

**Seaweeds (marine macroalgae) as
a renewable energy biomass:
Overview on seaweed mass cultivation
with an emphasis on European
conditions**

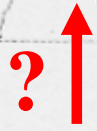
Klaus Lüning

Sylter Algenfarm GmbH & Co.KG, Germany



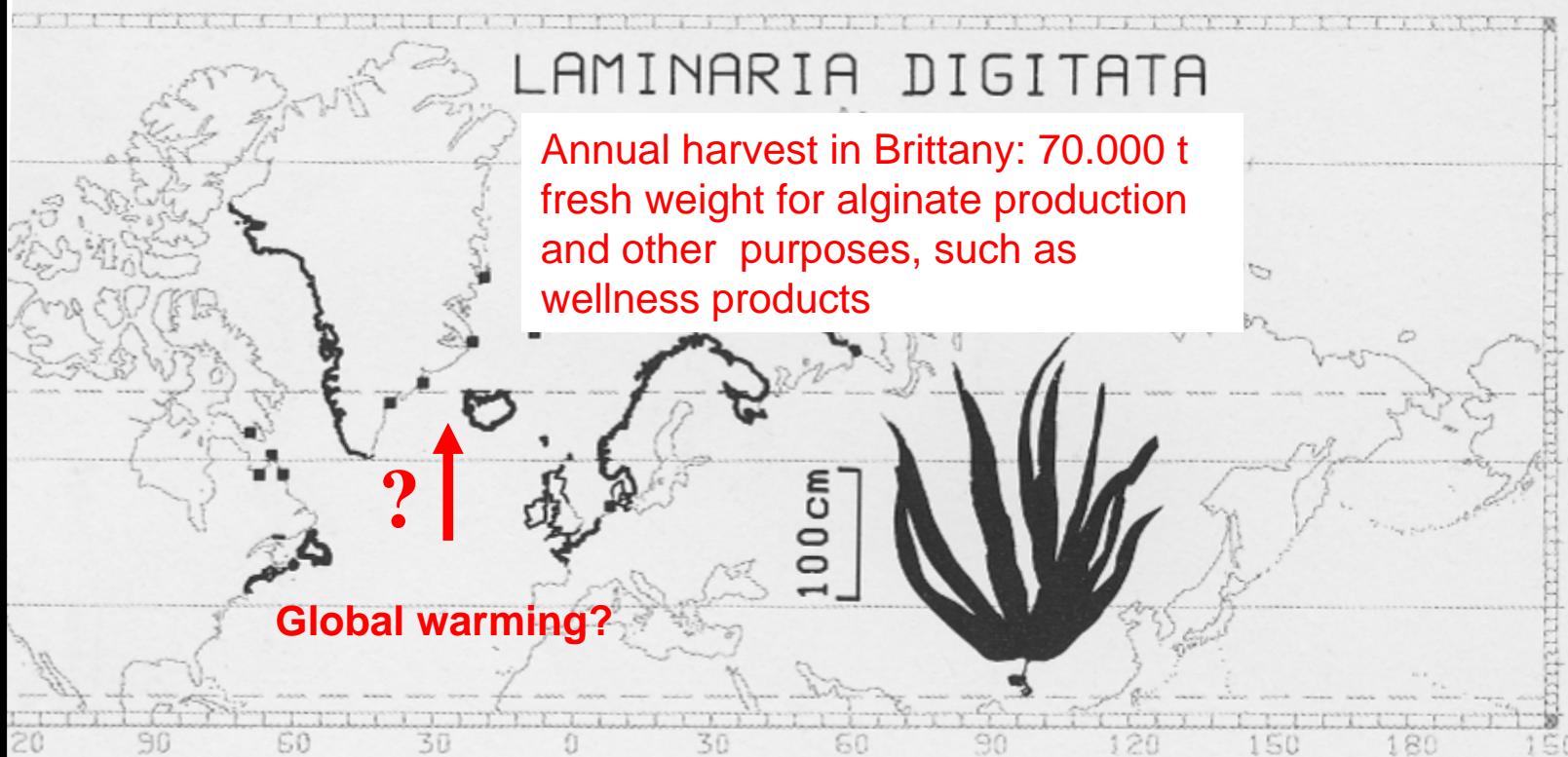
LAMINARIA DIGITATA

Annual harvest in Brittany: 70.000 t fresh weight for alginate production and other purposes, such as wellness products



Global warming?

