Nazaire France
2 days of a high-efficiency business convention
1000 companies tied to marine bio-resources
More than 2000 participants
(CEO, R&D, Business development, Financers...)
Top investors
Unique net working opportunities
World-class speakers from industry,
science or civil society
2 days of debates
1 discovery day, special networking event
between local key players and international
actors in the marine bio-resources sector
International media coverage
BioMarine Business Convention Highlights:
Marine renewable energy
GRAB THE OPPORTUNITY TO :
Broaden your business
prospectives
Develop transversal markets
Who should attend?
Search...
THEY SUPPORT BIOMARINE
WOODS HOLE OCEANOGRAPHIC INSTITUTION
Thalocea
Invest
1930