

Kelp farming in British Columbia: ecophysiology, genetics and technology



*"First of all, let me say yes, you
are getting enough kelp."*

NEW YORKER, September 24,
1990

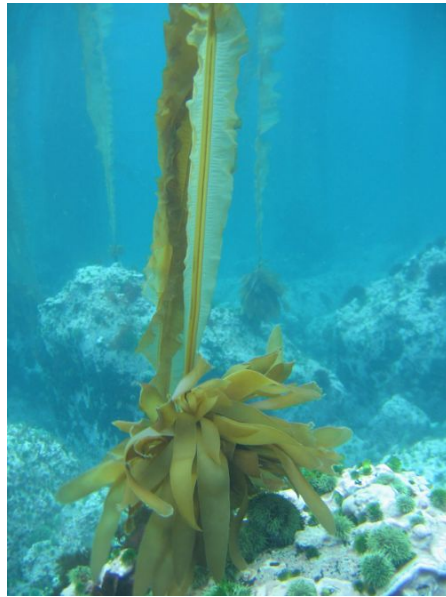
Louis Druehl

Bamfield Marine Sciences Centre
Canadian Kelp Resources

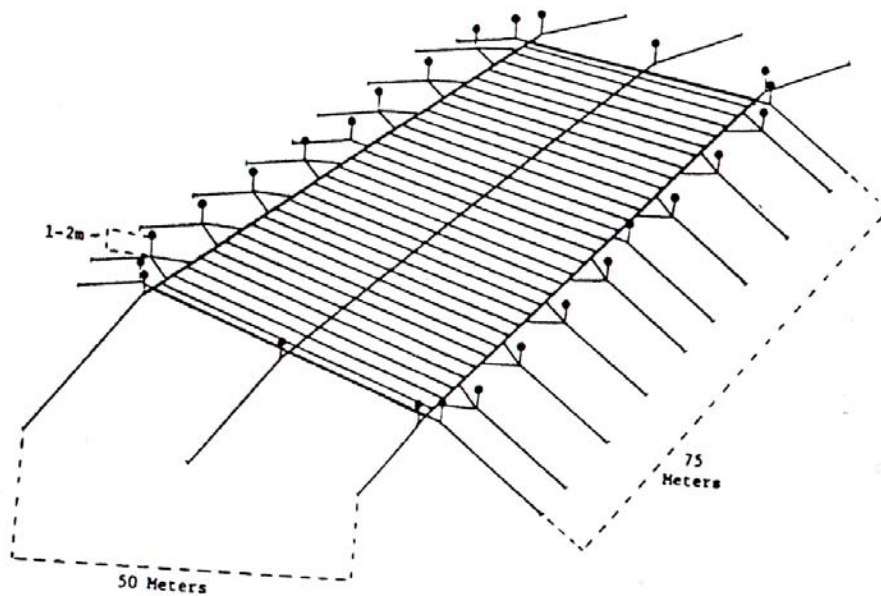
PowerPoint Design: Hana Kucera



Postels & Ruprecht 1840



Druehlia fistulosa, Dragon Kelp



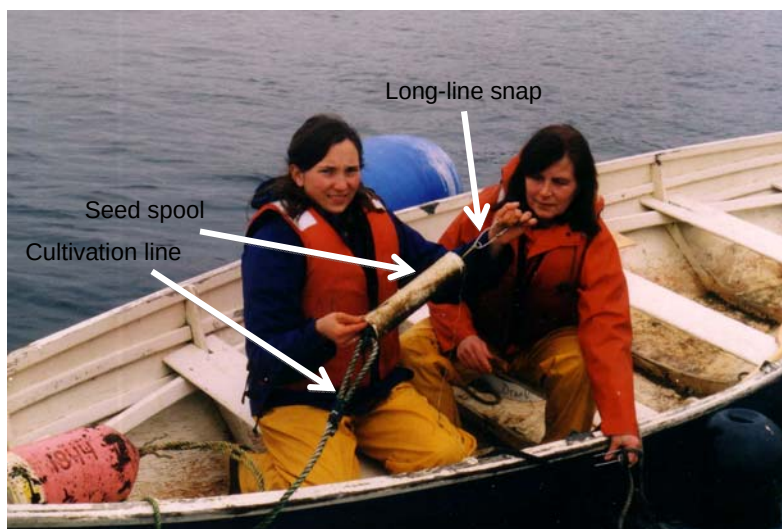
Merrill and Gillingham 1991: NCRI-T-91-011