100 cm

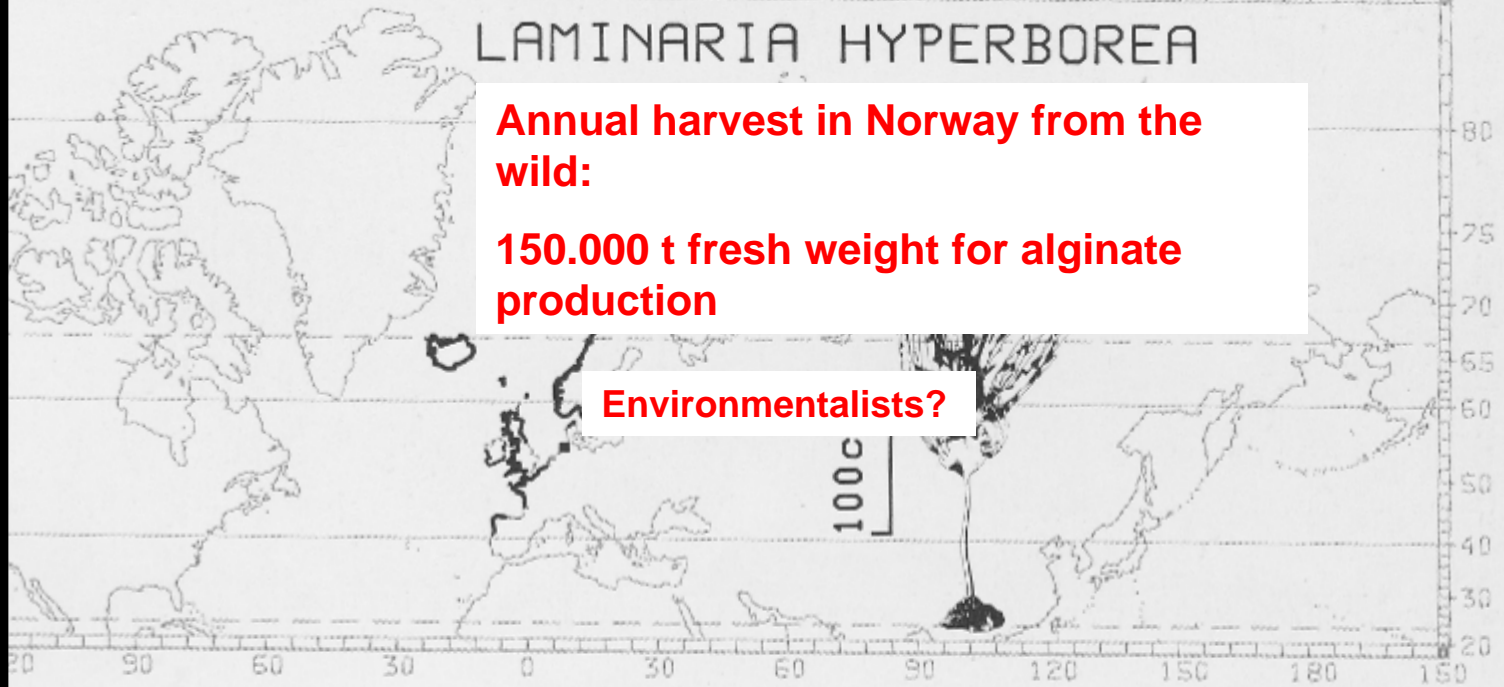


LAMINARIA HYPERBOREA

Annual harvest in Norway from the wild:

150.000 t fresh weight for alginate production

Environmentalists?





**Ireland: Company Amamara Teo Ltd (since 1947):
6000 t dry weight Ascophyllum from the wild per
year Jahr = 25000 t fresh weight**

**Ascophyllum in Canada: Global warming decreases
Ascophyllum biomass?**

**Ugarte, Critchley, Serdynska & Deveau (2009) J.
Appl. Phycol. 21, 591-598.**



Giant kelp
Macrocystis
pyrifera
(50 m long)

Annual harvest in California from the wild:
150.000 t fresh weight for alginate production



Commercial harvest of wild algae from nature

Dangers:

