Aquaculture Immersion Excursion 2009
Teacher Workshop

Plant Aquaculture: Seaweeds

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Ocean Science for a Better World™

Outline

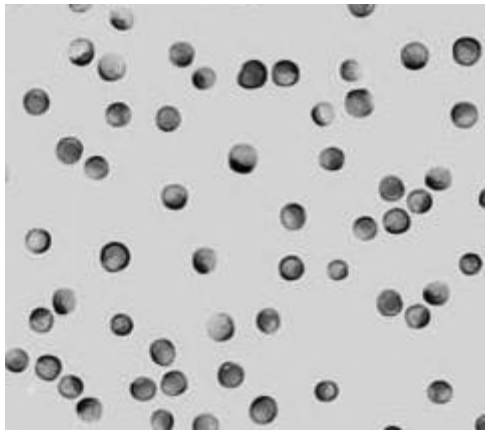
1. Marine Plants Used in Aquaculture
2. Seaweed Aquaculture
   a. Uses of Seaweeds
   b. Economic Value
   c. History of Seaweed Cultivation
3. Future Applications in Florida

Marine Plants Used in Aquaculture

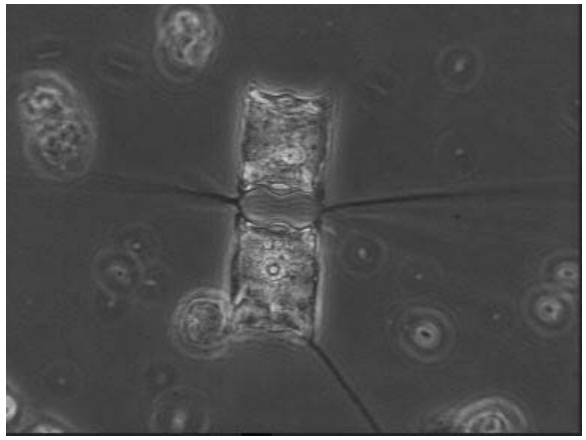
1. Phytoplankton
2. *Spirulina*
3. Angiosperms
4. Macroalgae (Seaweeds)

