Is it possible to cull jellyfish blooms and make valuable products ?

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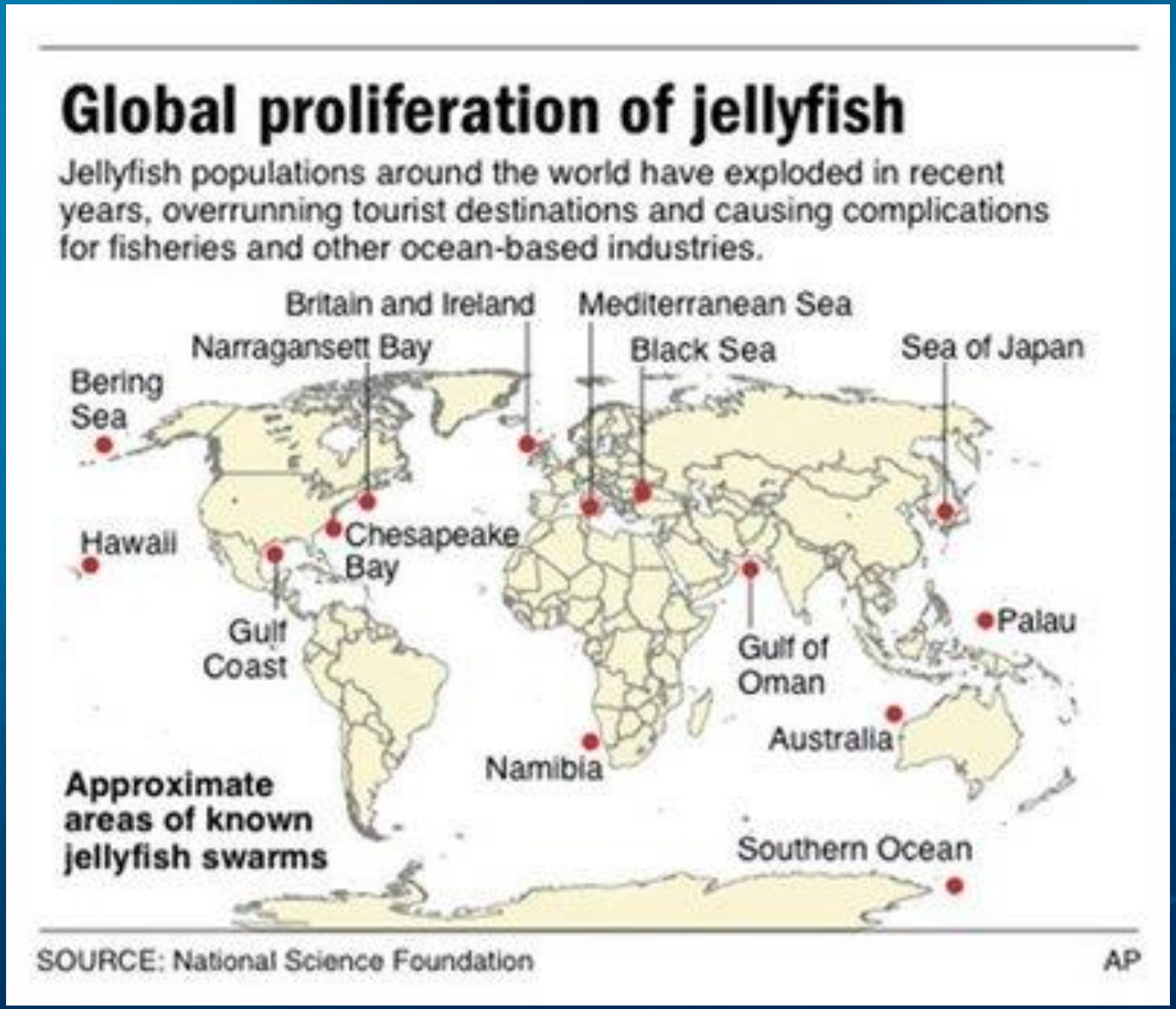
Large jellyfish blooms