Canadian Kelp Resources Kelp Farm



Farmed *Saccharina latissima* (Sugar Kelp): 8kg kelp/meter rope

Applying seed string to cultivation line



Saccharina harvested *in situ*



Feeding Farmed Kelp to Sea Urchins



Hanging Cultivation Line To Dry



Stages of Farming



Seed
Spool



Seed Planting



Mature Kelp

Young Farmed Kelp



Saccharina latissima



Alaria marginata



Macrocystis integrifolia



Nereocystis leutkeana

World kelp production numbers

Species	Per meter of rope	Reference
<i>Nereocystis leutkeana</i> (Bull Kelp)	5-22 wet kg	Merrill & Gillingham
<i>Saccharina latissima</i> (Sugar Kelp)	8-29 wet kg	Kain, Druehl
<i>Saccharina groenlandica</i> (Tangle)	9-24 wet kg	Druehl
<i>Saccharina japonica</i> (Kombu)	8-24 wet kg	Kawashima
<i>Alaria esculenta</i> (Winged Kelp)	7-12 wet kg	Kain
<i>Alaria hybrid</i> (Winged Kelp)	45 wet kg	Kraan
<i>Undaria pinnatifida</i> (Wakame)	5-10 wet kg	Akiyama & Kurogi

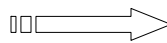
Saccharina farm production

Scaled to 1 hectare, 4000 m cultivation lines
Saccharina latissima (Sugar Kelp) at 20 wet kg/m cultivation rope

Detritus production during growth	320 MT/ha	Mann 1973. Sci. 182: 945
Harvested wet weight	80 MT/ha	
Total wet tissue produced	400 MT/ha	
Carbon production	1870 g/m ² /yr	
Puerto Rico alfalfa Carbon production	2100 g/m ² /yr	Mann 1973.
Harvested dry weight (18 % wet)	14.4 MT/ha	Bird & Benson 1987. Devel. Aqua. & Fish. Sci 16:285-303
Harvested volatile solids (74 % dry)	10.7 MT/ha	
CH ₄ production (0.27 SCM/kg VS)	2889 SCM/ha	
Fucoxanthin production, shallow growth	0.202 g/wet kg	

Manipulating Farmed Kelp

Seed Production
 Sorus Induction
 Gametogenesis
 Forced Cultivation



Farm Grow-Out
 Productivity
 Pigmentation
 NO₃ Enrichment
 Protein/Carbohydrate Ratio
 Substantiality



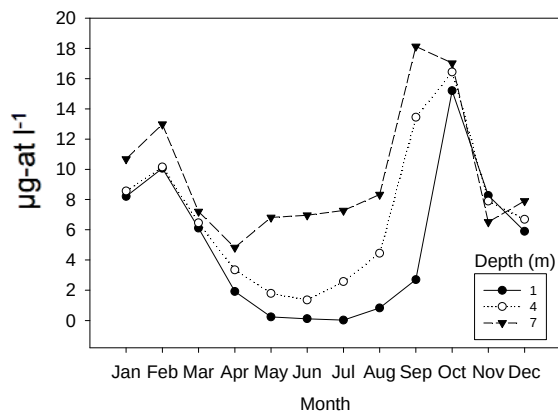
Methods

Photoperiod
 Blue Light Exclusion
 Plant Trauma (hole punch)

