홍조류 바다식물로 만드는 펄프와 종이, 바이오에탄올

Pulp, Paper & Bio-ethanol made from Red Algae

PEGASUS International

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Pegasus International, Inc.

The New Era of Pulp & Paper

201011 English

World First Invention

PEGASUS International

- **Invented in Korea, Patents Applied for 43 Countries (Obtained from 41 Countries)**


특 허 증
CERTIFICATE OF PATENT

특 허 제 0512793 호
(PATENT NUMBER)

출원번호 (APPLICATION NUMBER) 제 2004-0092297 호
출 원 일 (FILING DATE:YY/MM/DD) 2004년 11월 12일
등 록 일 (REGISTRATION DATE:YY/MM/DD) 2005년 09월 01일

발명의명칭 (TITLE OF THE INVENTION)
홍조류로 제조된 펄프와 종이 및 그 제조 방법

특 허 청 장


특 허 협 력 조 약
(PATENT COOPERATION TREATY)

발신:수리관청

수신:
KWON, Hyuk-Sung
2F, Myung-Jin Bldg. 746-9, Yeoksam-dong, Gangnam-Gu Seoul 135-080, Republic of Korea

PCT

국제출원번호 및 국제출원일 통지서

(PCT 규칙 20.5(C))

발송일 (일/월/년) 26 NOVEMBER 2004 (26.11.2004)

출원인 또는 대리인의 서류참조기호
PCT000021

중요통지사항

국제출원번호	국제출원일 (일/월/년)	우선일 (일/월/년)
PCT/KR2004/002939	12 NOVEMBER 2004 (12.11.2004)	13 NOVEMBER 2003 (13.11.2003)

출원인
YOU, Hack-Churl

발명의 명칭
PULP AND PAPER MADE FROM PHODOPHYTA AND MANUFACTURING METHOD THEREOF

- 국제사무국은 수리관청에 의한 기록원본의 송달을 감시하고 그 접수사실을 출원인에게 통지합니다. (서식 PCT/IB/301). 국제사무국은 우선일부터 14월이 경과할 때까지 기록원본을 수령하지 않은 때에는 출원인에게 이를 통지합니다. (규칙 22.1(c)).

수리관청명칭 및 우편주소
Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
팩스번호: 82-42-472-7140

특허청장
COMMISSIONER
전화번호: 82-42-481-5281

서식 PCT/RO/105 (1992년 7월; 2004년 1월 재인쇄)

- **Obtained Patent, 41 Countries (as of March, 2010)**

Republic of Korea, Vietnam, Indonesia, Australia, Mexico, South Africa, Russia, Austria, Belgium, Bulgaria, Switzerland, Cyprus, Czech, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Ireland, Iceland, Italia, Liechtenstein, Luxemburg, Monaco, Netherland, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, Turkey, Canada, USA, Japan, China, India

(Patent applications outstanding for another 2 countries)

Structure of Red Algae

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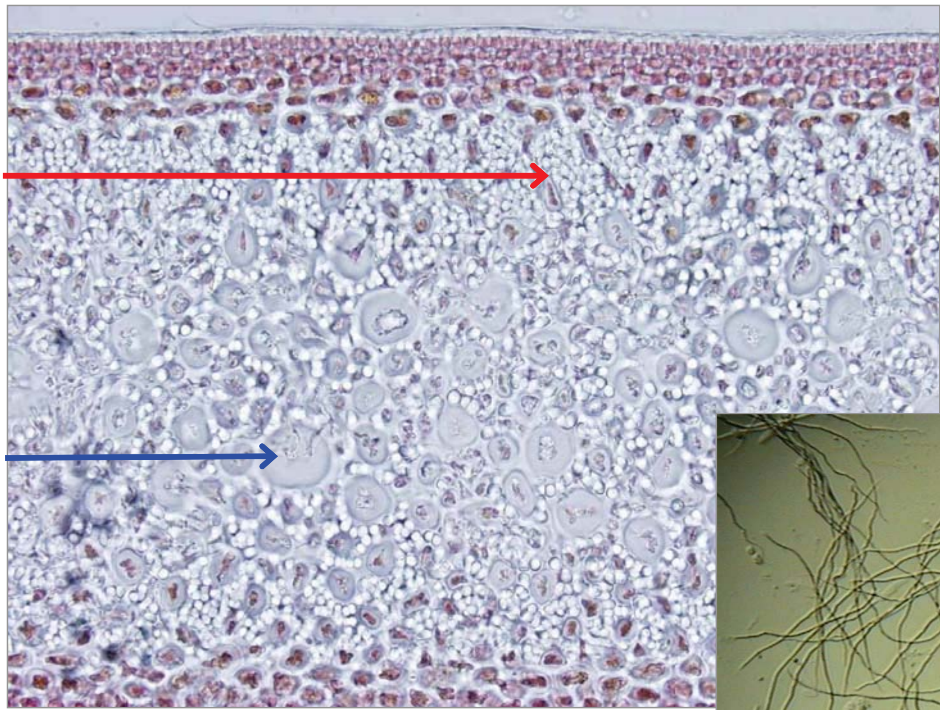
- Endofibers for Pulp and the polysaccharide for Bio-energy

- Endofiber
- Tubular cell

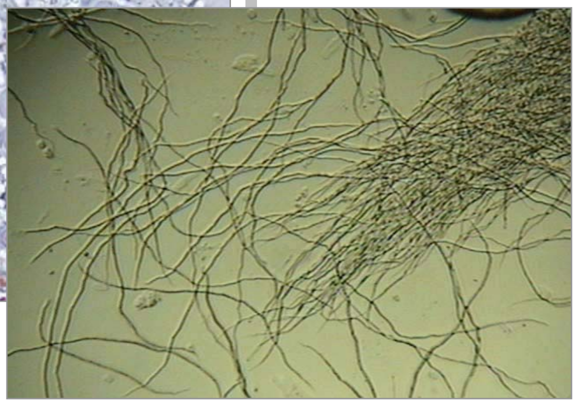


Epicortex

Endothelial layer

Medullary layer

- Endofiber (300X)