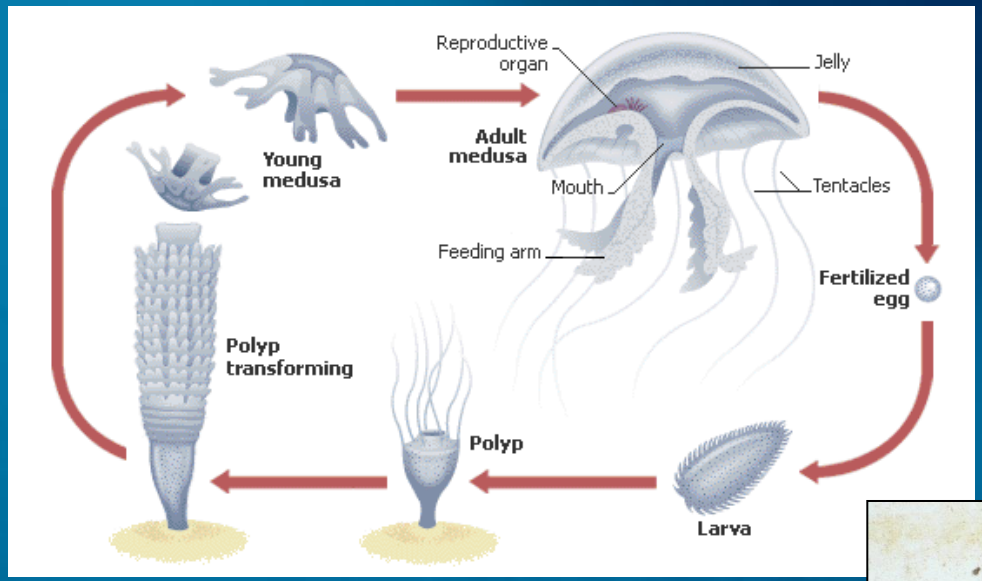
Why large blooms?

- Apparently a climate-signal
  - Significant INVERSE correlasjon with NAO in The North Sea, (Lyman, Hay and Brierly , 2003)
  - Large scale changes in ecosystems
    - A consequence of over-fishing?
    - Fertilization/Eutophication?
    - A partly stochastic process depending on initial conditions in spring bloom?
    - Competition in the water coloumn? (Predator / prey)?
    - Competitive conditions for winter(polyp) stage?

Physiology & Ecology

- ”Low Carbon density» – High water content (typically >95%)
  - – Facilitates rapid growth
- High fecundity
  - – Large number of offspring.
- Many have winter-stage with ability to produce clones.
  - – Rapid growth → Large blooms
- Potentially large impact on carbon and nutrient flux in the ecosystem

Life history



Schyphomedusae & leptomedusae

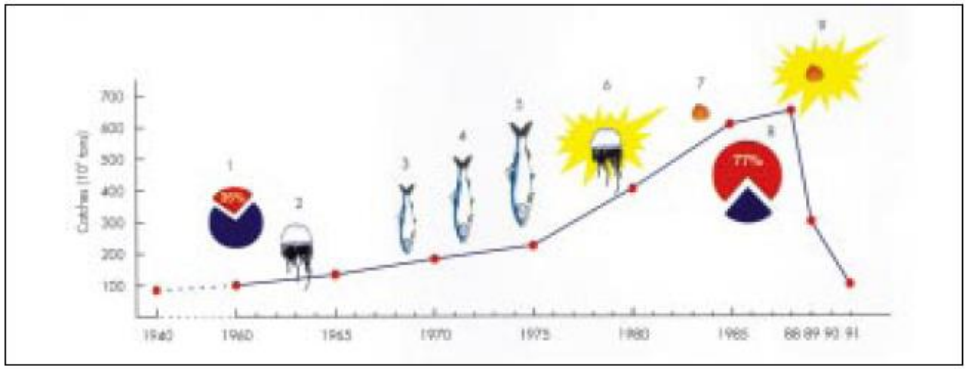
Coronata & ctenophora

Ecological impact

- Moon jellyfish can turn over more than 25% of the zooplankton biomass per day. Uye & Shimagushi, (2005)

- In 2004 ,the jellyfish biomass represented more than 98% of the total catch in the Jangtze estuary. Xian et al., (2005)

Mnemioposis leidyi in the Black Sea



Catches of Black Sea countries and some important ecological events in the Black Sea from 1940 to 1991:
1- The percentage of anchovy in total catch (35%)
2- The total biomass of jellyfish Aurelia aurita in the Black Sea reached one million tons
3- The end of fishing for mackerel in the North West Black Sea area
4- The end of fishing for bonito in the North West Black Sea area
5- The end of fishing for bluefish in the North West Black Sea area
6- Outburst of the Aurelia aurita. Total biomass in the Black Sea reached up 300-500 million tons
7- First single specimens of the comb jelly Mnemiopsis leidyi in the Black Sea are observed
8- The percentage of anchovy and sprat in total catch (77%)
9- Outburst of the Mnemiopsis. Its total biomass in the Black Sea reached 700 million tons

- 700 mill tonnes (ww) corresponds to
- approx 3.5 mill tonnes C (on proten reduction-level) and at same trophical level.