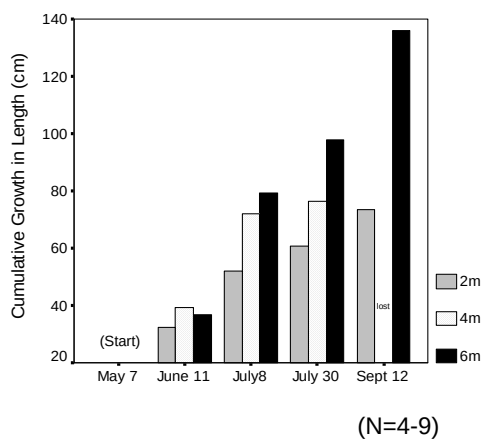
Time of Planting
 Depth of Planting
 Time of Harvesting

Nitrate Conditions at Kelp Bay Farm Site

Average Monthly Nitrate Concentrations



Saccharina latissima Growth vs. Depth



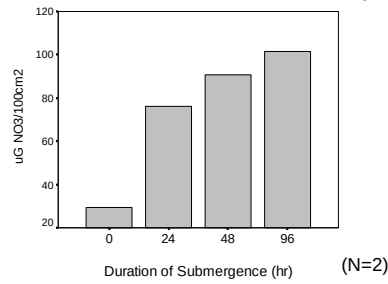
S. latissima grown at 2 m depth. June 11, 2003.



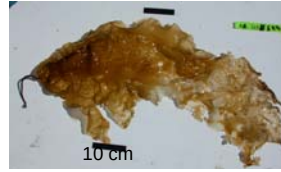
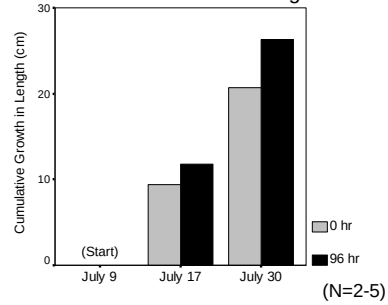
S. latissima grown at 6 m depth. June 11, 2003.

S. latissima Luxury Uptake of Nitrate Through Submergence

Tissue Nitrate vs Duration of Submergence



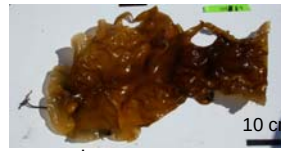
Growth vs Duration of Submergence



Control. 0 hr submergence.



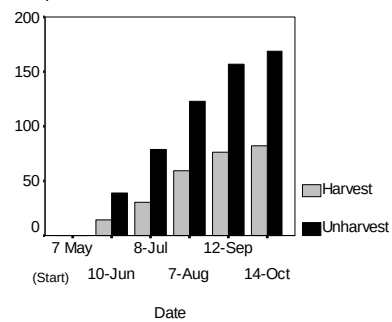
24 hr submergence.



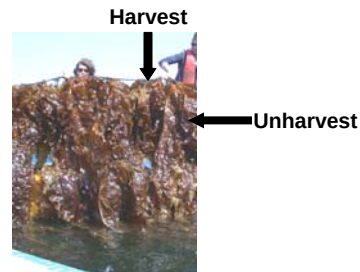
96 hr submergence.

S. latissima Harvest vs Unharvest

Cumulative growth in centimetres
Harvest (7-May, 2003)



Harvest vs Unharvest. Start May 7, 2003.



Harvest vs Unharvest. July 30, 2003.