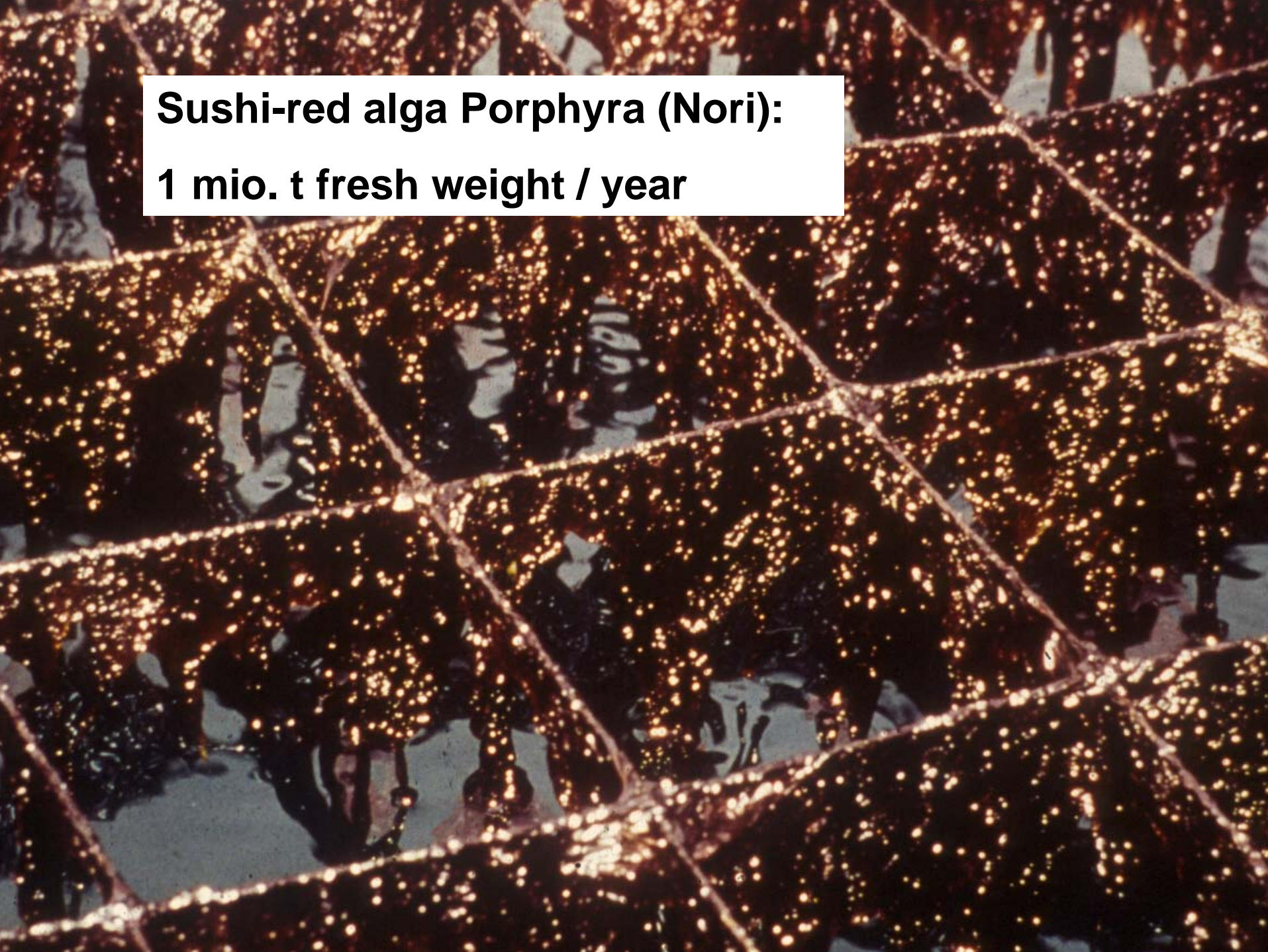
---Ecologically: Destroying ecosystems (sublittoral kelp seaweed forests as a cradle for marine animals); global warming