Marine Phytoplankton Used in Aquaculture

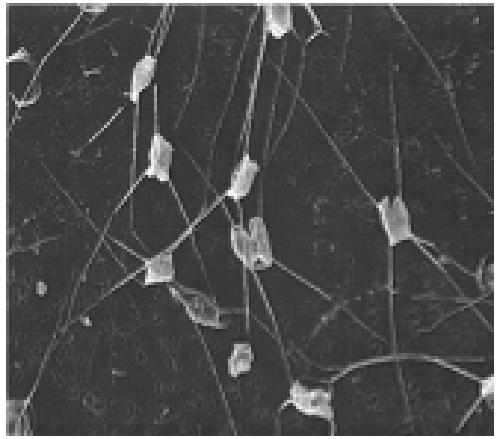
Top 5 Species



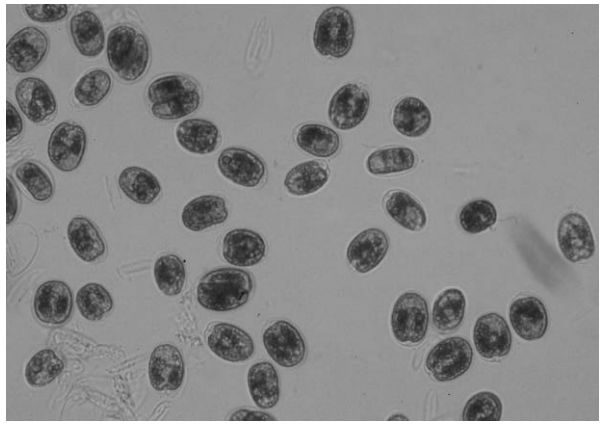
Isochrysis **("T-iso")**



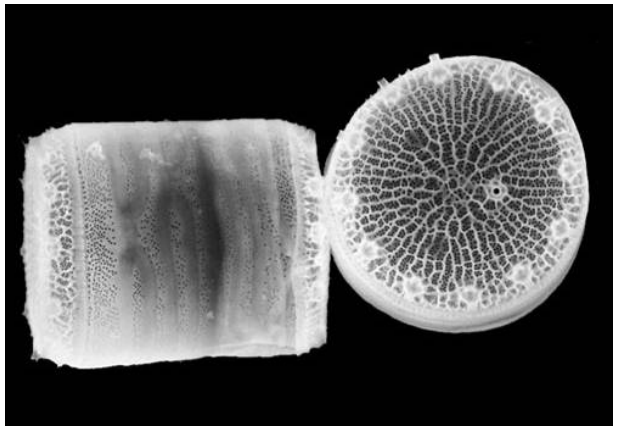
Chaetoceros gracilis



Chaetoceros calcitrans

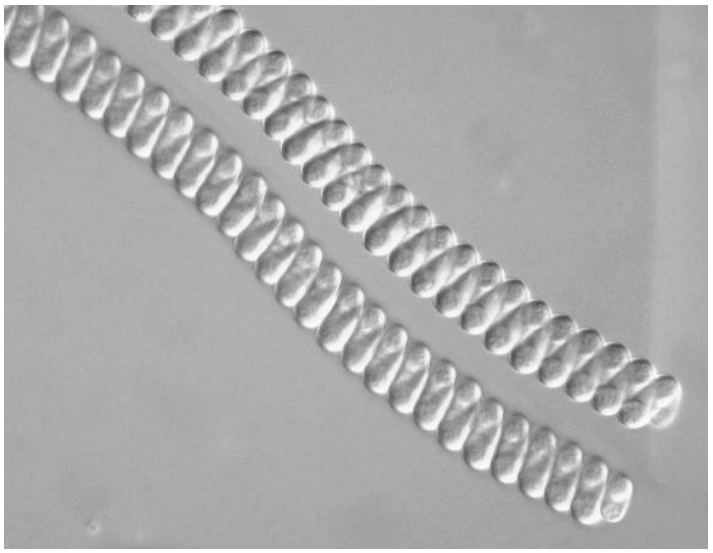


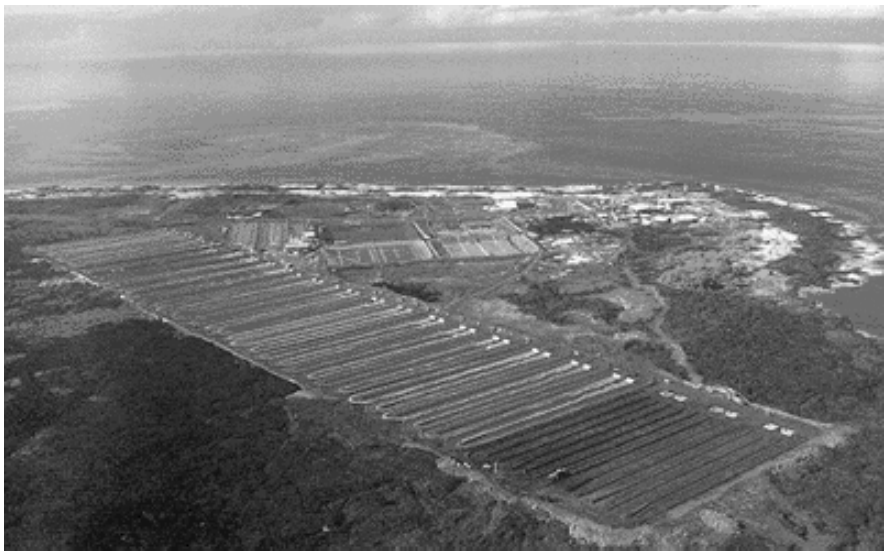
Tetraselmis suecica



Thalassiosira pseudonana **(clone 3-H)**

Spirulina



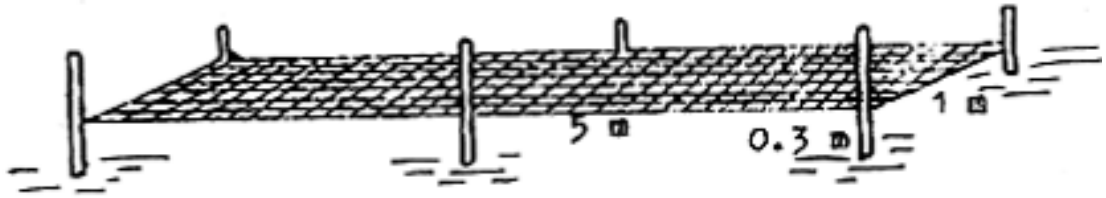


Established Uses of Seaweeds
(A Short List!)