Gelidium amansii

Endofiber

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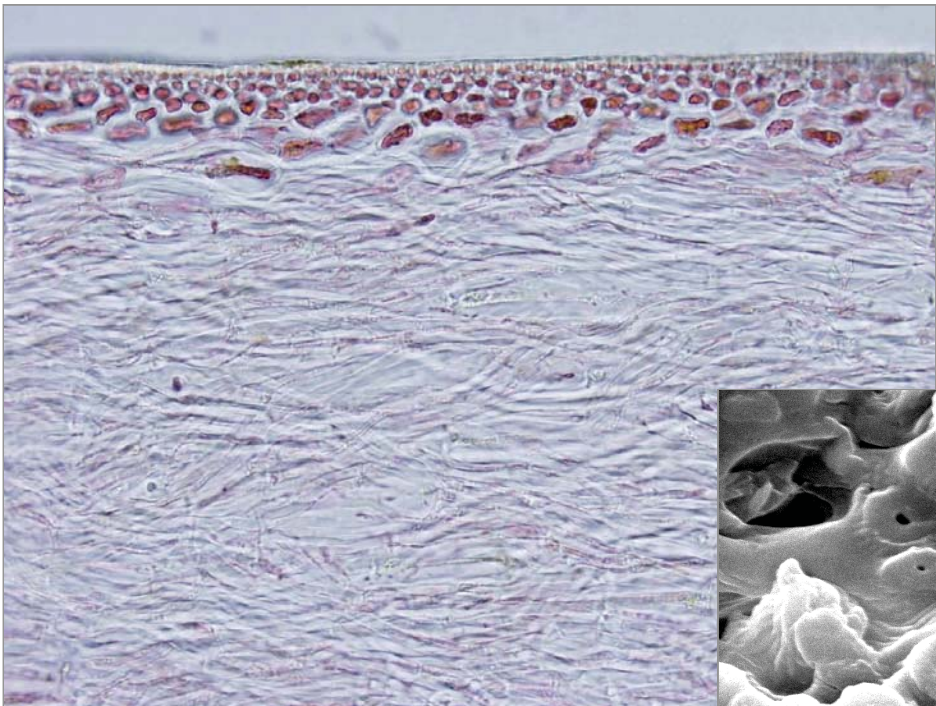
- Almost same thickness, has a lumen in fiber

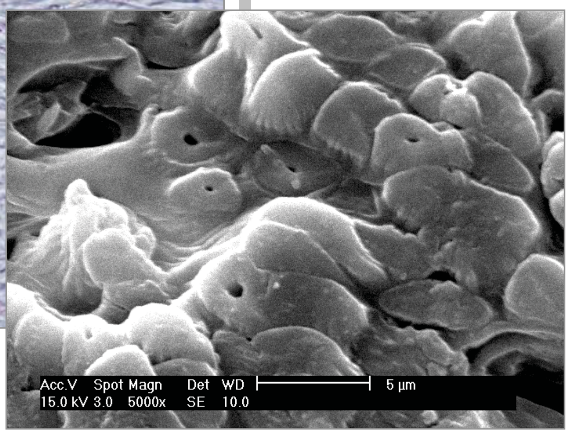


Epicortex

Endothelial layer

Medullary layer

- Endofiber (5,000X)



Gelidium amansii

Advantages of Marine Plants

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Properties	Land Plants (Air)	Marine Plants (Water)
Habitat	▪ Soil, but stem and leaves are exposed to the air	▪ Root, stem, leaves are all in water
Space	▪ Air (density=1), affected by gravity	▪ Water holds buoyancy and viscosity ▪ Density is 850 times higher than that of air
Sustainability	▪ Has to support itself against gravity ▪ Requires extra energy to strengthen its branches ▪ Growth of climbing type plants is faster than that of bush type plants	▪ Marine plants sustained by buoyancy ▪ Demands small amount of energy to sustain
Temperature	▪ Air temperature change greatly varies seasonally and day and night ▪ Epidermal cell (bark) has advanced to adapt itself to temperature changes, requiring additional energy (ex. coniferous tree)	▪ Temperature change in water is not as dramatic as it is in the air ▪ Therefore, epidermal cell is thin, enabling high level of energy efficiency
System	▪ Roles of root, stalk and leaf are clearly distinguished	▪ Root only serves the role of providing 'anchor' in substrate
Nourishment	▪ Root is the only channel to suck up water from the earth ▪ Source of water and nutrients are limited to the reach of roots	▪ Absorbs nutrients from the surrounding water directly into the cells ▪ Oceanic circulation helps sustain marine life by stirring up the chemical nutrients in the water and carrying them
Reproduction	▪ Requires considerable amount of energy to produce fruit and seed for reproduction ▪ Seasonal limitation	▪ Asexual reproduction enables harvesting in growth period before it develops reproduction ability
Growth	▪ Energy is used to sustain and adapt itself to the surrounding temperature and to reproduce, leading to slow grow	▪ Energy is used for growth only, enabling faster growth than that of land plants

Why Red Algae?

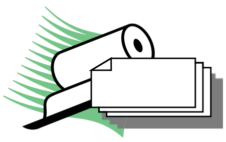
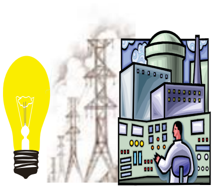
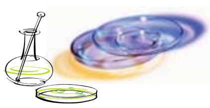
PEGASUS International

- **Red Algae has higher commercial value than Green Algae or Brown Algae**

Division	Species	Condition	Dry or Wet Weight (per 100g)			
			Moisture	Carbohydrates		Others
				Saccharinity	Fiber	
Green	*Enteromorpha prolifera*	Dry	12.8	42.2	4.3	40.7
	Entromorpha compressa	Wet	87.6	3.0	0.5	8.9
	Ulva pertusa	Dry	13.7	40.1	3.4	42.8
Brown	*Hizkia fusiformis*	Wet	88.1	4.0	1.0	6.9
	Laminaria japonica	Wet	91.0	3.6	0.6	4.8
	Laminaria japonica	Dry	12.3	41.1	4.1	42.5
	Undaria pinnatifida	Wet	87.6	4.8	0.3	7.3
	Undaria sp.	Dry	16.0	33.9	2.4	48.0
Red	*Gracilaria sp.*	Wet	89.1	5.9	0.3	5.0
	Gelidium elegans	Wet	70.3	18.5	3.0	8.2
Product	Agar-agar, powdered		20.1	74.6	0	5.3
	Agar-gel		99.0	0.8	0	0.2