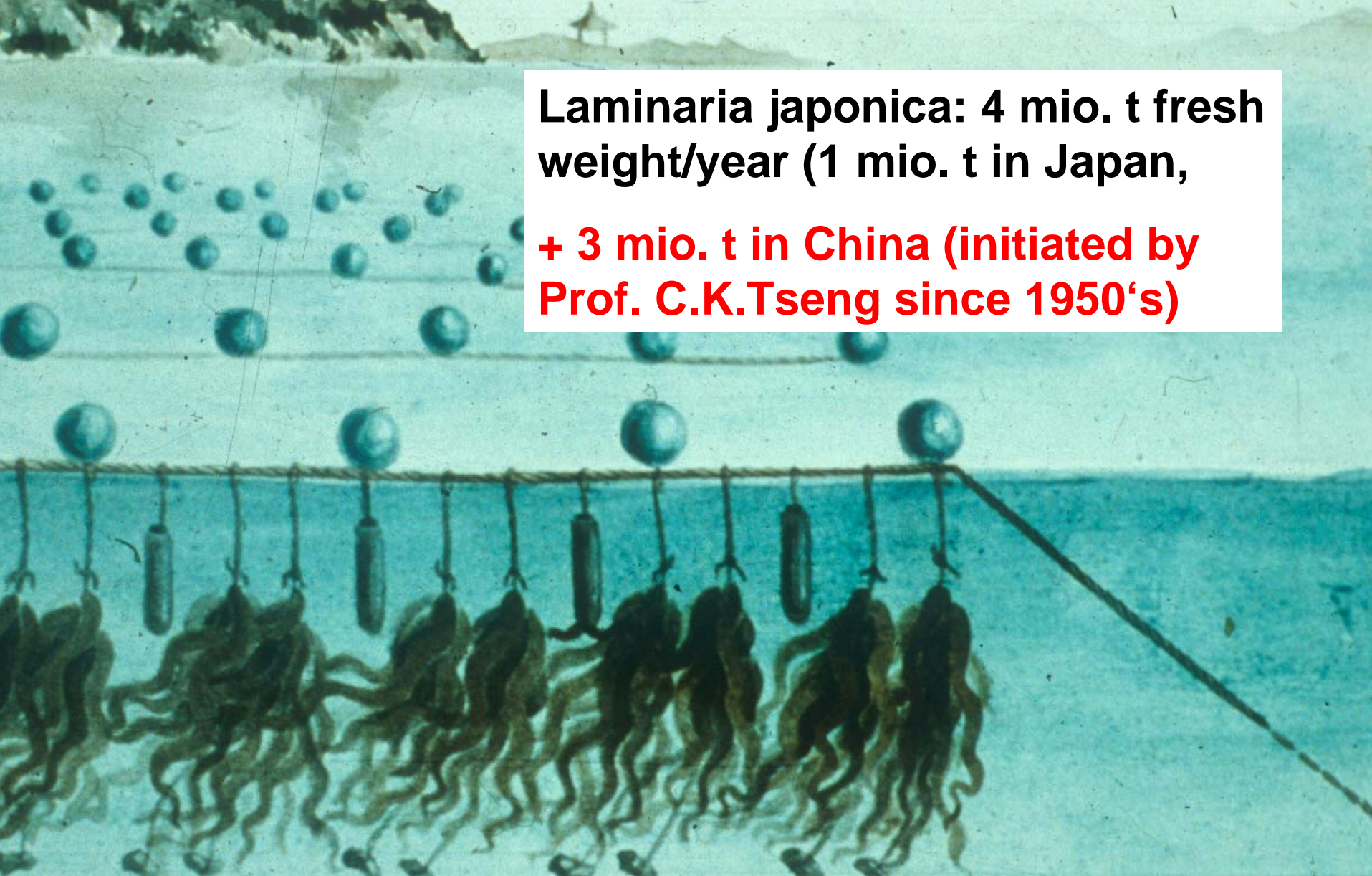
---Commercially: Stop of harvest due to environmental decisions

***Conclusion: Mass cultivation required
Today: 10 mio. t fresh weight are harvested,
most of this already from aquaculture***

Sushi-red alga Porphyra (Nori):

1 mio. t fresh weight / year





Laminaria japonica: 4 mio. t fresh weight/year (1 mio. t in Japan, + 3 mio. t in China (initiated by Prof. C.K.Tseng since 1950's)