Phenolics to tannins

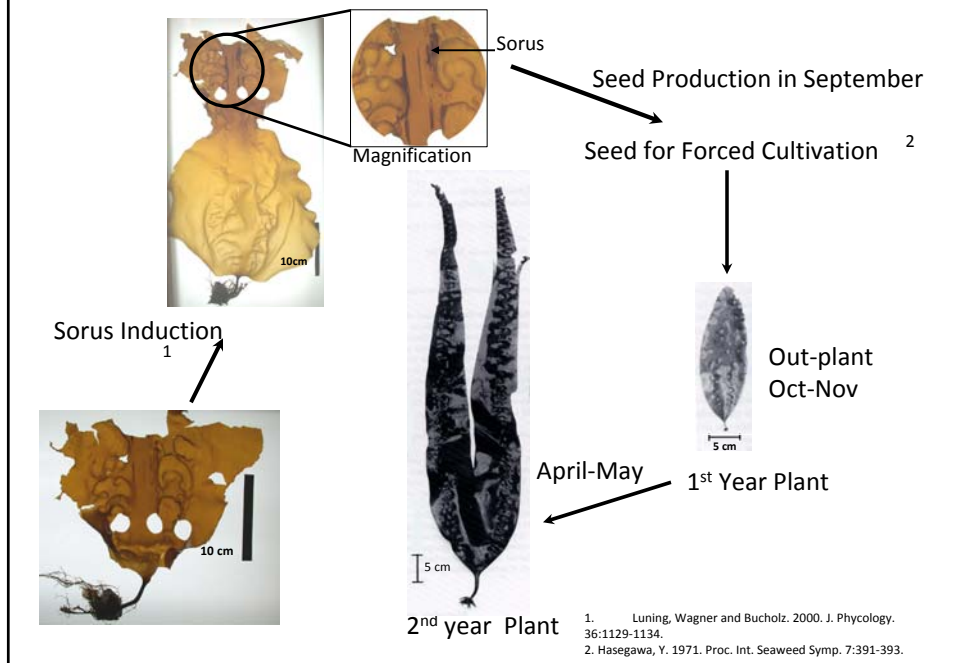
Natural UV radiation



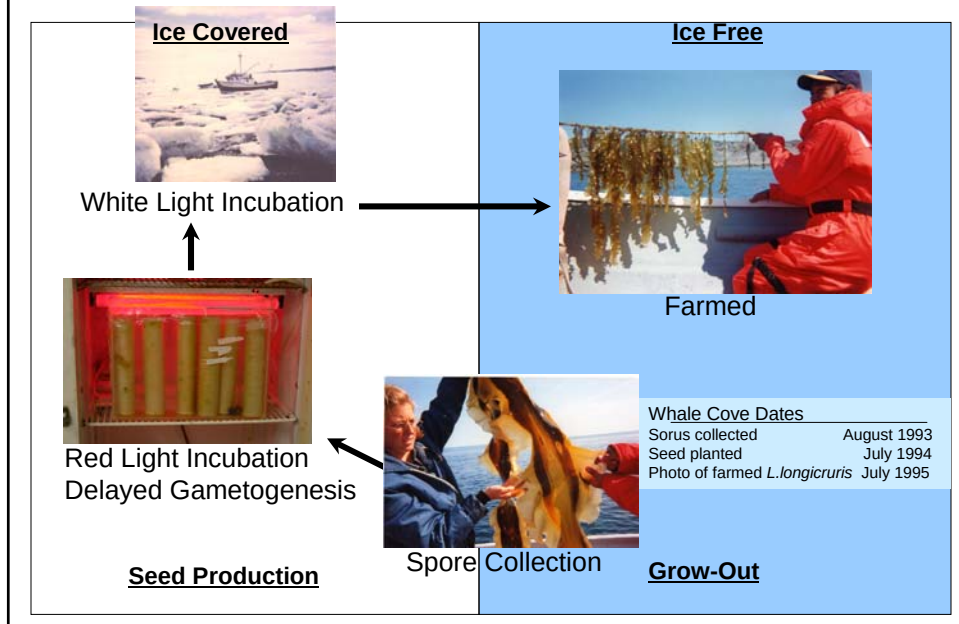
Other possible chemical manipulations

- Fucoxanthin (depth/nitrate)
- Phenolics (depth/UV light)
- Fucoidans (depth/nitrate)
- Polyunsaturated fatty acids (?)
- Phlorotannins (?)
- Melatonin (?)

