홍조류 바다식물로 만드는 펄프와 종이, 바이오에탄올

Pulp & Paper, Bio-ethanol Made from Red Algae

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Pegasus International, Inc.

The New Era of Pulp & Paper

World First Invention

- Invented in Korea, Patent Applied for 44 Countries, Obtained for 39 Countries

특 허 증

CERTIFICATE OF PATENT

특 허 제 0512793 호

(PATENT NUMBER)

출원번호 제 2004-0092297 호

출 원 일 2004년 11월 12일

등 록 일 2005년 09월 01일

발명의명칭 (TITLE OF THE INVENTION)

홍조류로 제조된 펄프와 종이 및 그 제조 방법

특 허 협 력 조 약

(PATENT COOPERATION TREATY)

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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

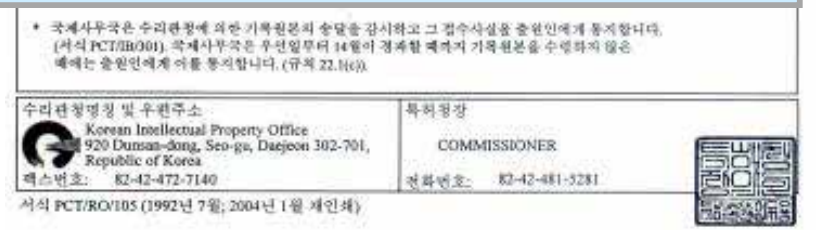
- Obtained Patent, 39 Countries (Sept.2009)

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

(Patent Applications Outstanding for other 5 Countries)