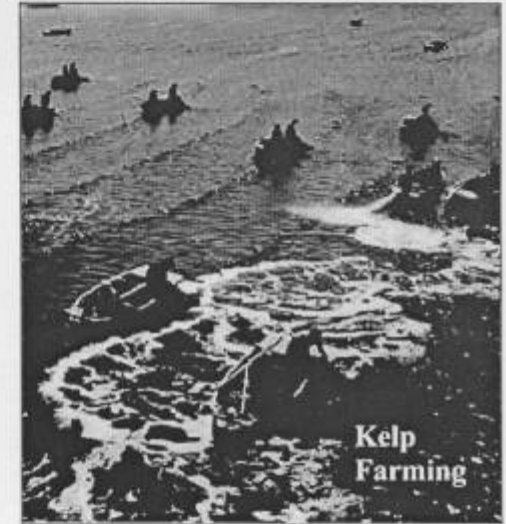
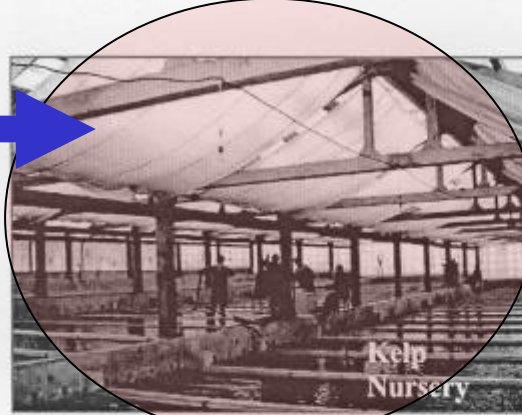
Completely new and „artificial“, since sea water temperature in northern China reaches 27°C – no survival of Laminaria in summer

Kelp nursery:

---cooled seawater in summer

---cultivation of gametophytes from zoospores (partially also from vegetative gametophytes), and subsequently of *Laminaria* summer sporelings up to a length of 1-2 cm