- Food
- Fodder
- Fertilizer & Soil Conditioner
- Chemicals (potash, soda, iodine)
- Phycocolloids (agar, carrageenan, alginate)

Seaweed Cultivation throughout the World

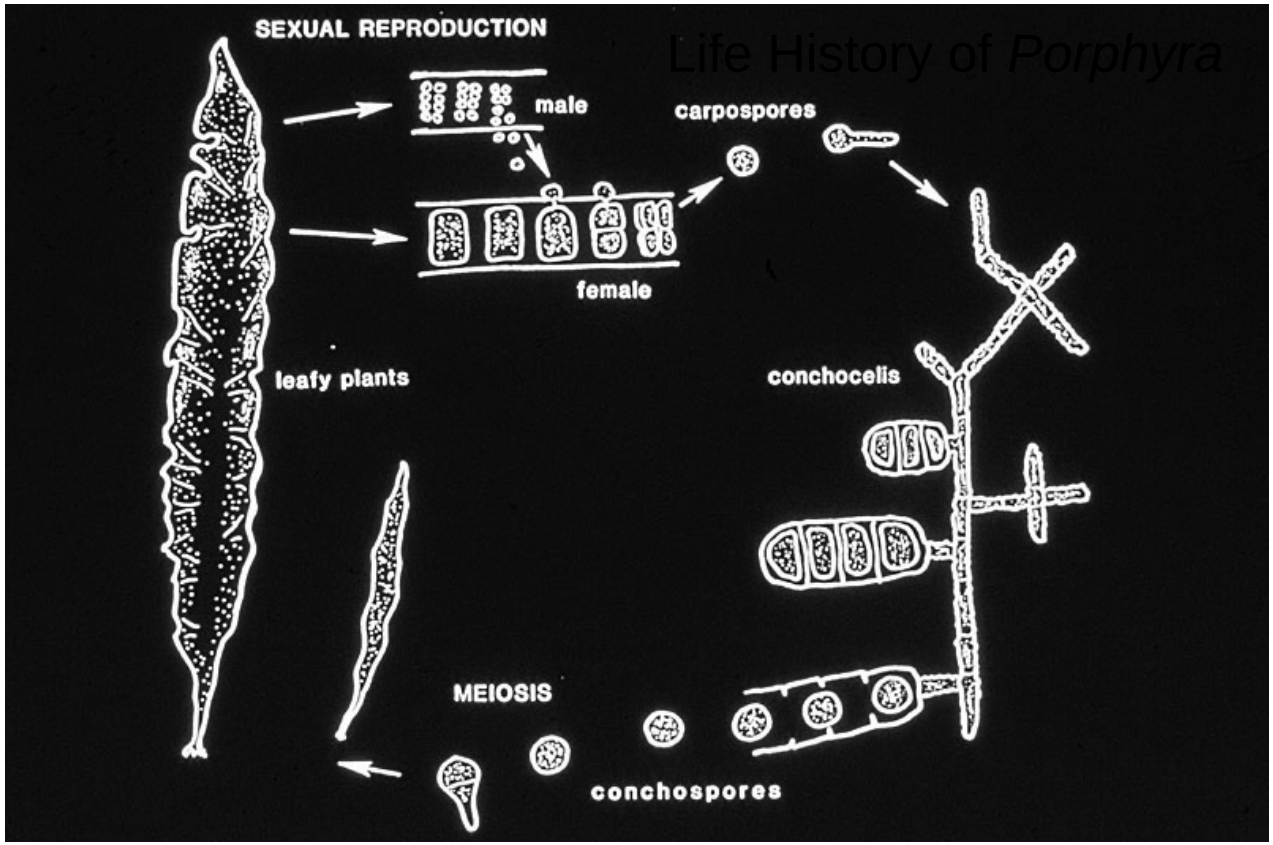
- Seaweeds harvested throughout historic times
- 1600's - First known cultivation of seaweeds (nori - Japan)
- 1700's - Cultivation of *Laminaria* (kombu - Japan)