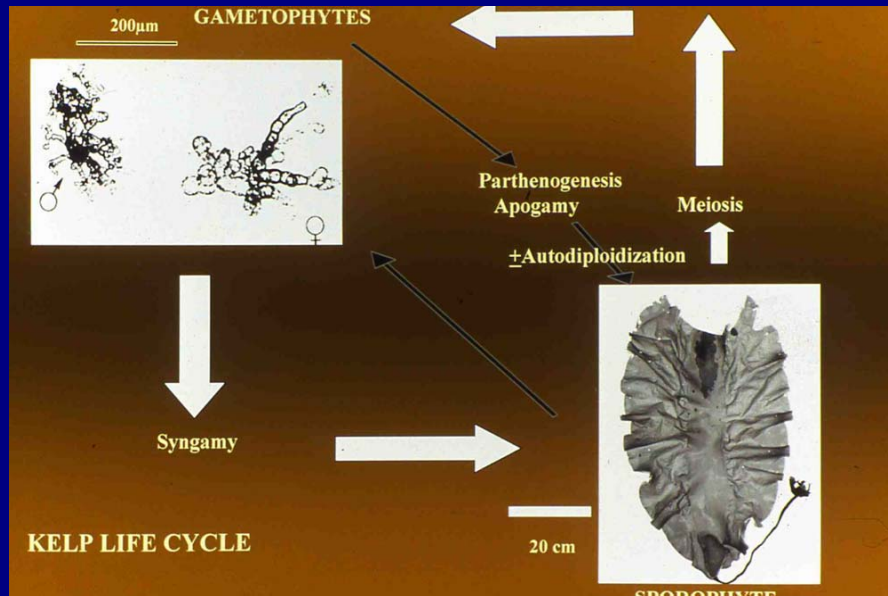
Accelerated Sorus Production in *Saccharina latissima*