- National Fisheries Research and Development Institute of Korea, 1995

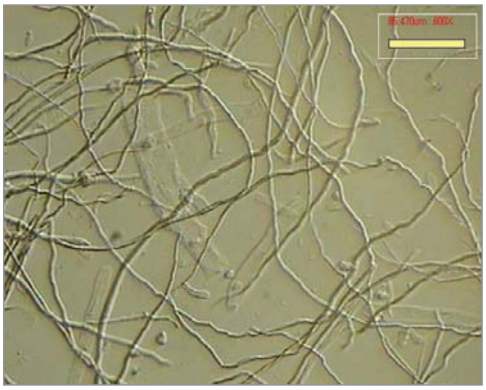
Applications of Red Algae

Classification	Field of Application	Remarks
	Food and Cosmetics	▪ It is currently used as a source of food (agar), cosmetics, medical supplies ▪ Red algae can be cultivated, Daily growth rate is about 3-13% ▪ CO_2 absorption level per unit area is higher than that of forest ▪ It is relatively easy to develop hybrid plants by cross breeding
	Pulp and Paper	▪ Pulp can be produced 100% from Red Algae, without cutting down trees ▪ Environment friendly production process eliminates use of toxic chemicals ▪ Simple production process, high energy efficiency ▪ Red algae pulp is suitable for production of high quality paper, realizing high value
	Bio-ethanol	▪ Ethyl alcohol can be produced by fermenting agar ▪ Mass farming of red algae enables production of bio-ethanol at even cheaper price than making it from corn ▪ When producing pulp with red algae, agar is produced as a by-product, which means "free raw materials" ▪ By building a pulp plant geographically in proximity with a red algae farm, red algae can serve as an energy source
	Biocomposite Material	▪ Can substitute for packaging materials such as plastic and styrofoam that pollute environment ▪ Applicable as a material for natural polymer matrix ▪ Agar can serve as a partial substitute for industrial starch
	Agar Medium and Agarose	▪ Materials for culture of microorganism agar medium for biochemical test labs (Raw material for agar medium for cultivation with microorganism used in biological laboratory) ▪ Highly refined agarose is a high value and expensive product

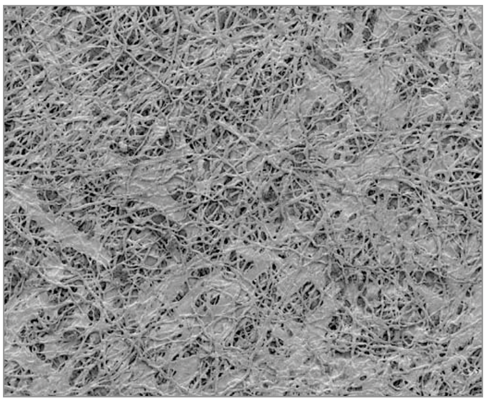
Advantages of Red Algae Pulp

- **High quality Pulp and Paper made from Red Algae's Endofiber**

Wood Pulp	Red Algae Pulp
Thick	Thin
Not Equal Length	Equal Length



Wood Paper	Red Algae Paper
Coarse	Smooth
Requires Filler	High Opacity



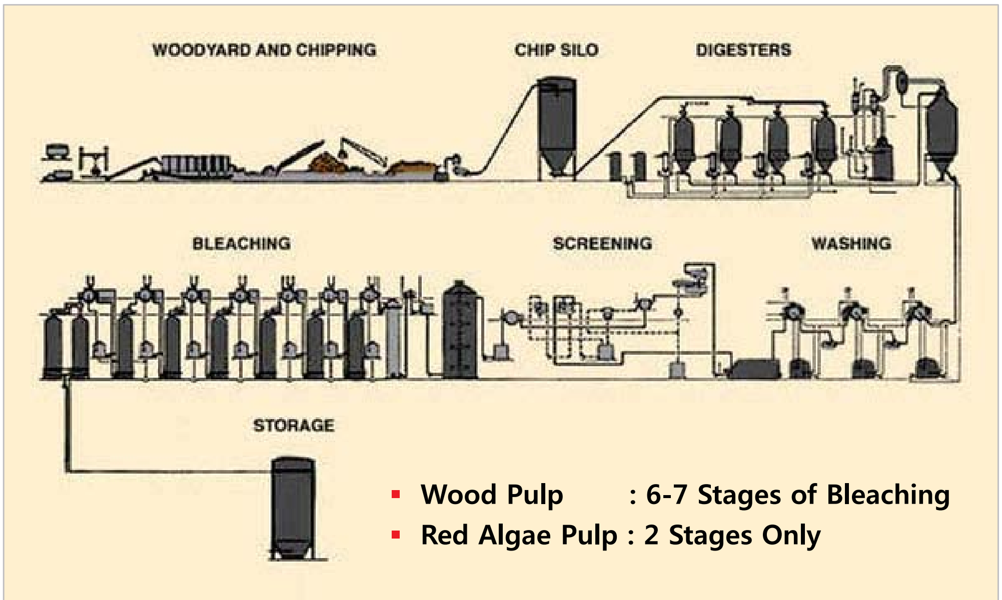
Fundamental Difference

- **Comparison to Wood Pulp**

Wood Pulp	Vs.	Red Algae Pulp
	Appearance (Drawing)	
Bar, Stick, String	Figure	Pipe, Hose, Straw
Dry Normally (Ordinary)	Wet Condition	Dry Slowly, Effluence Slowly
Absorb Liquid Normally (Ordinary)	Dry Condition	Absorb Liquid Quickly & Plenty
Different every single fiber	Shape & Size	Almost Equality

Comparison to Wood Pulp

- **Red Algae Pulp, Only 20% of Wood Pulp Process, Saving Energy & CO_2 Reduction**
  - Wood Pulp : 180℃, 8 Hours, NaOH
  - Red Algae Pulp : 100℃, 2 Hours, Water (No Lignin Removal)



- Wood Pulp : 6-7 Stages of Bleaching
- Red Algae Pulp : 2 Stages Only

- Wood Pulp Process
- Red Algae Pulp→

Red Algae Pulp Processing

- ClO_2 [5% of aqueous solution] Dilute to 10,000 times of water, it's tab water itself

Agar Extraction → 1st Bleaching → 2nd Bleaching

Extraction First

Cleaning

Boiling with Water

By ClO_2 5%

By H_2O_2 35%

Ozone First

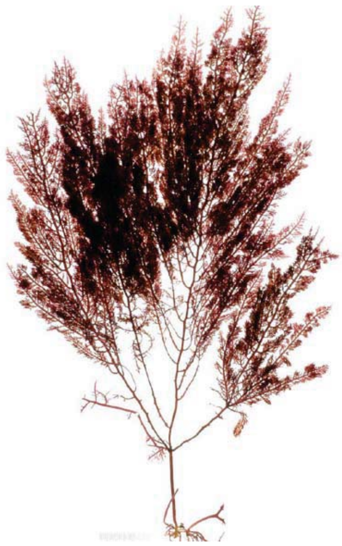
Ozone Bleaching (Boiling Shortly) → 1st Bleaching → 2nd Bleaching

Species in *Gelidium* family

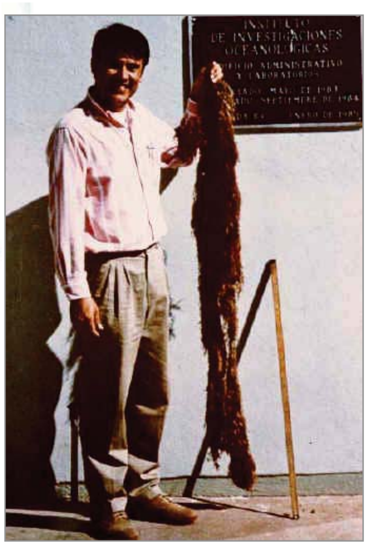
- Large Species in *Gelidium* family (Family *Gelidiaceae*)