--- immersion in the sea in September at temperatures $<17^{\circ}\text{C}$

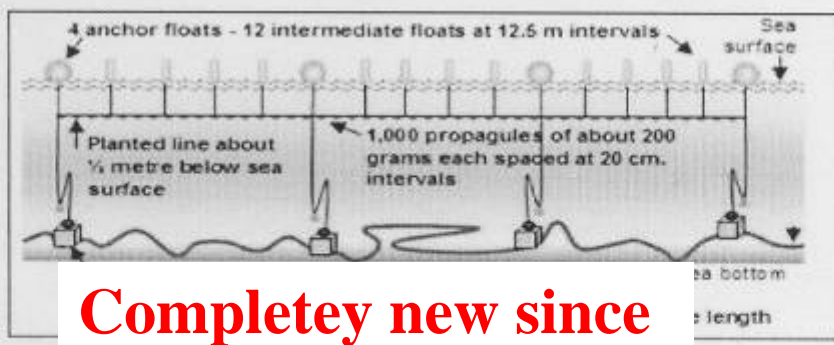


Red alga *Eucheuma* spp./

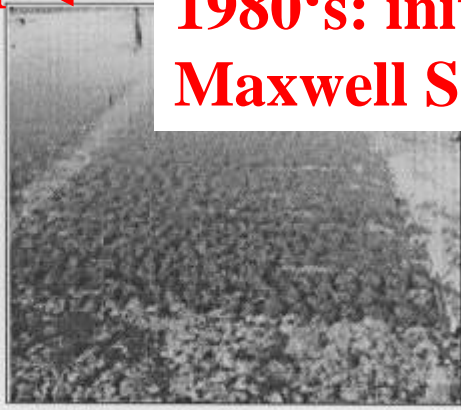
***Kappaphycus* spp.:**

**Mass cultivation in the sea for
production of carrageenan:**

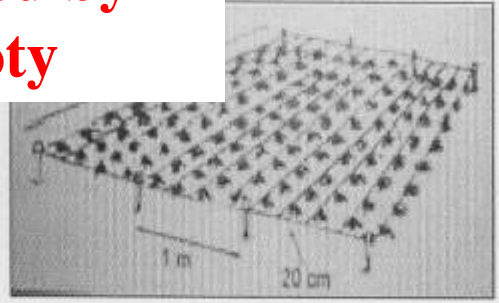
1 mio. t fresh weight per year ←



**Completely new since
1980's: initiated by
Maxwell S. Doty**



Eucheuma amoldii
Philippines

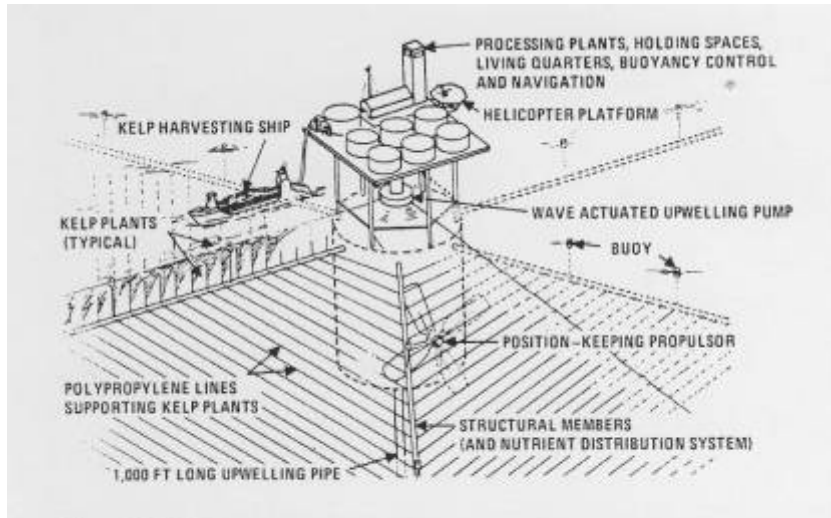


Green and brown *Eucheuma spinosum*
varieties

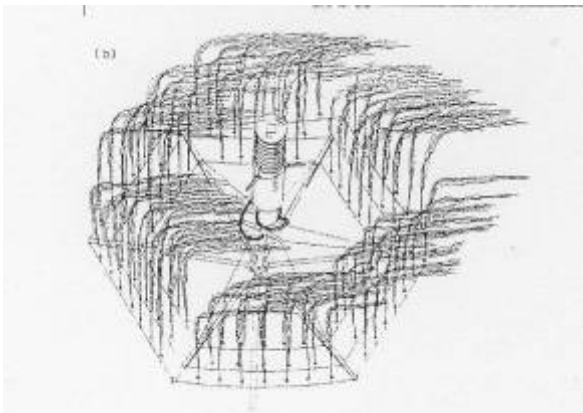


Kappaphycus alvarezii (*Cottonii*)

Oil embargo of the early 1970's



Wilcox 1975: Concept for an Ocean Food and Energy Farm with giant kelp Macrocystis



Wheeler North 1987: Floating Macrocystis Farm with central pump bringing up nutrient-rich water from depth

SEAWEED CULTIVATION FOR RENEWABLE RESOURCES

1987

Edited by

K.T. BIRD

Harbor Branch Oceanographic Institution, 5600 Old Dixie Highway, Fort Pierce, FL 33450 (U.S.A.)

and

P.H. BENSON

Renewable Energy Systems Inc., 12115 South 87th Street, Palos Park, IL 60464 (U.S.A.)



ELSEVIER Amsterdam - Oxford - New York - Tokyo 1987

U.S.A. today

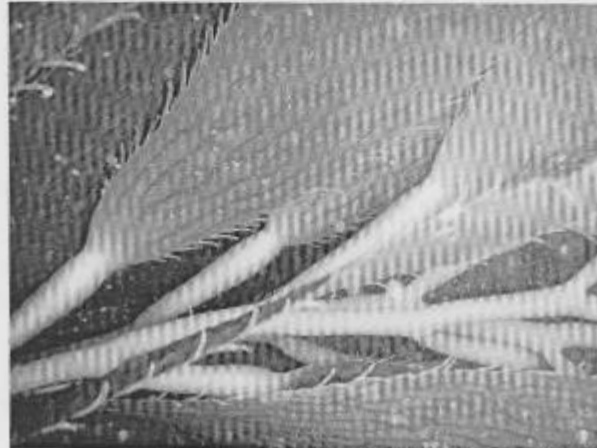
Techno-Economic Feasibility Analysis of Offshore Seaweed Farming for Bioenergy and Biobased Products

Independent Research and Development Report

IR Number: PNWD-3931

Battelle Pacific Northwest Division

2008



California kelp macroalgae seaweed underwater (Copyright: Jane Thomas, IAN, UMCES)

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Aquacopia Ventures, LLC

Oil embargo of the early 1970's

Commission of the European Communities

energy

Part I THE CULTIVATION OF LARGE BROWN ALGAE AS AN ENERGY CROP

Head of Project: Joanna M. JONES

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Part II BIOMASS FROM OFFSHORE SEA AREAS OF EUROPE