Seaweed Cultivation throughout the World

(1950-60's)

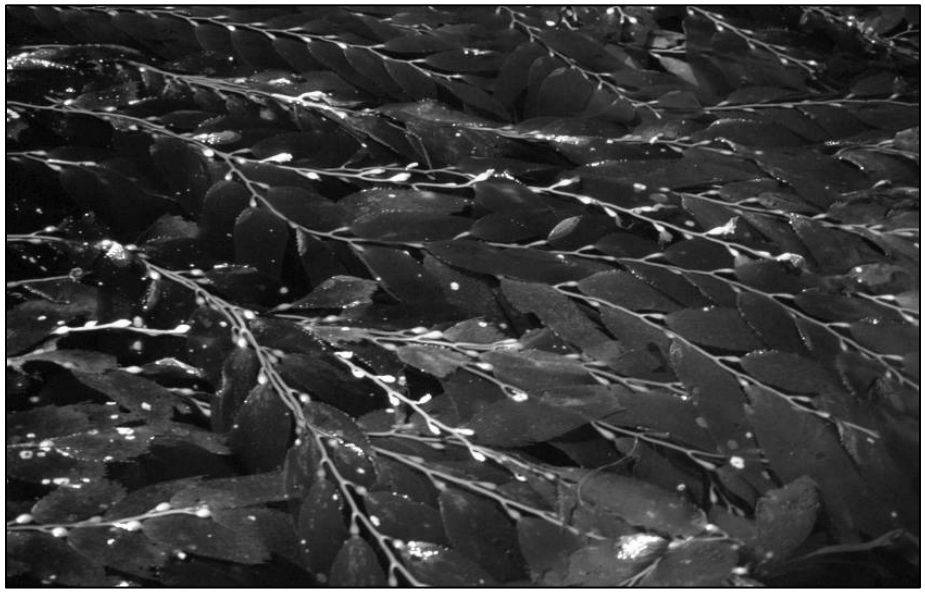
- Increased cultivation of seaweeds for food, primarily in the Orient, enhanced by scientific breakthroughs (life histories)



Seaweed Cultivation throughout the World

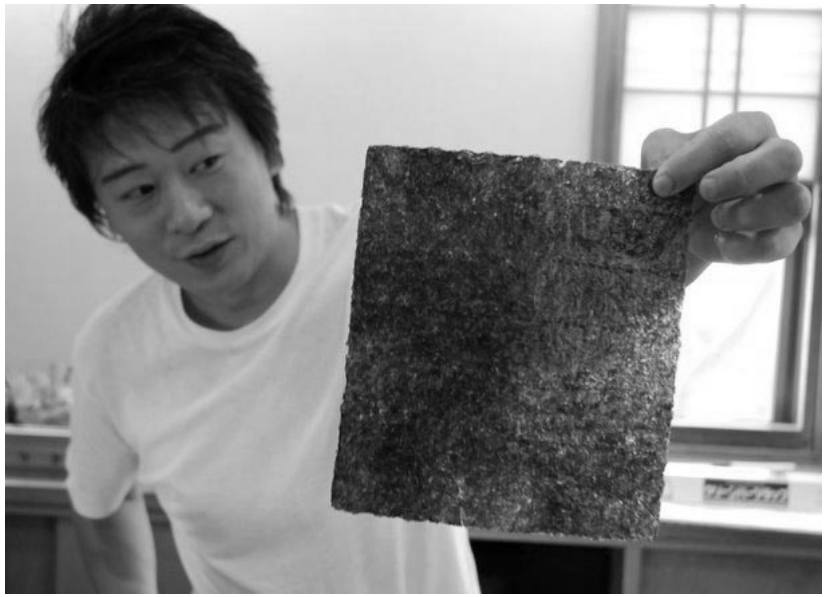
(1970-80's)