- *Pterocladia lucida*
- Genus *Pterocladia*
- Length : 40cm

- *Gelidium asperum*
- Genus *Gelidium*
- Length : 50cm



- *Gelidium robustum*
- Genus *Gelidium*
- Length : over 50cm



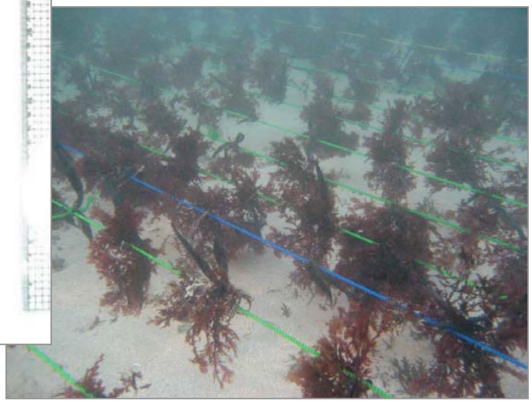
- *Gelidium robustum* from Mexico

Large Scale Cultivation

- **Cultivation in Indonesia Since 2006**

- *Ptilophora sp.*

- **Family** ***Gelidiaceae***



Gelidium Cultivation

- **Aquaculture of** ***Gelidium***
  - **FAO report, 1987**
  - **Maximum daily growth rate = 6.5%, double fold growth in 30 days**
  - **Images below show maximum 6 fold growth in 60 days (Research already done in Korea)**

The attempts to grow these species under free-floating conditions represent an alternative approach. The first such attempt were performed with Hawaiian populations of Pterocladia (Santelices, 1976) and, more recently, species of Gelidium from India and Norway have been maintained in free-floating conditions with growth rates up to 6.5% daily. This type of cultivation has been initiated with the three Chilean species of Gelidium. Gelidium chilense was the species with fastest growth, a doubling time of about 30 days. The capacity of these algae to grow free floating is related to their ability to adopt a globular habit, devoid of holdfasts and with production of a profusion of radially-oriented branches. In G. chilense the thalli become globose after 28 days. Radially branching thalli of G. ligulatum resulted from proliferations appearing on the attachment parts of the thalli while G. rex did not show any growth or any modification of its morphology at all (Santelices, Oliger & Montalva 1981).

Trial Cultivation in Korea

- **Cultivation in Dang-Mok Ri village, Wan-Doh county in 2006**
  - **In 2006, *Pterocladia tenuis* trial cultivation experiment was conducted**
  - **Pilot trial farm of PEGASUS is located in Dang-Mok Ri village, Wan-Doh county**
  - **Organisms grew an average of 4.5 times during 30 days with an average daily growth rate of 4.23%**





Trial Cultivation in Indonesia

- **A Korean species *Gelidium amansii*, Transplanted to Indonesia**

- **Well-adapted, Growing 4-Times in 70-Days (average)**
- **Manado, North Sulawesi**

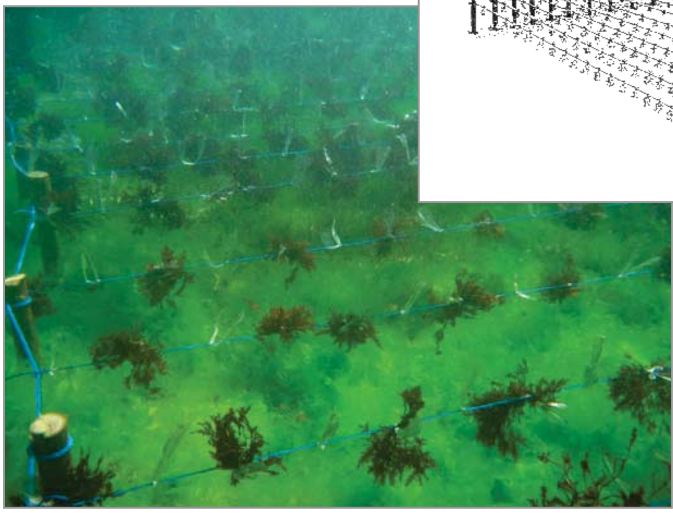
- ***Gelidium amansii* (Korea)**

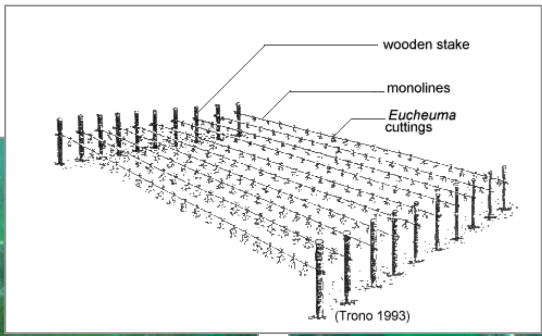
- **Trial pilot farm (Indonesia)**

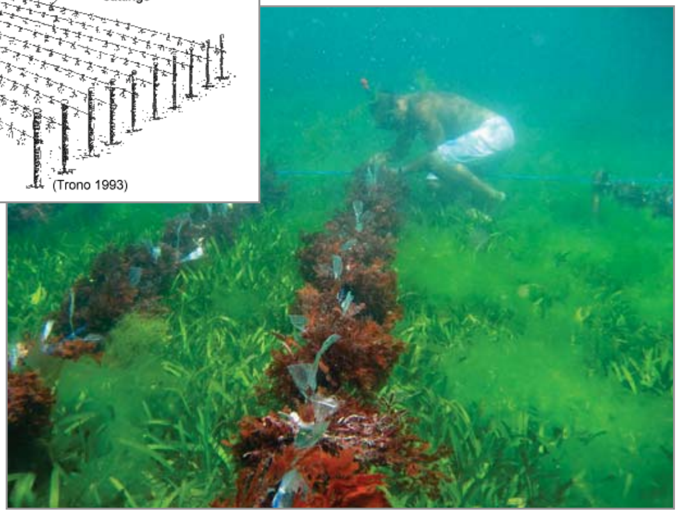
- **70-Days After Seedling**

Cultivation Method #1

- **Bottom Line Type**
  - **Shallow waters up to 3m depth; Work can be done with mask and snorkel**
  - **Piles are rammed down into sea bottom; Frame is made by winding think ropes around the piles**
  - **10m x 10m area is usually set as 1 unit; Thin ropes 5-10m long, and seeds are tied to the ropes**
  - **The distance between ropes is 30-50cm, and between seeds is 20-30cm**