특 허 청

COMMISSIONER, THE KOREAN INTELLECTUAL PROPERTY OFFICE



* 국제사무국은 우리관청에 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

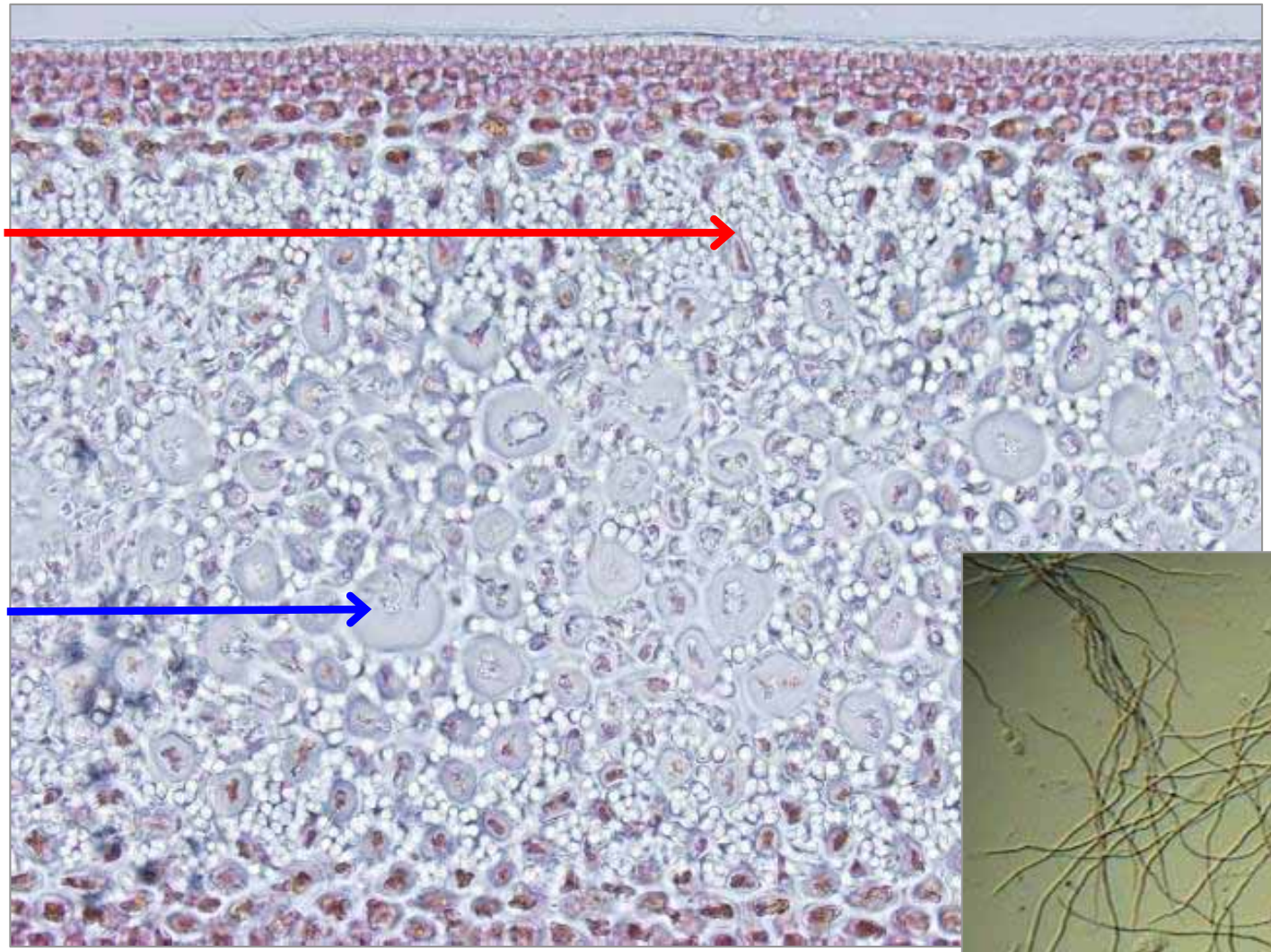
전화번호: 82-42-481-5281

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

Structure of Red Algae

- Endofibers for Pulp and the polysaccharide for Bio-energy

- Endofiber
- Tubular cell

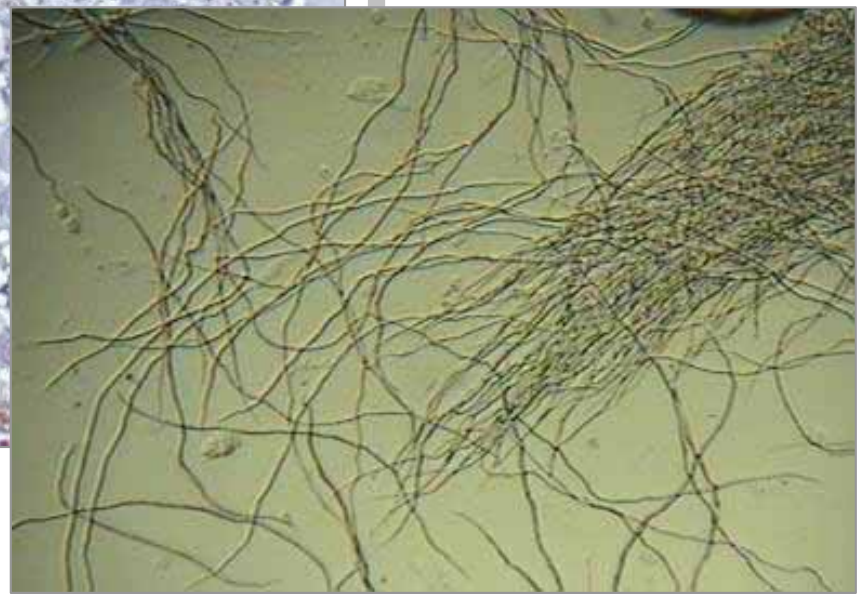


Epicortex

Endothelial layer

Medullary layer

- Endofiber (300X)



Gelidium amansii

Advantages of Marine Plants

PEGASUS International

Properties	Land Plants (Air)	Marine Plants (Water)
Habitat	▪ Soil, but stem and leaves are exposed in 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 sustain by buoyancy ▪ Demands small amount of energy for sustain
Temperature	▪ Air temperature change greatly varies seasonally and day and night ▪ Epidermal cell (bark) is advanced to adopt 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 a role of providing 'anchor' in substrate
Nourishment	▪ Root is the only channel to suck up water from the earth ▪ Source of water and nutrient is 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 adopt 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

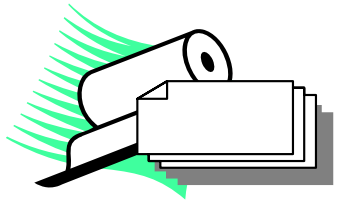
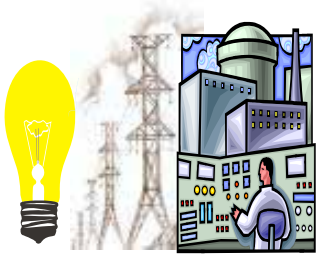
- Red Algae has higher Commercial Value than Green Algae or Brown Algae

Division	Species	Condition	Dry or Wet Weight (per 100g)			
			Moisture	Carbohydrate		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