- Increased cultivation for phycocolloids, driven by dwindling wild stocks/uncertain supplies
- Increased interaction of scientists and industry in utilizing biology to develop culture technology
- Pioneering work in seaweed genetic manipulation
- Peak in looking at innovative culture technologies and novel uses of seaweeds



Economic Value of Seaweeds

- Over 80% of commercial seaweeds are cultivated
- Worldwide seaweed aquaculture production is over 10 million tons wet weight, with an economic value of $5.6 billion
- Ca. 80% of all cultivated seaweeds are used for food



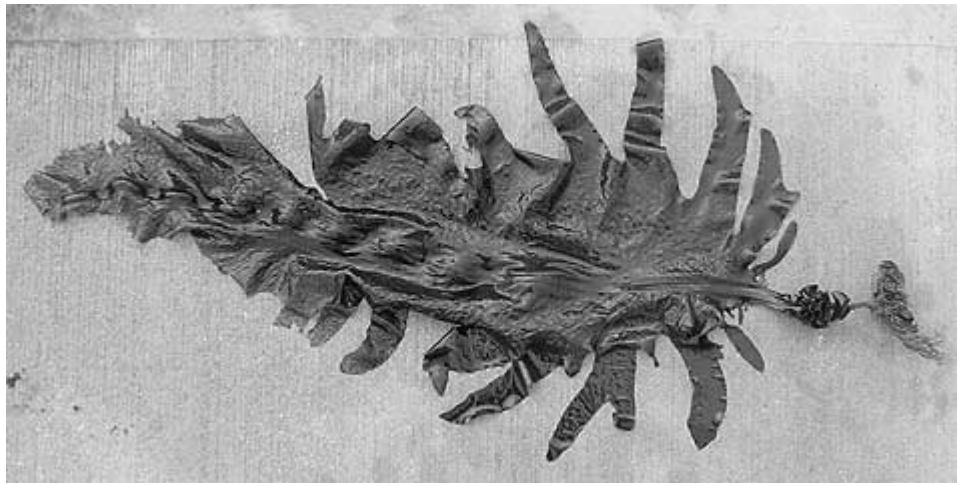
Economic Value of Seaweeds

Top 5 Species

Laminaria (Kombu)

Laminaria japonica

Undaria (Wakame)



Undaria pinnatifida

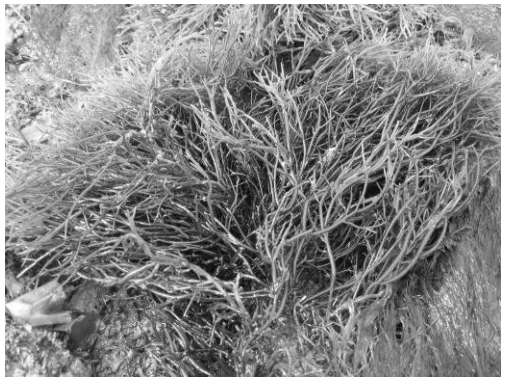
Porphyra (Nori)

Porphyra yezoensis

Eucheuma

Eucheuma cottonii

Gracilaria



***Gracilaria* sp.**

Economic Value of Seaweeds

- **Top 5 Countries - Seaweed Cultivation**
  - **China (*Laminaria, Porphyra*)**
  - **Korea (*Undaria, Porphyra, Laminaria*)**
  - **Japan (*Porphyra, Laminaria, Undaria*)**
  - **Philippines (*Eucheuma*)**
  - **Indonesia (*Gracilaria*)**