Cultivation Method #2

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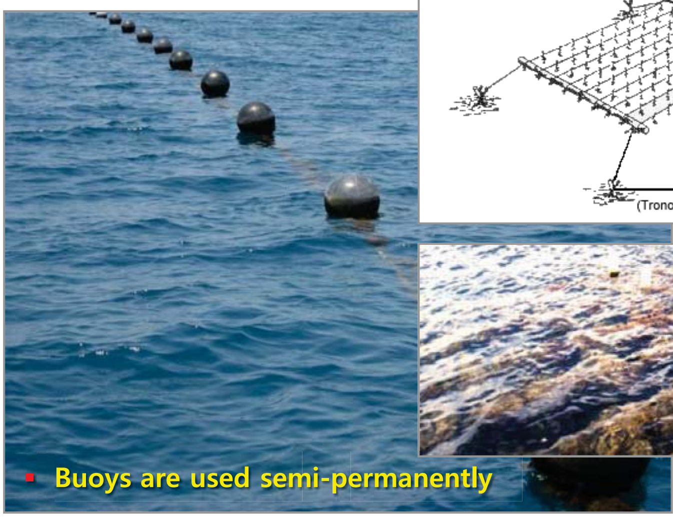
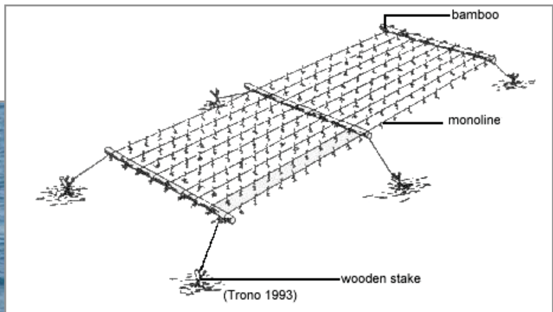
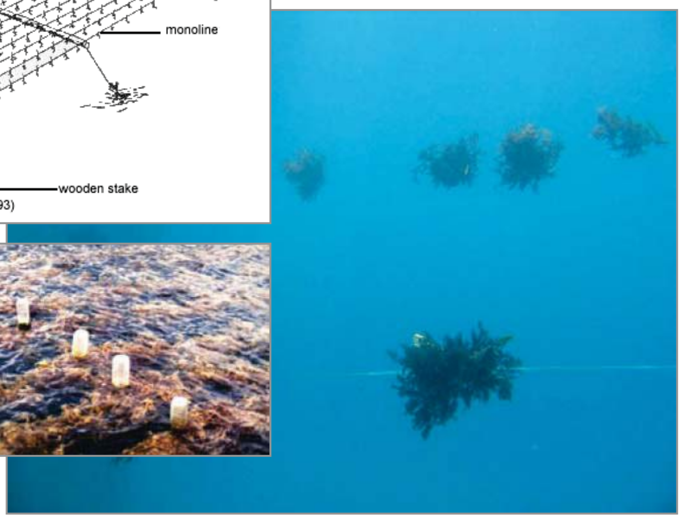
- **Floating Line Type**
  - **For large-scale cultivation at more than 3m depth**
  - **The water depth does not matter if ropes can be fixed**
  - **Concrete anchor is fixed on the sea-bed, and the rope is floated with plastic buoys to build the cultivation area**
  - **Length of the ropes is 10m-100m; Ropes are installed by fixing them 30-50cm under the surface of the water**





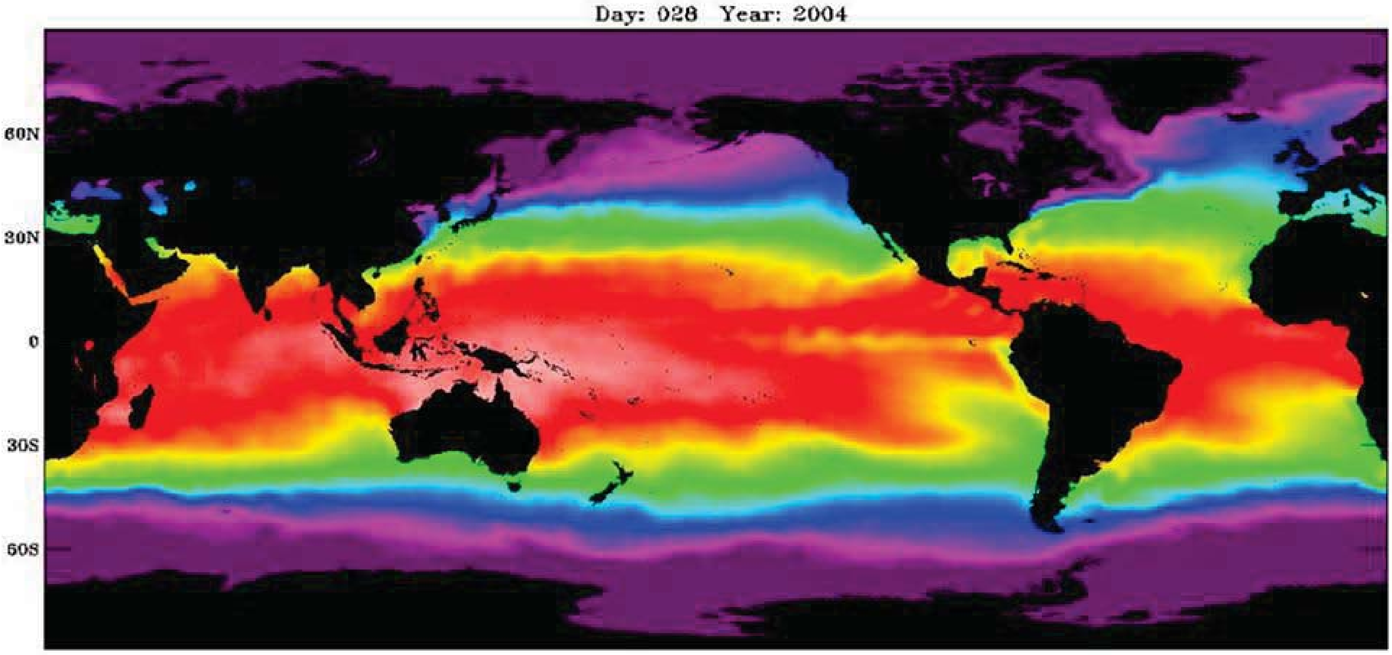


Waters Available for Cultivation

PEGASUS International

- **Sea Surface Temperature**

▪ Source : NASA's Jet Propulsion Institute



▪ Between latitude 15 degrees North and 15 degrees South

Cost of Cultivation

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- **Reference on Cultivation Cost**
  - Seaweeds currently cultivated in large scale to meet the industrial demand are : *Porphyra , Undaria, Laminaria, Gracilaria, Cottonii,* etc.
  - There are large differences in the demand and price among nations according to availability of cultivation and application, and the gap between export and local prices is also considerable
  - Labor and material costs are included in the production cost of the cultivation farm, and the materials for cultivation are divided into permanent, semi-permanent and disposable

- **Production Cost for Seaweeds**
  - Top cultivated seaweed genera in the world during 2000 (World Food Plan FAO 2003 Report)