Jellyfish blooms cause other problems

- Clogging cooling systems
  - Nuclear power-plant shutdown (Japan, India)
  - Engine failure (overheating) on ships.
  - Shutdown of ferry (Austevoll, Norway, 2010)
- Tourism:
  - Closing of beaches (e.g. Spain) (>30 000 persons burnt in one season)
  - Fatalities in Indonesia (Box-jellies)

Other problems

- Destruction of entire fisheries(Japan, Strong disturbance (episodes) of fisheries in the Beering Sea and Benguela current.
- May contribute to slow fish stock recruitment / rebuilding (Worldwide)
- Damage to aquaculture
  - Salmon in N-Irland (*Pelagia noctiluca*) †
  - Salmon in Austevoll, Norway (*Bolinopsis infundibulum*)

From problem to rescource

- Jellyfish can be utilised
  - Direct for human consumption
    - Species dependent
    - Valuable product in Asian markets
  - Collagen
    - A valuable commodity at a global market
      - Pharmaceuticals, cosmetics, medical research,
      - **14-15 Eur /kg**
- Harvesting jellyfish is possible!

Periphylla periphylla in Norway

Catch after ~30 min towing
100m depth, Norway

Photos, Jarle Mork

Products for direct consumption

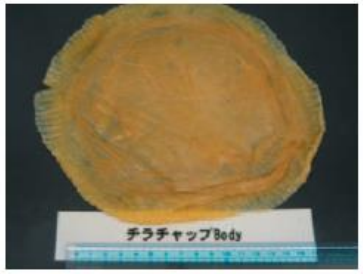
⑥チャイナタイプ

中国のビゼンクラゲによく似ていることから「チャイナタイプ」と呼ばれる。主産地はマレーシアのクチン、インドネシアのポンティアナ地区である。以前は 500 トン近く輸入されていたこともあるが、近年では 100 トン以下である。AA ランクで約 2400 円/kg、D ランクで約 1000 円/kg であり、高価である。

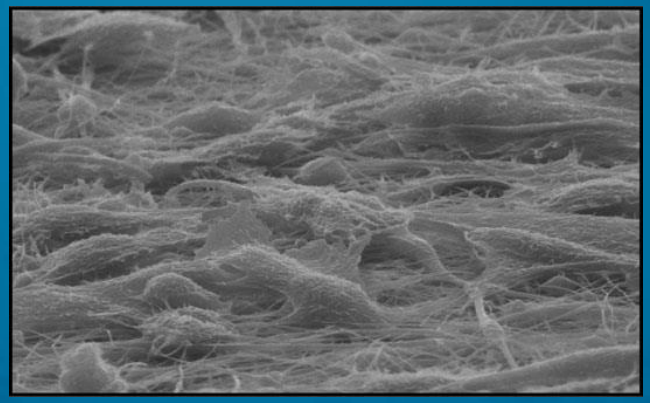
⑦チラチャップ

ヒマワリの花のような特徴のある形状をしていることから、「サンフラワークラゲ」等の呼称がある。加熱してもちぢれたり巻いたりしないことから日本では付加価値が低いとされる。

チラチャップは中国で多く利用され、ミャンマー、インド、バーレーン等から毎年 3000 トンくらい中国に輸出されている。チラチャップは臭いが強く、癖があることから、日本ではよほどクラゲが不足している時しか使わない。



Raw materials for medicine, pharmaceuticals, cosmetics



Some technical challenges:

- Trawl design.
  - Continuous transportation of catch to deck?
    - Technical solution exists for shrimp trawl
- Bycatch (fish and e.g. sea turtles) at an acceptable level .
    - A likely feasible technical solution has been suggested
- Robust system for neutralizing stinging cells .
  - The theoretical requirements for solution has been identified
- Cost-effectiveness (i.e. minimizing energy consumption, removal of water from product)
- Determine salt content for a stable product

Production of crude collagen

- Technology for extraction of collagen from fish skin is developed and available.
  - Tested for *P.periphylla* with good results

- Japanese technology (Technoble Co)
  - 1g collagen / kg jellyfish (Mer.Mar report, 2010)
  - Not considered commercially mature in 2010

Biological og managemental challenges

- Catch:
  - Only periods with high numbers/ densities
  - Only areas depths with high aggregates
  - «Safety mechanism»: As effort is fairly high (costly WRT energy), trawling at low densities will cease.
- Bycatch iissues
- Knowledge on the importance of jellyfish in the food-web is still modest
  - Jellyfish carcasses on sea-floor.

