Historical Review and Future Perspectives of Aquaculture Industry in Korea

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Introduction

- Marine aquaculture has shown a continuous expansion and reached over 30% of the total fisheries production in Korea
- The extractive cultures with seaweeds and shellfish have been major species of aquaculture industry and showed decreasing trends since 1990s for seaweeds and 1980s for shellfish
- Recently the intensive fed cultures were introduced in 1980s and grew at a rapid rate

Catches by shallow-sea cultures

In metric ton

Year	Total	Fishes	Crustacean	Shell fishes	Other animals	Seaweeds
1991	775,419	3,905	511	308,409	16,968	445,625
1992	935,478	4,595	592	338,602	11,726	579,963
1993	1,038,119	5,471	291	345,696	22,343	664,318
1994	1,072,126	6,643	575	264,135	50,576	750,197
1995	996,451	8,360	438	312,252	26,302	649,099
1996	874,810	11,402	382	306,738	17,298	538,990
1997	1,015,134	39,121	1,537	301,873	24,760	647,843
1998	777,230	37,323	846	239,754	29,538	469,769
1999	765,252	33,453	1,180	221,031	35,916	473,672
2000	653,373	25,986	1,158	222,608	29,165	374,456
2001	655,827	29,297	2,081	217,078	33,833	373,538

Percentage (%) of catches by shallow-sea cultures

Year	Fishes	Crustacean	Shell fishes	Other animals	Seaweeds
1991	0.5	0.1	39.8	2.2	57.5
1992	0.5	0.1	36.2	1.3	61.9
1993	0.5	0.1	33.3	2.2	64.0
1994	0.6	0.1	24.6	4.7	70.0
1995	0.8	0.1	31.3	2.6	65.1
1996	1.3	0.1	35.1	2.0	61.6
1997	3.9	0.2	29.7	2.4	63.8
1998	4.8	0.1	30.8	3.8	60.4
1999	4.4	0.2	28.9	4.7	61.9
2000	4.0	0.2	34.1	4.5	57.3
2001	4.5	0.3	33.1	5.2	57.0

Production of cultured marine organisms in 2001 in Korea

Production	Quantity (M/T)	(%)	Value (US $)	(%)
Fishes	29,297	4.5	244,594,748	40.9
Crustacean	2,081	0.3	27,357,394	4.6
Shells	217,078	33.1	153,846,310	25.7
Other aquatic animals	33,833	5.2	34,211,555	5.7
Seaweeds	373,538	57.0	137,625,416	23.0
Total	655,827	100.0	597,635,423	100.0

- Aquaculture of finfish has become a well-established industry in Korea during the last two decades

- The present output from fish farming is 29,297 metric tons with an economic value of 294 billion won (approximately US$ 245 million)

- This accounts for 4.5 % by weight and for 40.9% by value of the total aquaculture production (MOMAF, 2002)

- Aquaculture of seaweed has become a well-established industry in Korea during the last two decades

- The present output from seaweed culture is 373,538 metric tons with an economic value of 165 billion won (approximately US$ 138 million)

This accounts for 57.0% by weight and for 23.0% by value of the total aquaculture production (MOMAF, 2002)

- **Although we had a solid foundation of aquaculture in terms of the quality of farms, the level of production skill and the cultural aspects, there are several problems in finfish, shellfish, and seaweeds production**
- **In addition, coastal waters are stressed by self-pollution of aquaculture**
- **With rapid decline of the condition of culture ground, the sustainable development of aquaculture has been main object**
- **With the administrative legal supports for polyculture, the practical codes of conduct are required to satisfy the environmental concerns**

- In Japan, the "Law to Ensure Sustainable Aquaculture Production" was established to promote the improvement of aquaculture grounds by the Fishermen's Cooperative Associations, which supervise farmers in each local farm, and to prevent spread of contagious disease of cultured organisms
- To promote improvements of the environmental quality in the vicinity of aquaculture activities, the Laws including environmental criteria and indicators has been established (Yokoyama, 2003)

- Intensive culture system, however, generates large amounts of organic wastes, which are released to the immediate environment around the fish farm, which often results in adverse environmental changes such as deoxygenation (Hirata et al., 1994), outgassing of hydrogen sulfide (Tsutsumi, 1995) and harmful algal blooms (Nishimura, 1982), leading to negative consequences for both farm management and the environment
- Therefore, we need to clarify the criteria and critical thresholds for fish farm environments that allow sustainable aquaculture (Yokoyama, 2000)