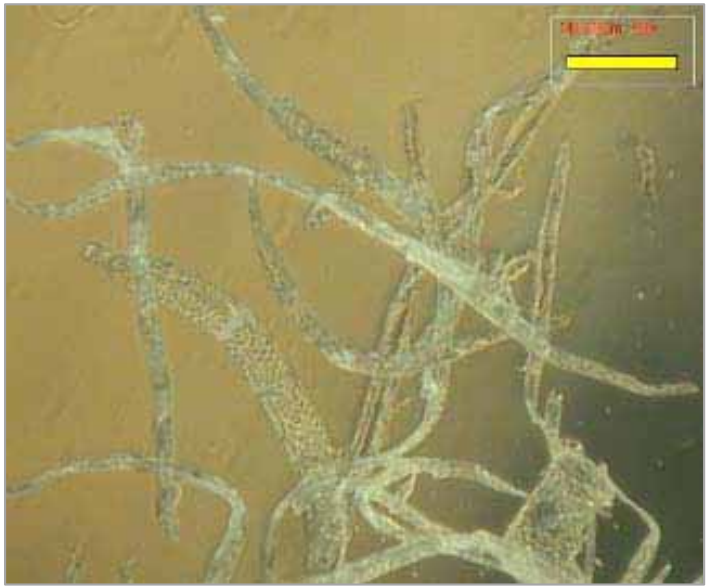
Applications of Red Algae

PEGASUS International

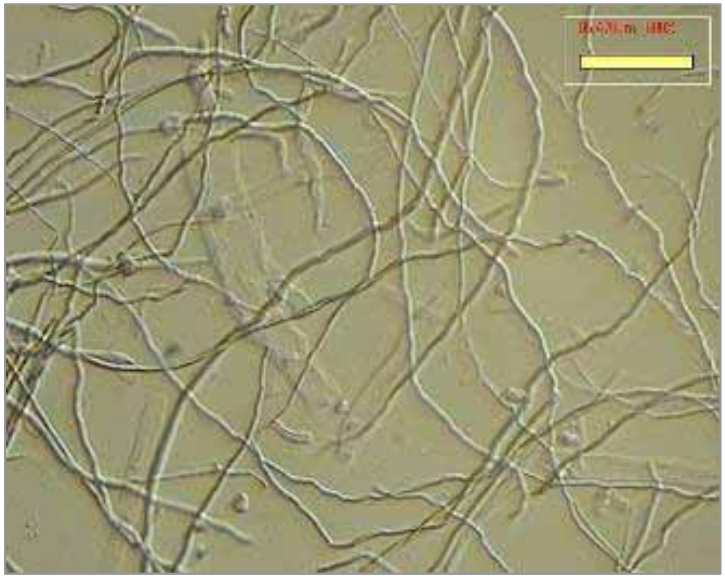
Classification	Field of Application	Remarks
	Food and Cosmetics	▪ It is currently used as a source of food (agar), cosmetics, medical supplies ▪ Red algae can be cultivated, Daily growth rate is about 3-13% ▪ CO_2 absorption level per unit area is higher than that of forest ▪ It is relatively easy to develop hybrid plants by cross breeding
	Pulp and Paper	▪ Pulp can be produced 100% from just marine plant than tree ▪ 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 corns ▪ When producing pulp with red algae, agar is produced as by-product, which means “free raw materials” ▪ By building a pulp plant geographically in proximity with red algae farm, red algae can serve as a energy source
	Biocomposite Material	▪ Can substitute 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 to 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

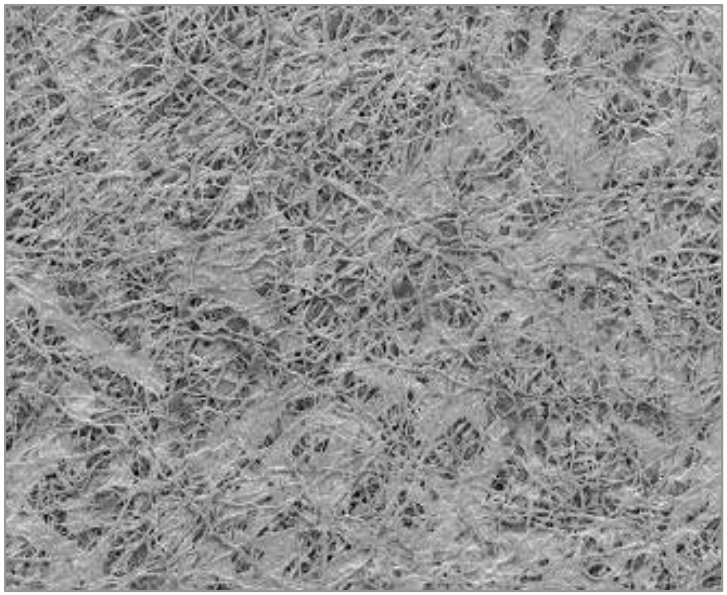
- High quality Pulp and Paper made from Red Algae's Endofiber