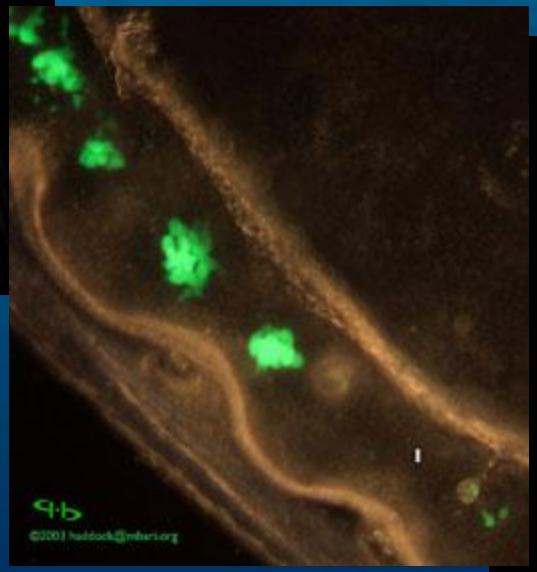
Jellyfish trawling

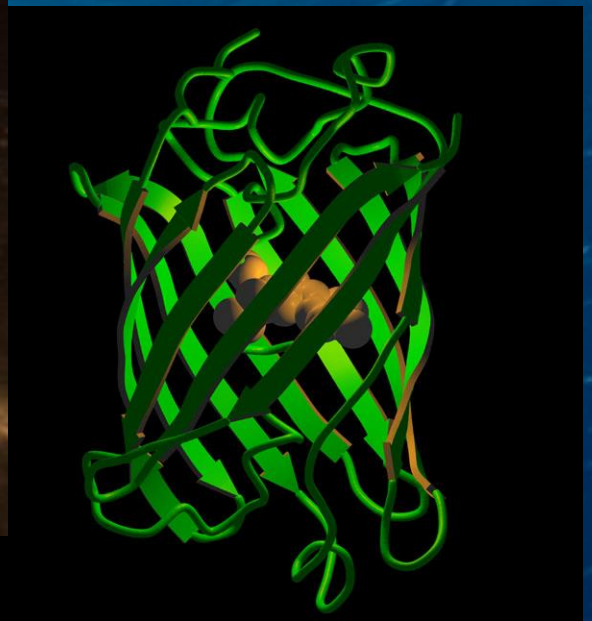
- Main goals:
  - Develop a modular trawling systems that allows continuous harvest and on-board processing yielding a stable crude product enabeling:
    1) **Cullling large/harmful jellyfish blooms**
    2) **Exploit jellyfish biomass as a resource:**
       1) **Crude Protein/Collagen** (Shrimp feed, fish feed)
       2) **Refined products** (Collagen… Medicine -pharmacy)
    3) **Harvesting jellyfish for consumption**
       1) **Dependent of suitable species**

Market

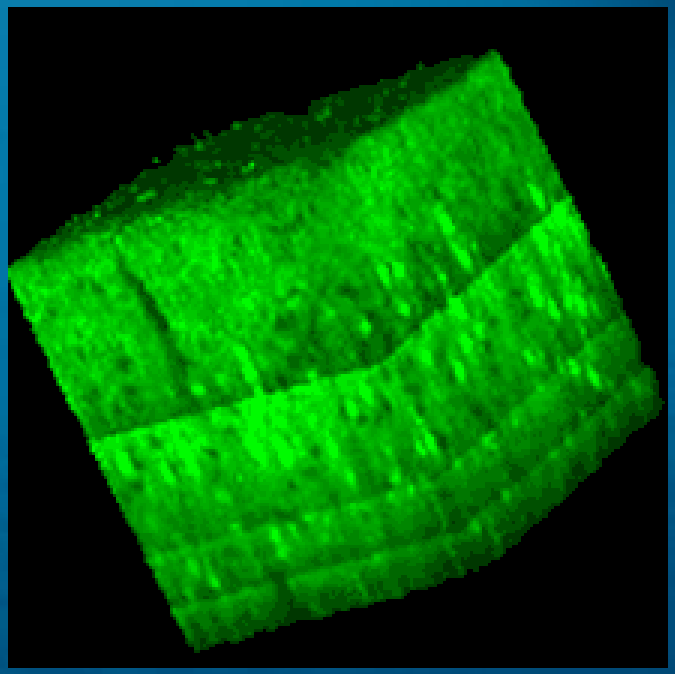
- WW jellyfish catch approx 400 000 tonnes annually
- Japan imports 5 000 – 10 000 t / år
  - Estimated value 25 mill $
- *Rhopilema esculenta* in China: 2,25$ / kg