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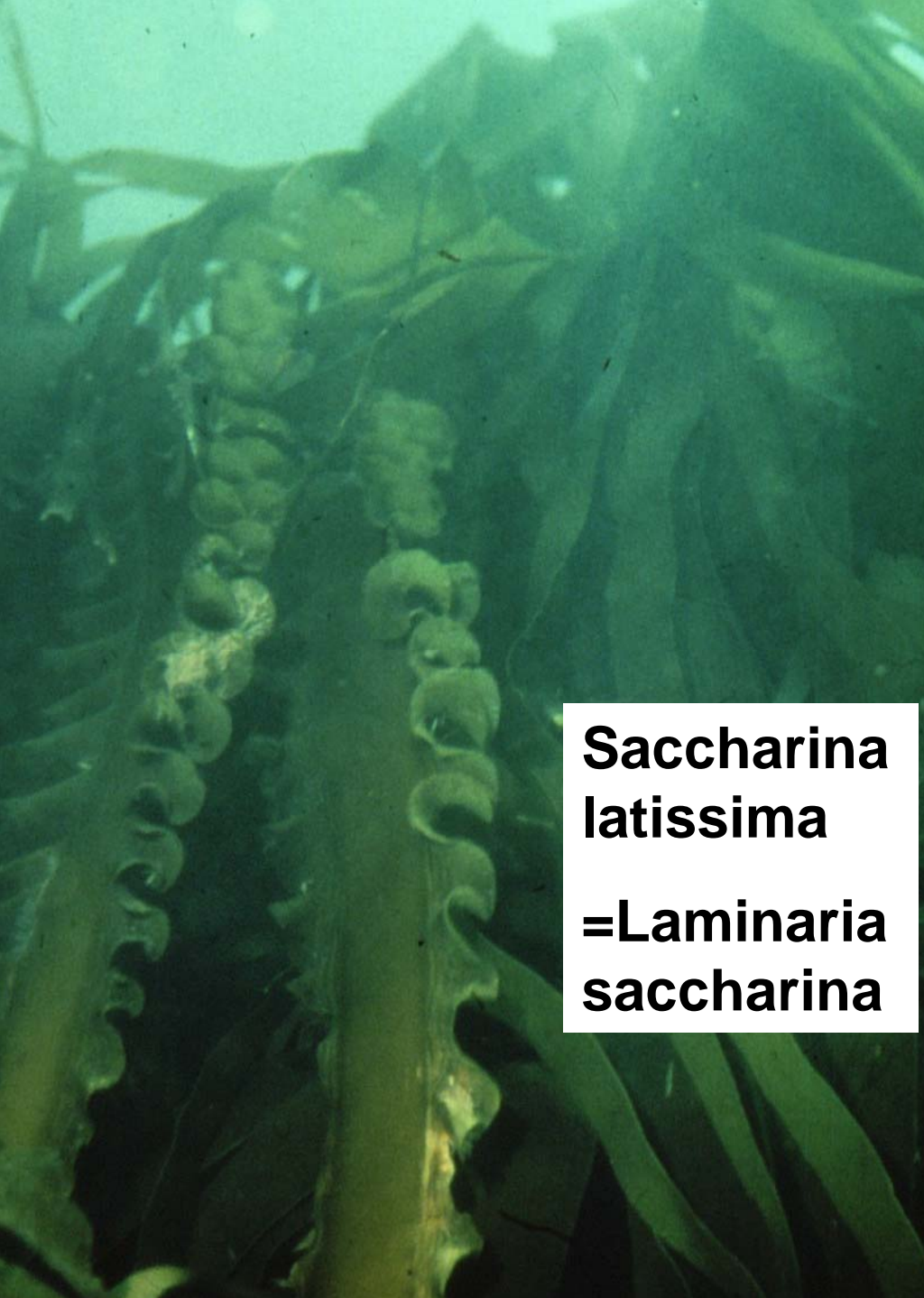
University of Nottingham