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

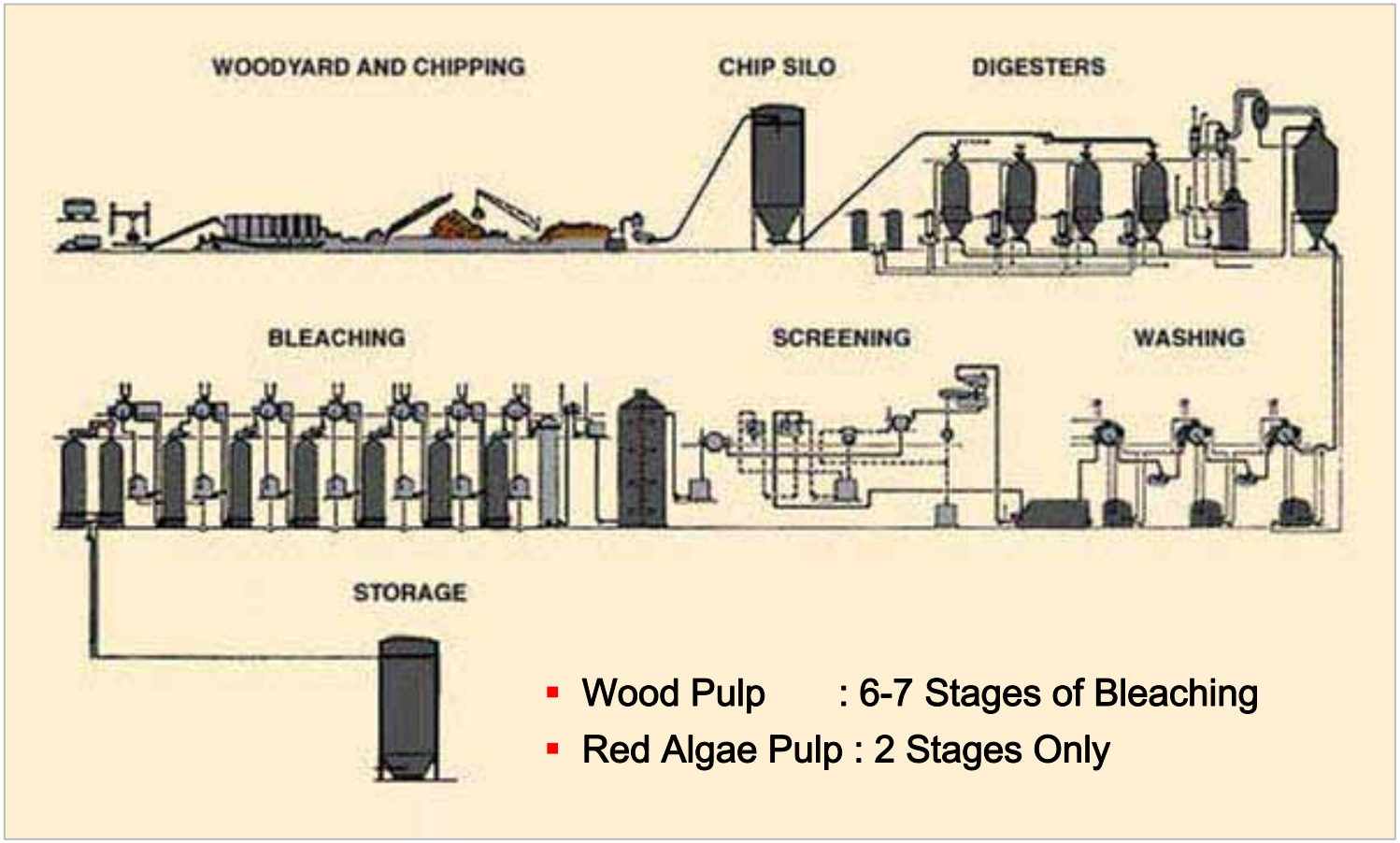


Wood Paper	Red Algae Paper
Coarse	Smooth
Requires Filler	High Opacity



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

- Bleaching Method and Process

Agar Extraction → 1st Bleaching → 2nd Bleaching

Extraction First

Cleaning

By ClO_2

By H_2O_2

Ozone First

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

Pulp and Paper Production

- Pulp production facility in “Tae-Ryong Agar Company” factory in Mil-Yang city

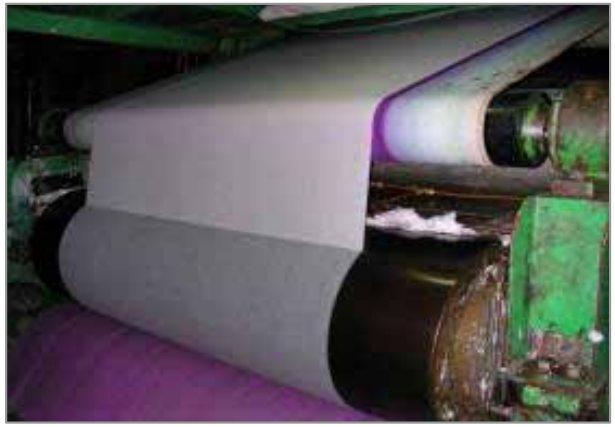
Agar Extractor →

Pulp Bleacher →

Pulp Thickener

- Paper production facility in “Cheon-Yang Paper” factory in Wan-San county

Paper Mill →



Wet Press →

Dryer

Species in *Gelidium* family

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

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

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

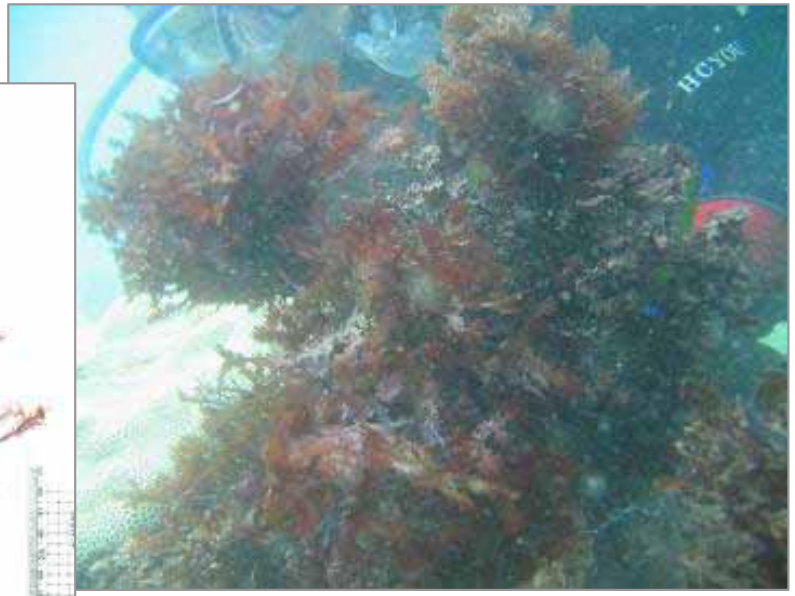
- *Gelidium robustum*
- Genus *Gelidium*
- Length : over 50cm