Seaweeds Common names	Scientific names	Production amount ($1 million)	Production weight (ton)	Cost per ton (U.S. $)	Remarks
Green laver	*Porphyra*	1,118	1,011,000	1,105	
Sea mustard	*Undaria*	149	311,105	480	
Laminaria	*Laminaria*	2,811	4,580,000	613	
Gracilaria	*Gracilaria*	11	12,510	879	
Cottonii	*Kappaphycus*	46	628,576	73	Same methods
Total		4,632	5,972,737		

Cultivation in Indonesia

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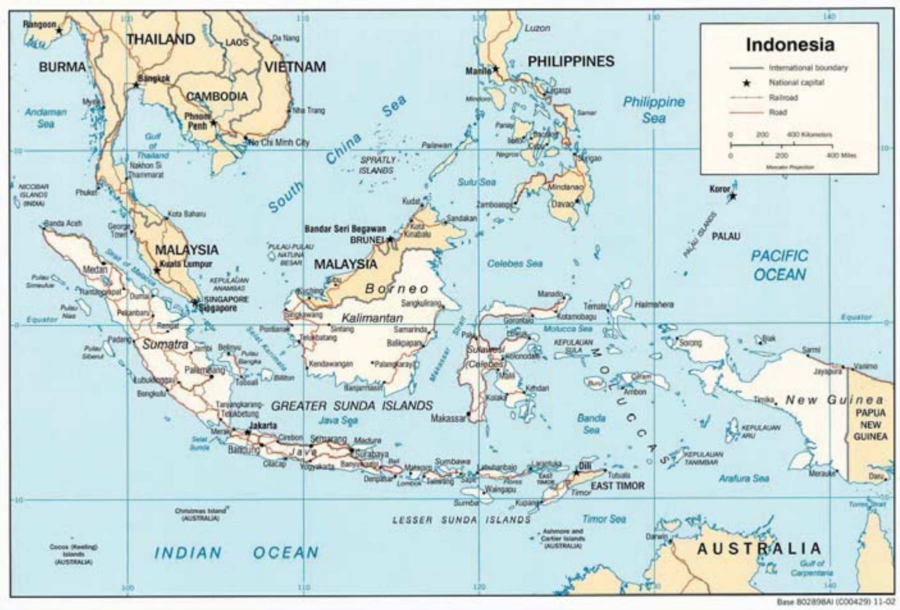
- **Bilateral Research Cooperation Contract with organizations in Indonesia since 2006**
  - **Indonesian National Aquaculture Institute (Sekotong)**
  - **National Seaweed Center (Gerupuk)**



- **12,139,042 ha. (121,390㎢) cultivatable area available (official Indonesian government record)**