Delayed *Laminaria longicruris* Seed Production for Arctic Cultivation



Cloning Kelp Gametophytes



Female *Saccharina* gametophyte



Experimental Protocol

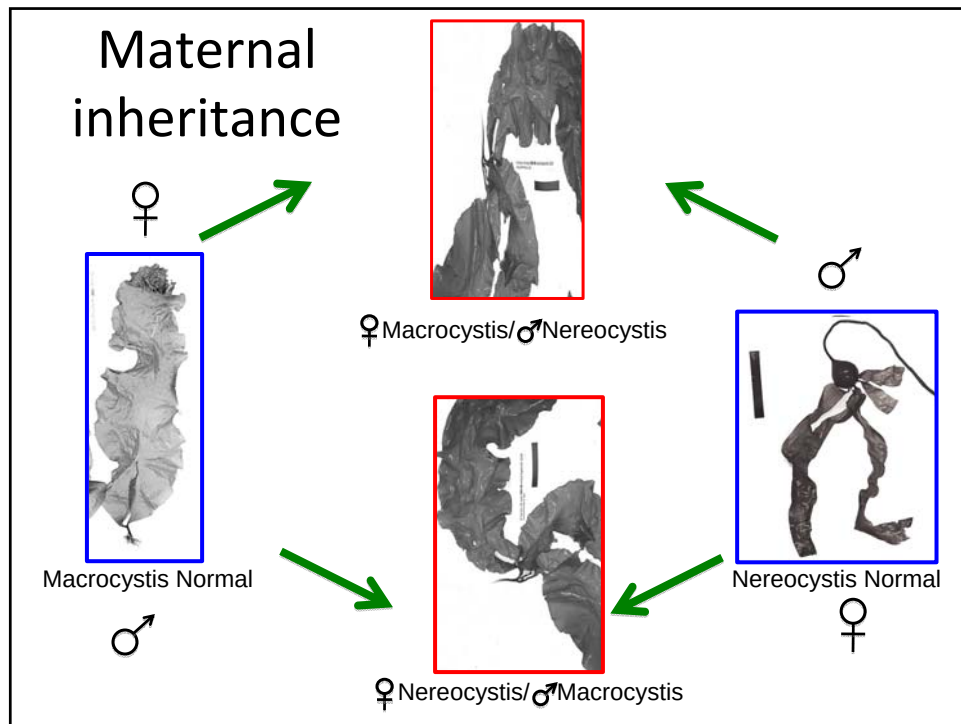


Strain selection in *Saccharina japonica* from cloned gametophytes

(Li et al. 1999. Hydrobiologia 398/399:473-476)

♀ ♂	W8	Lid	Rong
W8	800 cm	<u>1300 cm</u>	700 cm
Lid	700	1100	600
Rong	900	800	1100

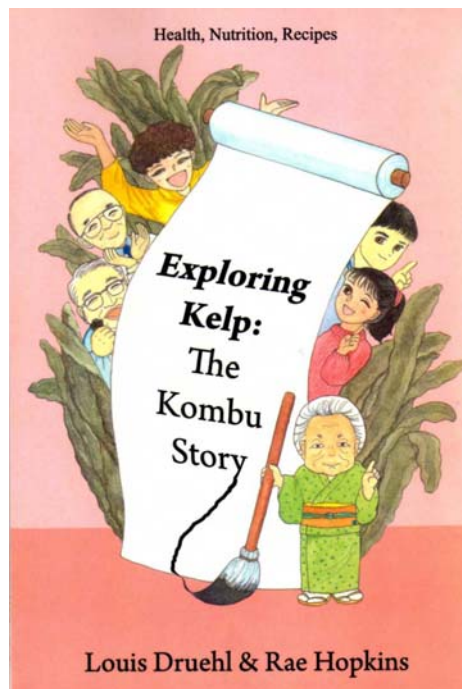
Average length of sporophytes from different crossing combinations.



Kelp in art, recreation, leisure, and contemplation



Canadian Kelp Resources Sea Vegetables



Kelp chips



Macro Sushi

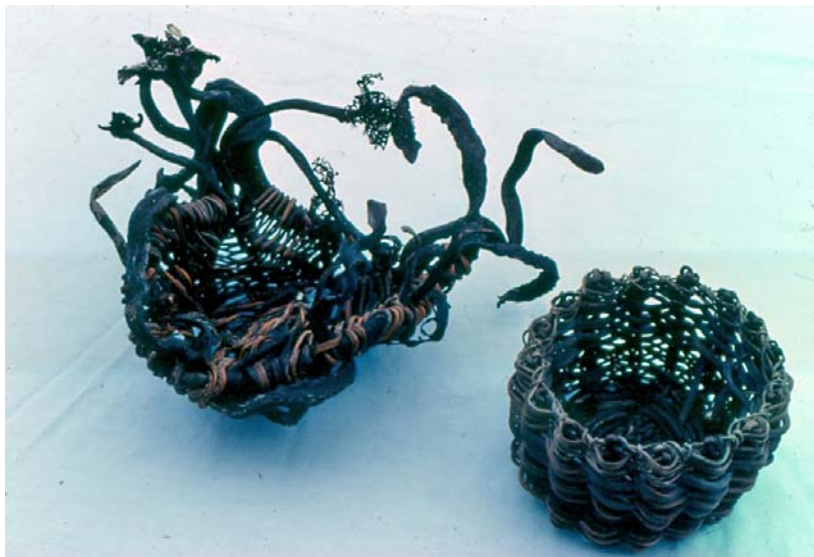


With apologies to
Denmark's Sushi Sensei,
Ole Mouritsen



The Kelp Swizzle Stick

that justifies that second vodka





True North Brass



Girl with *Costaria costata*





Breakfast at Tiffany's

Macrocystis dress with
Fucus accessories

Ja Whitcombe creation,
photo Billy Pipe



Bull Kelp — beach accessories

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