- *Gelidium robustum* from Mexico

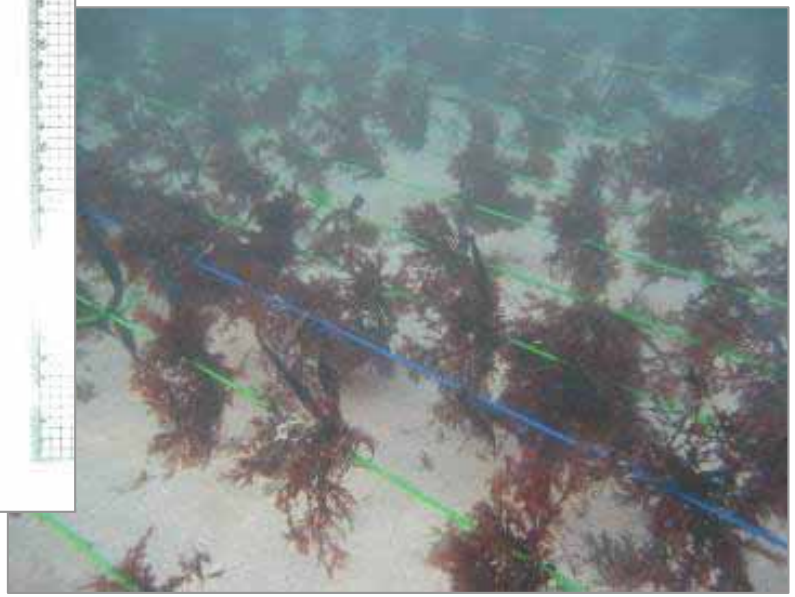
Large Scale Cultivation

- Cultivation in Indonesia Since 2006

- *Ptilophora sp.*



- Family *Gelidiaceae*



Gelidium Cultivation

PEGASUS International

- Aquaculture of *Gelidium*
  - FAO report, 1987
  - Maximum daily growth rate = 6.5%, double fold growth in 30 days
  - Images below shows 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

PEGASUS International

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

- *Gelidium amansii* (Korea)

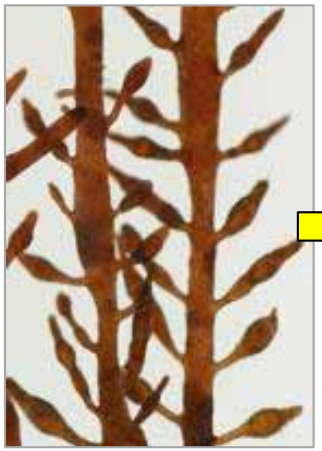
- Well-adapted, Growing 4-Times in 70-Days (average)
- Manado, North Sulawesi

- Trial pilot farm (Indonesia)

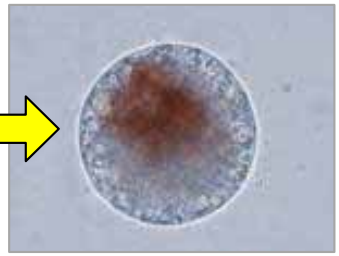
- 70-Days After Seedling

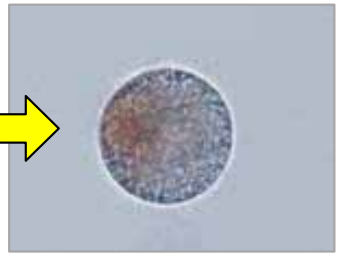
Crossbreeding for New strain

- Research for New Strain which can grow Larger and Faster by Cross-breeding
  - Korea have a good inventory for seaweed molecular-biology techniques
  - New strains grow larger and faster, Contain more useful compounds