Economic Value of Seaweeds

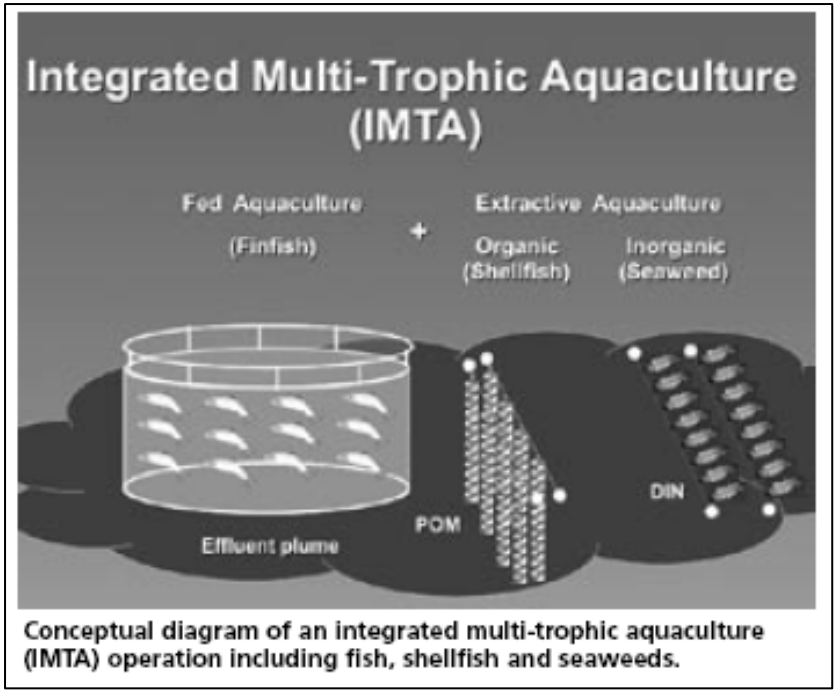
Almost all of the production in these countries is from *in situ* farms, using rafts or other means of anchoring/containing the seaweed

Emerging Uses of Seaweeds

- Fuel (Bioconversion to Methane, Methanol, Ethanol)
- Bioremediation
  - Nutrients (Wastewater, Aquaculture)
  - CO_2 Scrubbers (Climate Change)
  - Heavy Metals
- Feed Supplements (Aquaculture, Animal Feeds)
- Pharmaceutical (e.g., Anti-viral, Anti-cancer)
- Pigments
- Ornamentals

Future Applications

This technology can be applied to bioremediation, both for existing environmental problems (eutrophication) as well as in emerging opportunities (integrated aquaculture)



Conceptual diagram of an integrated multi-trophic aquaculture (IMTA) operation including fish, shellfish and seaweeds.

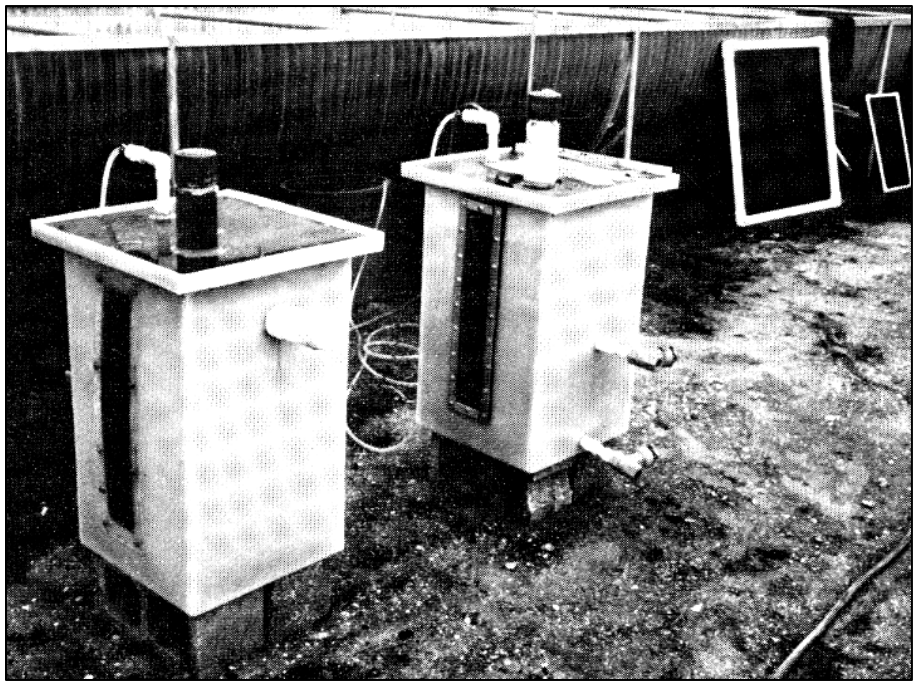
Chopin 2006

http://www.unbsj.ca/sase/biology/chopinlab

Integrated Multi-Trophic Aquaculture (IMTA) holds great potential for improving the sustainability of aquaculture