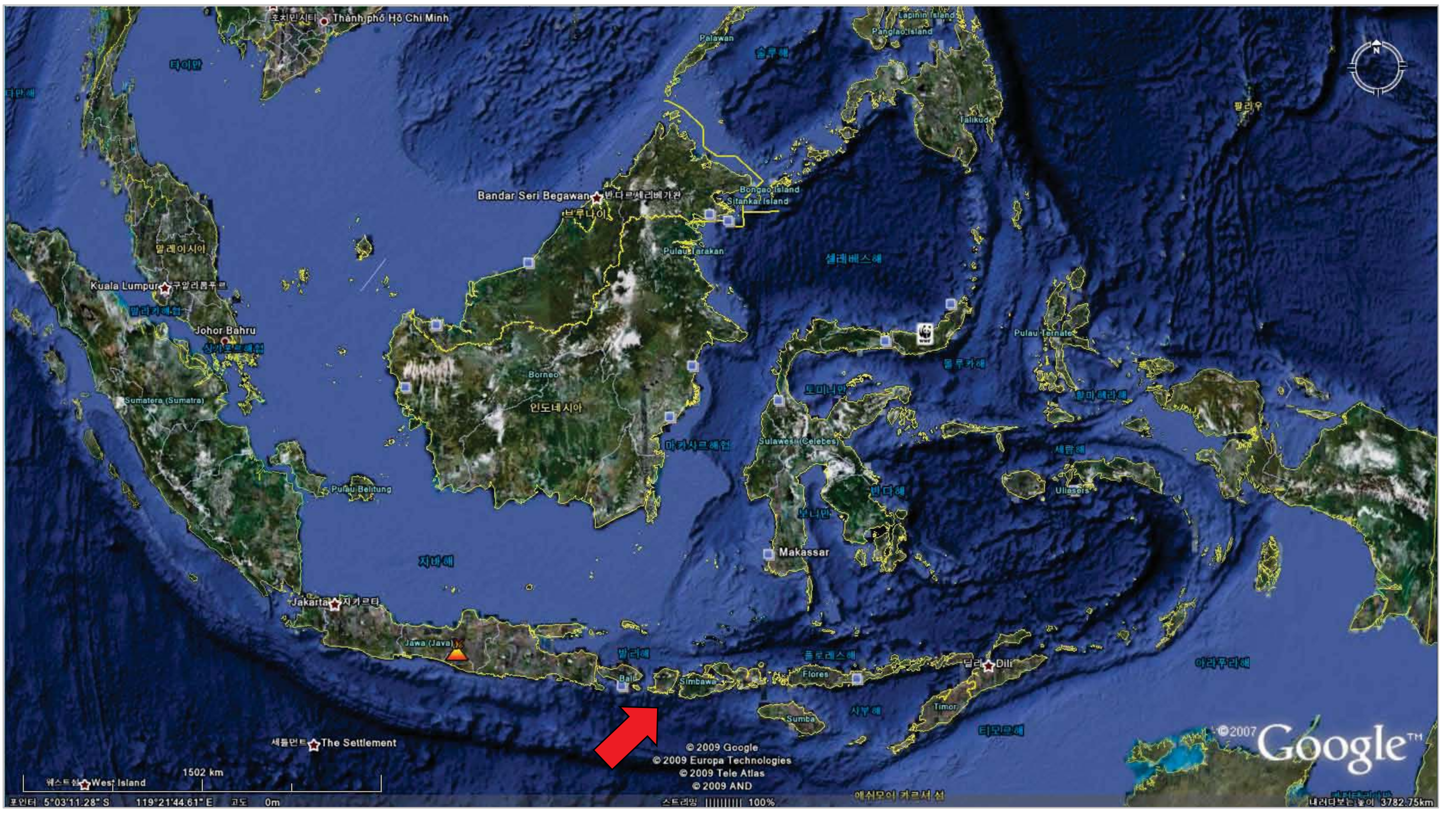
- **National Aquaculture Institute**

- **Research service contract**

Location of the Cultivation Site

PEGASUS International

- **Lombok Island, Next to Bali in Indonesia**



Location of the Cultivation Site

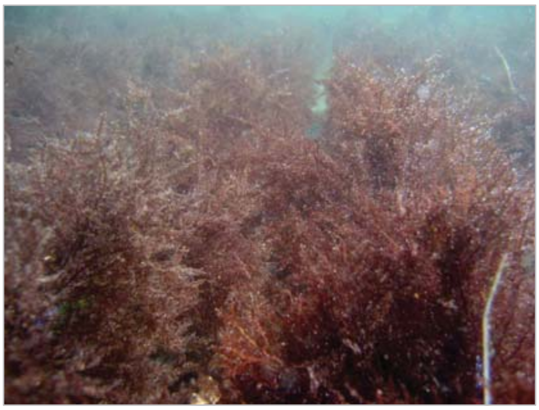
PEGASUS International

- "Gerupuk," the south coast of Lombok Island in Indonesia

Pictures of Cultivation Site #1

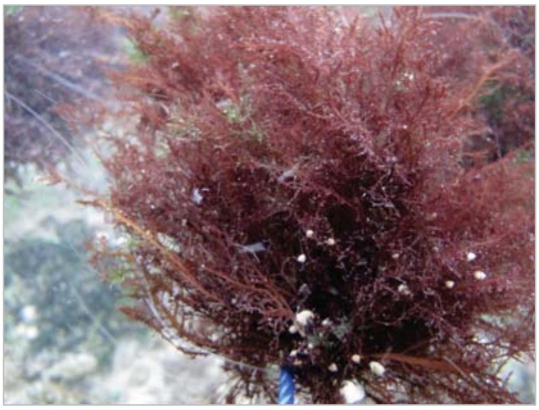
PEGASUS International

- Actual pictures of *Gelidium* cultivation



Pictures of Cultivation Site #2

- **Actual pictures of *Gelidium* cultivation**



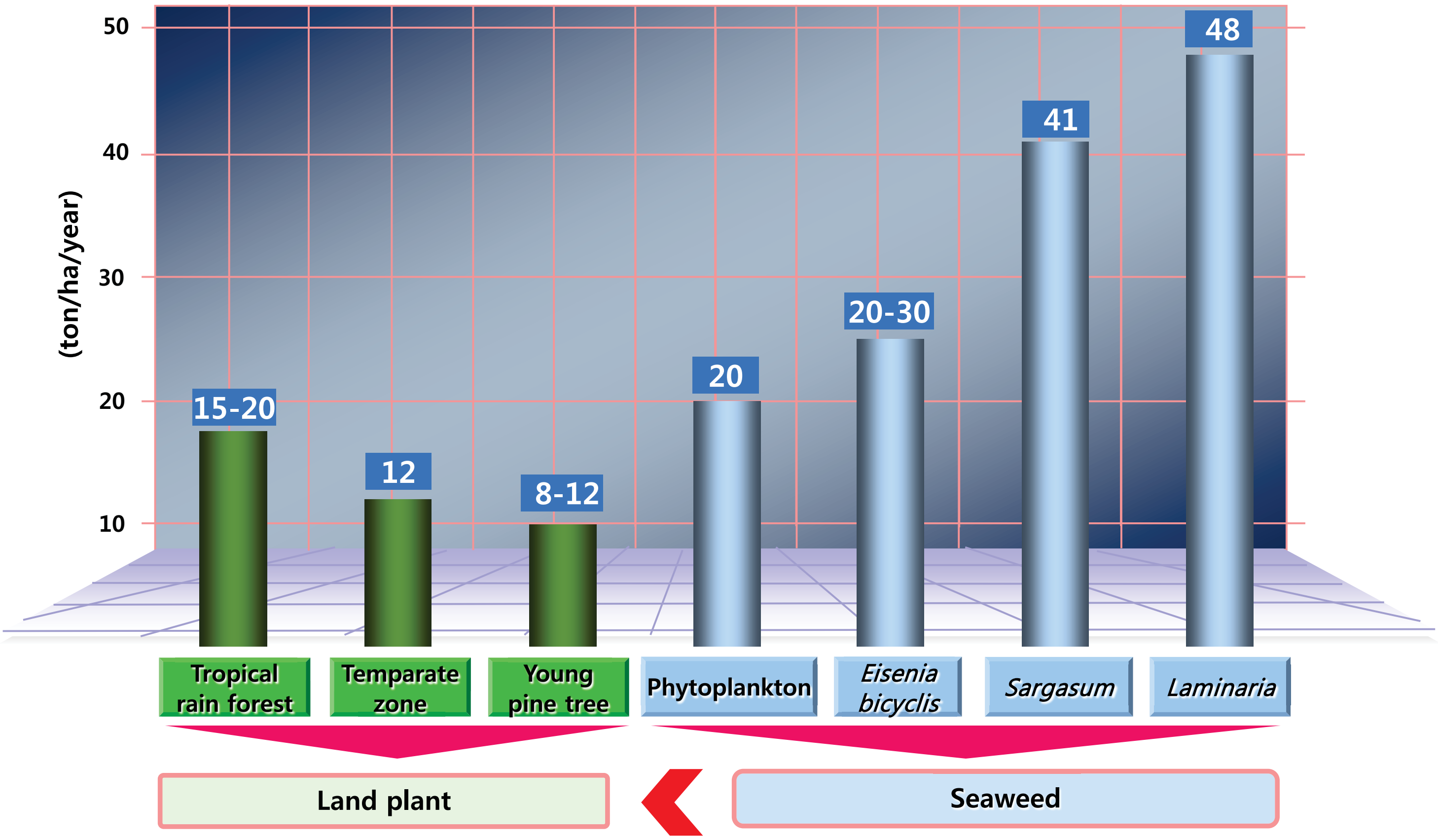

Remains after Agar Extract

- **An Agar company in Morocco**




Rate of CO_2 Absorption

PEGASUS International

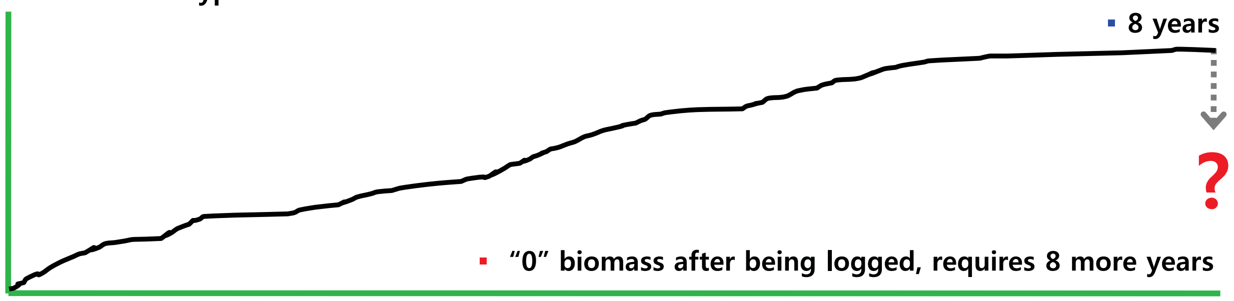


- Source : Dr. Taniguchi (1998), Japan

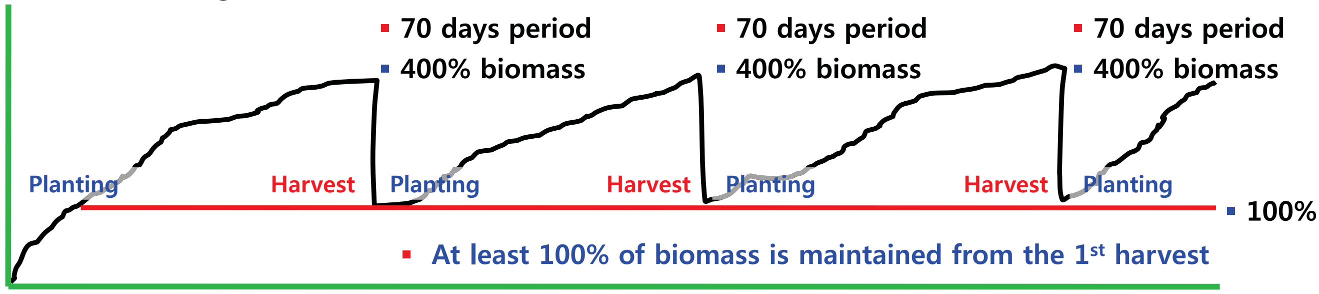
Concept for a Red Algal CO_2 Sink

PEGASUS International

- CO_2 sink must be durable & sustainable
  - Reforestation on land vs. Cultivation of Red Algae on sea
  - A case of Eucalyptus Reforestation



  - A case of Red Algae cultivation

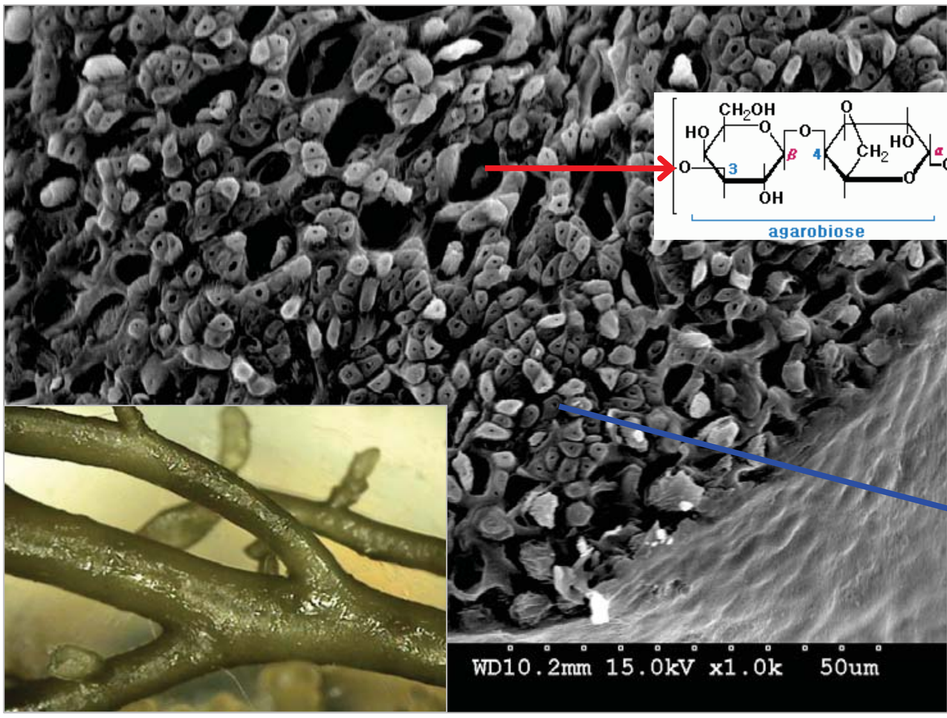