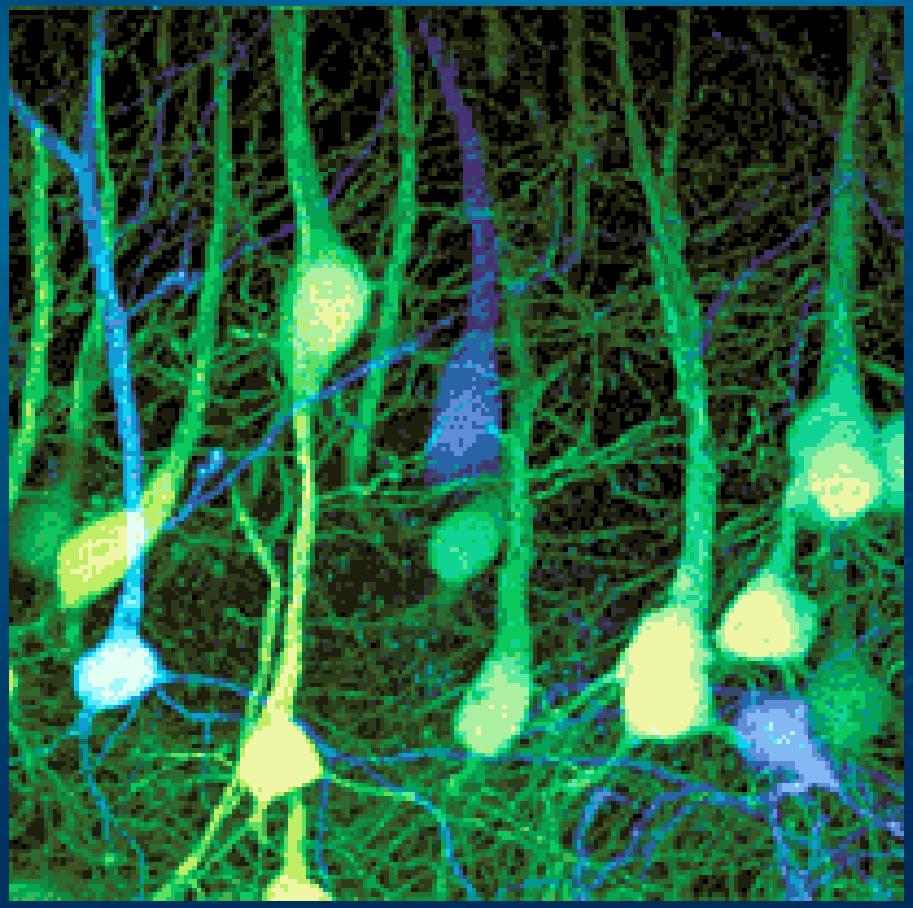
Other exciting products from jellyfish: GFP (Green Fluorescent Protein)





Ca2+ deteksjon





GFP Transgenic mouse

What would a project look like

- WP1: Harvesting technology
  - Flotation by air + surface trawl
    - Bycatch
  - Removal of stinging venoms
    - Feasability of ultrasound/high freqency exposure
  - Removal of water
    - Ultrafiltration (Typically 150 000 d)
    - Collagen can also be extracted by «salting out» (3.0-3.5 M NaCl, Hsieh, 2005)

Jellyfish utilization

- WP2: Product analysis and development
  - «Crude» : Protein source for aquaculture
  - (in particular shrimp farming)
  - «Advanced»
    - Exploring properties for pharmaceutical & medical use

Jellyfish utilization

- WP3 Market & commercialization
  - Demands
    - Public need to manage?
      - Funds for removal?
  - Aquculture industry
    - Formulated feed for marine species (e.g. shrimps)
  - «Health» : Medical, pharmaceutical & «beauty»-market

Questions?