Biofuel Production:

Marine Biomass Farming at Harbor Branch



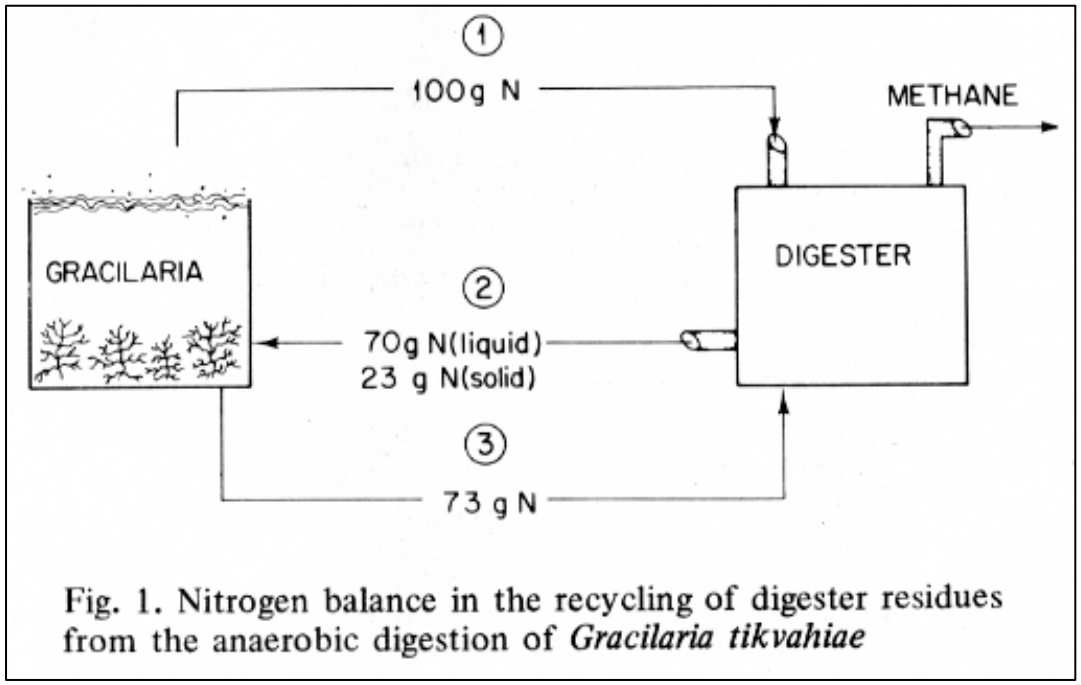
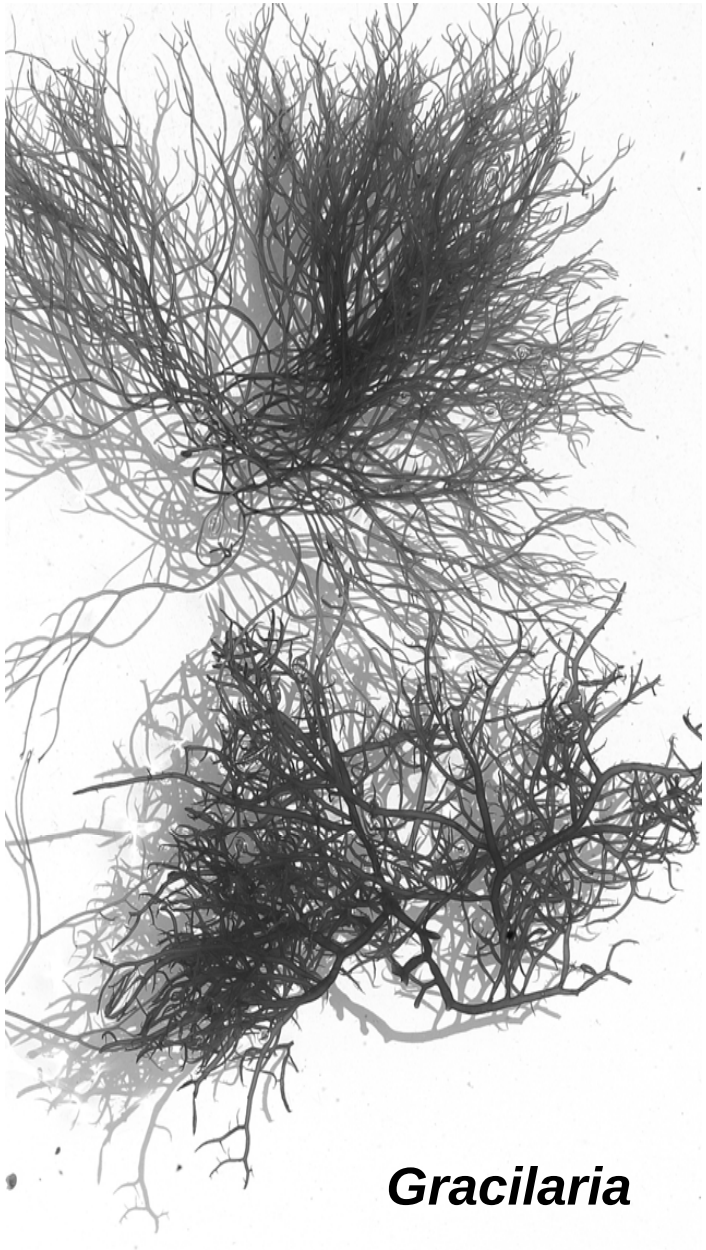