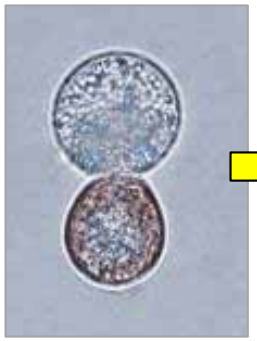


- Gametophytes (male & female)

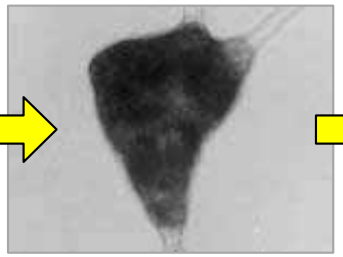




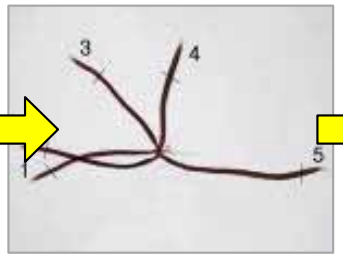
- Gametes



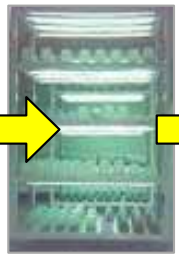
- Fusion of gametes



- Hybrid cell formation



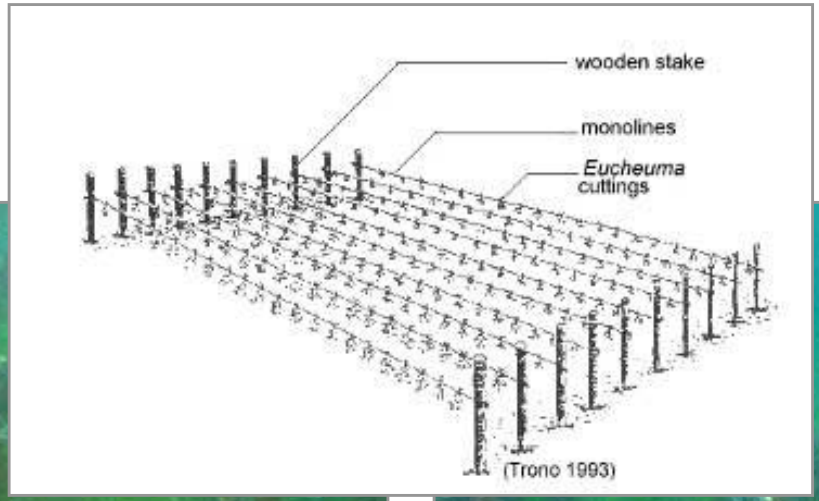
- Multi-polar organism

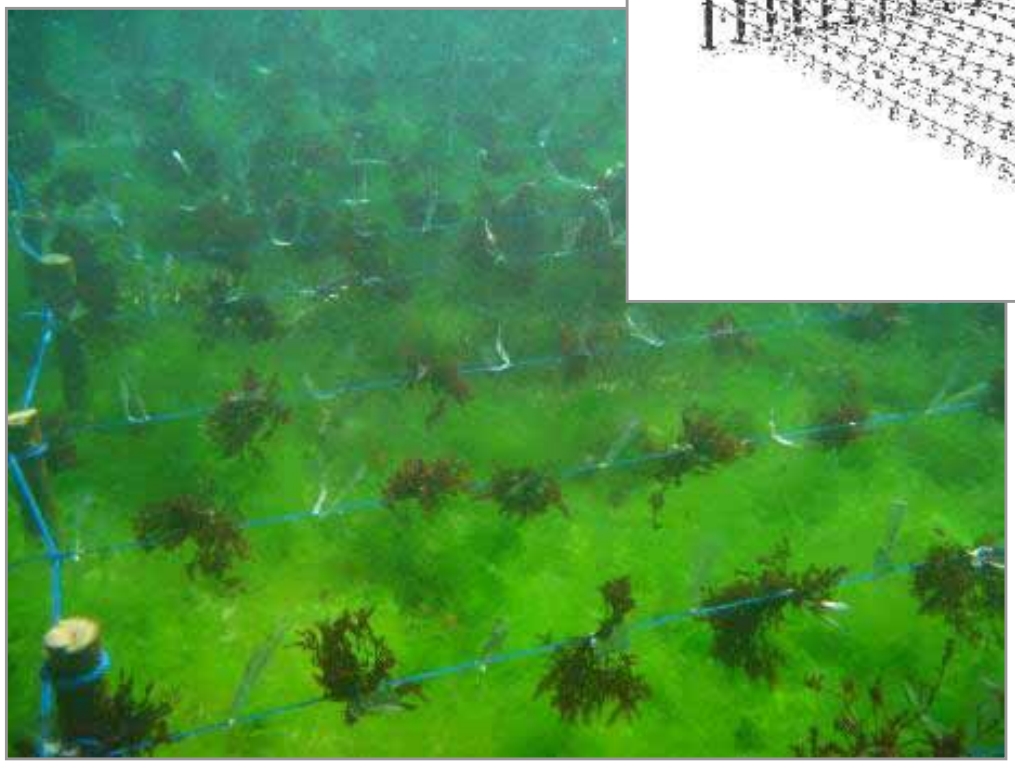


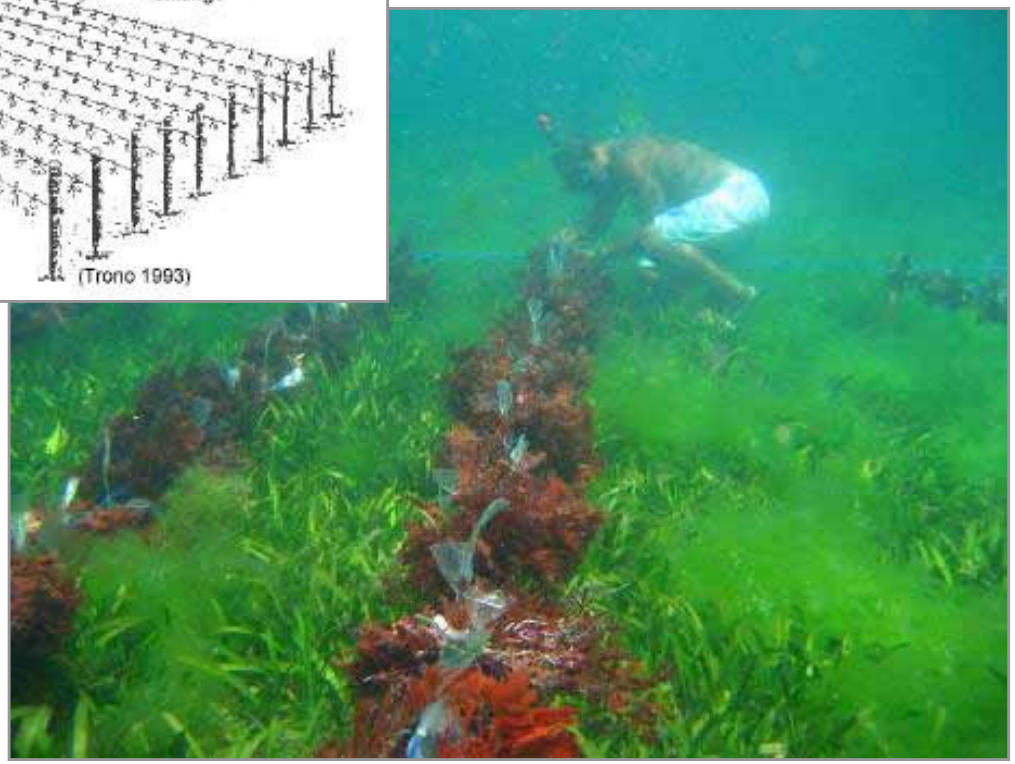
- Cultivation of isolated multi-polar organisms
- Genomic information of new strains