University Park

Nottingham, NG7 2RD

UK

1985



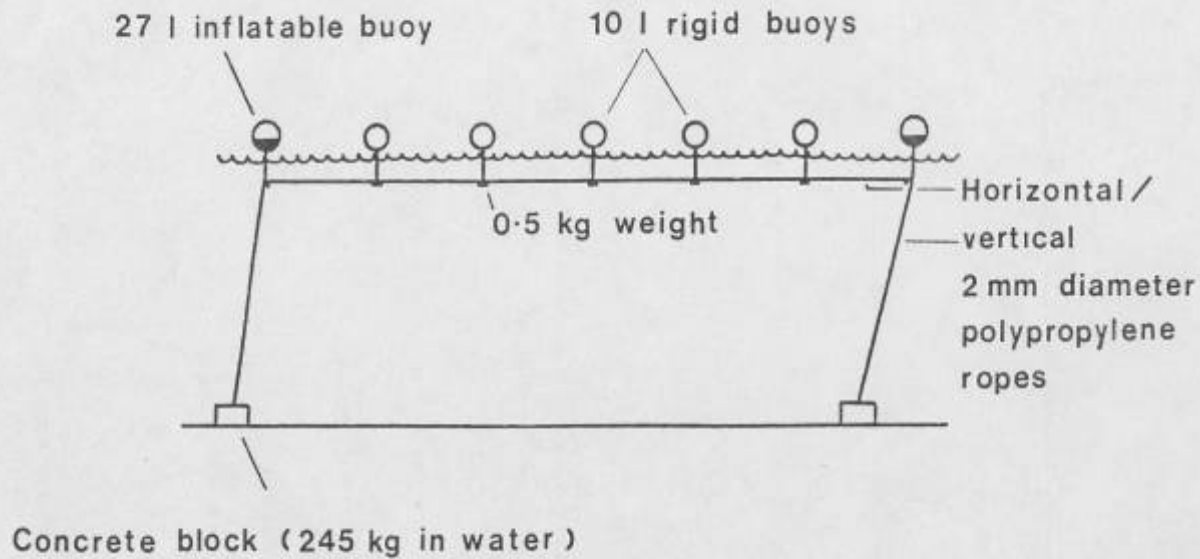
**Saccharina
latissima
=Laminaria
saccharina**



Saccorhiza polyschides

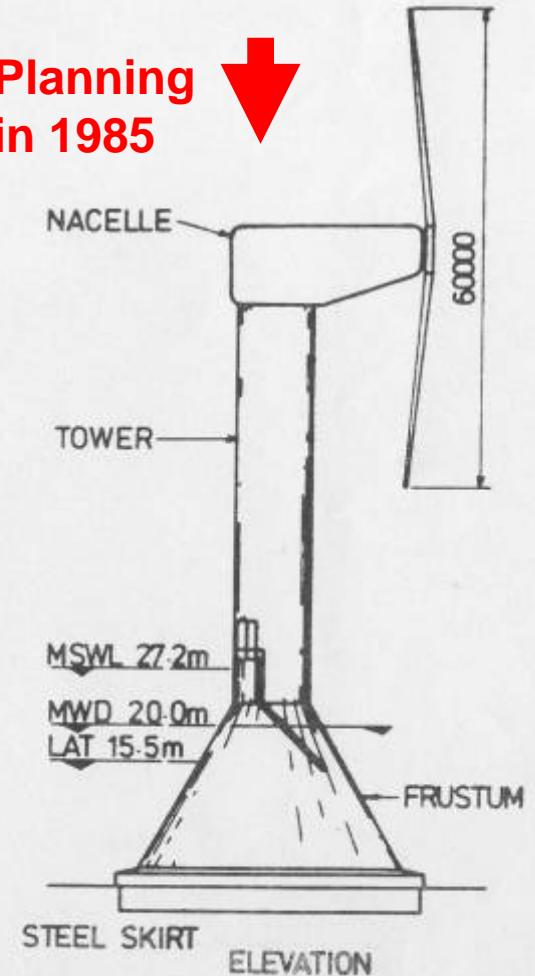


Alaria esculenta



Joanna Kain: „There was never a concrete block heavy enough to keep the seaweed rope cultures in place...“

Planning in 1985



Scotland today

The potential of marine biomass for
anaerobic biogas production:

a feasibility study with recommendations for further
research

Maeve S. Kelly and Symon Dworjanyn

2008

A report commissioned by The Crown Estate and supplied by the
Scottish Association for Marine Science

Scottish Association for Marine Science
Oban, Argyll, Scotland, PA37 1QA.



SCOTTISH
ASSOCIATION
for MARINE
SCIENCE

Ireland today

**Irish Seaweed Centre
Martin Ryan Institute, University Galway
Dr. Stefan Kraan**

**and Queen's University Belfast
Prof. Matthew J. Dring**

**1 mio. EURO: Irish project on rope cultivation of
Laminaria digitata
Alaria esculenta
*Palmaria palmata***