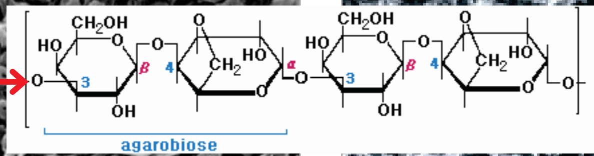
- A fixed amount of biomass could be maintained in a certain farm size; therefore, the farm was suitable as a CO_2 sink for CDM business

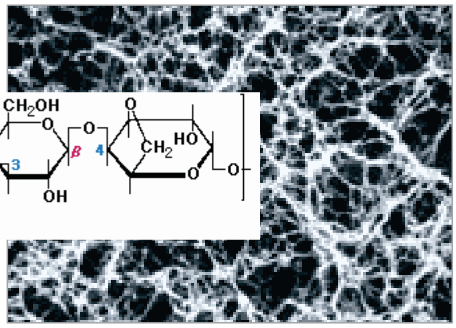
Bio-energy from Red Algae

PEGASUS International

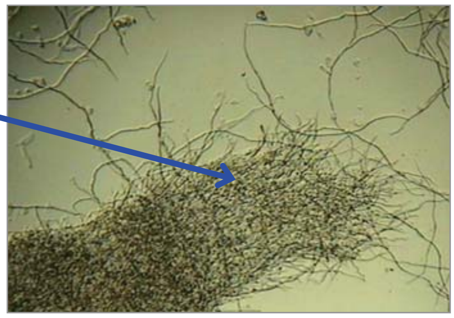
- Red Algae can make Polysaccharide (Galactan), which is similar to “Starch”







- Agar-agar



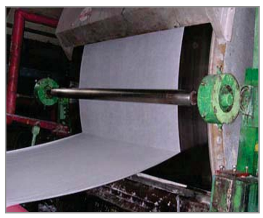
- Branch of *Gelidium*
- SEM micrograph of endofiber region
- Endofiber (300X)

Bio-ethanol from Red Algae

PEGASUS International

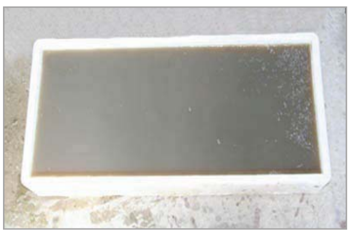
- Agar is a By-product of Pulping process, “Free of Charge” for Red Algae Pulp Makers

Red Algae → Agar Extraction → 1st Bleaching → 2nd Bleaching → Papermaking



Extracted Agar → Fermentation → Distillation → Bio-ethanol

Saccharification



Build New

- **Head Office, Institute and Pilot Plant**




UNFCCC-COP16

UNFCCC

COP16
CMP6 México2010
United Nations Climate Change Conference

Cancun, Mexico

29 November to 10 December 2010

Contribution to the prevention of Global Warming by saving forests while producing pulp and paper without cutting down trees.