Fig. 1. Nitrogen balance in the recycling of digester residues from the anaerobic digestion of *Gracilaria tikvahiae*

Demonstrated the bioconversion of seaweed biomass into methane and the efficient recycling of digester residues back into the cultivation system

Marine Biomass Farming at Harbor Branch

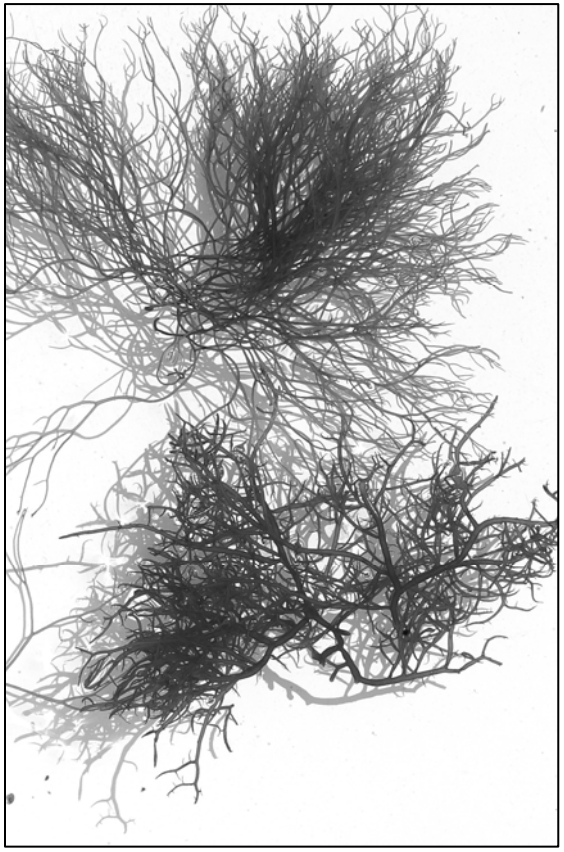


Gracilaria

Ulva

Future Applications

Macroscopic algae are sources of renewable energy, whose cultivation and bioconversion to fuels can provide a much-needed alternative to fossil fuels, especially in climates such as Florida's



References/Additional Reading

Chopin, T. 2007. Integrated multitrophic aquaculture. Canadian project combines salmon, mussels, kelps. Global Aquaculture Advocate 10(2): 52-55.

Hanisak, M.D. 1987. Cultivation of Gracilaria and other macroalgae in Florida for energy production. Pp. 191-218 in K.T. Bird and P.H. Benson (eds.), Seaweed Cultivation for Renewable Resources, Elsevier Science Publishers, Amsterdam.

Hanisak, M.D. 1998. Seaweed cultivation: global trends. World Aquaculture Magazine 29(4):18-21.

Highly Recommended Website

http://www.seaweed.ie/aquaculture/