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

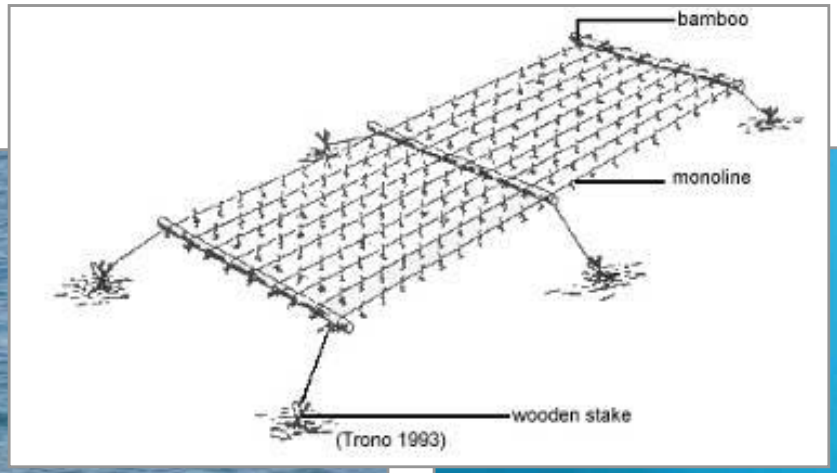


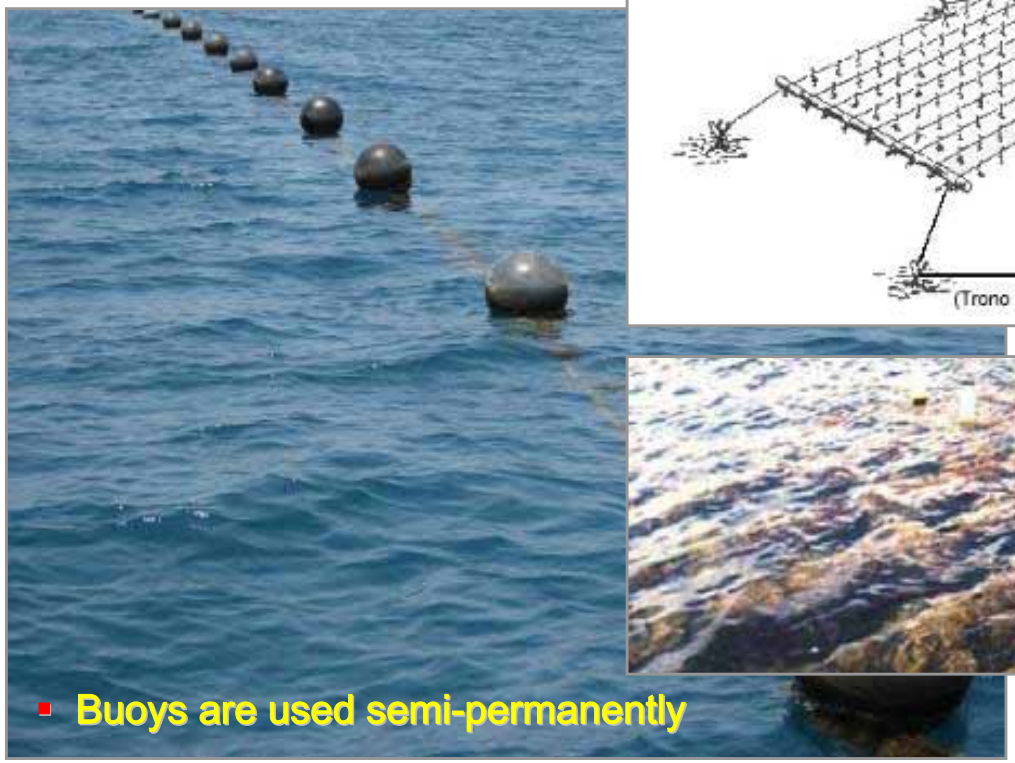


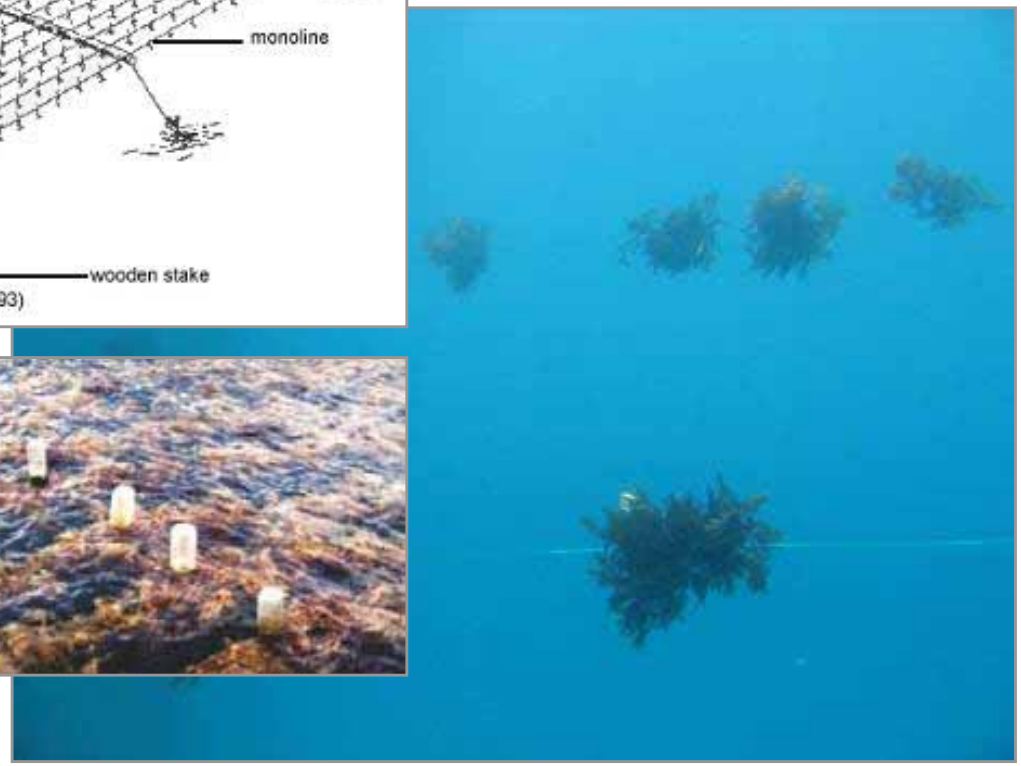


Cultivation Method #2

- Floating Line Type
  - For large-scale cultivation at more than 3m depth
  - The water depth does not matter if ropes can be fixated
  - 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







- Buoys are used semi-permanently