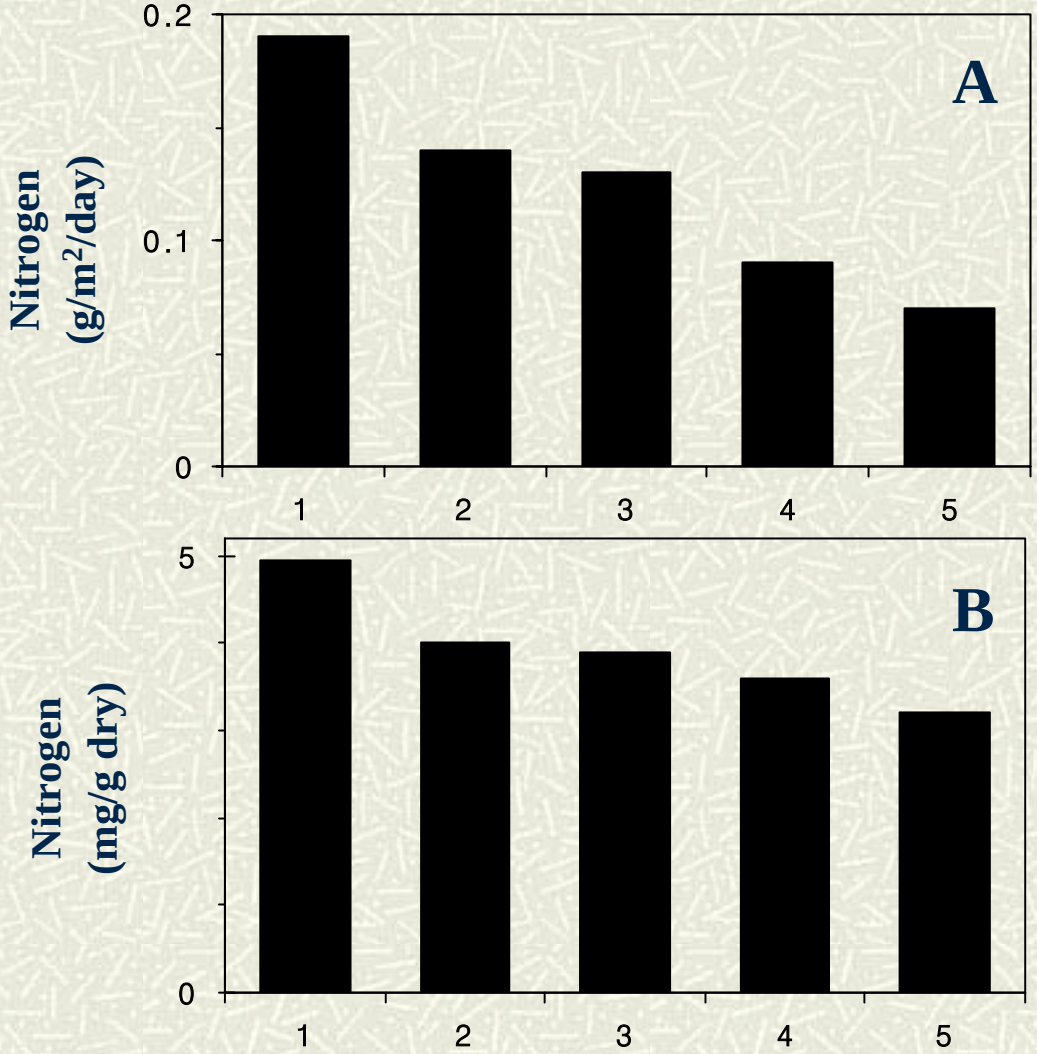


Fig. Environmental parameters in a fish farm in Gokasho Bay, Japan.

(A) Nitrogen content in sinking particles collected from the water column of 0 to approximately 15m depth; (B) nitrogen content in the sediment

Table. Annual fisheries damage by the HABs

Year	Damaged Organisms	The amount of damage
1995	flounder, rock fish, yellowtail, abalone, ascidian, oyster	$ 58.7 million
1996	flounder, rock fish, yellowtail	$ 1.6 million
1997	flounder, filefish	$ 1.2 million
1998	rock fish, yellowtail, parrot fish	$ 0.1 million
1999	yellowtail, rock fish, red sea bream, gopher, etc.	$ 0.2 million
2000	yellowtail, rock fish, etc.	$ 0.2 million

Porphyra cultivation in Korea

- Korean has been cultivating seaweeds especially *Porphyra* species for a long time
- *Porphyra* cultivar species in Korea : *P. dentata, P. kuniedae, P. pseudolinearis, P. seriata, P. tenera,* and *P. yezoensis* including a hybrid by crossing between two dioecious species, *P. pseudolinearis* and *P. dentata* as a new cultivar
- The production of *Porphyra* from culture grounds is estimated to be 168,000 tons (wet wt.) in 2001

- **Now a good quality of *Porphyra* products is strongly demanded and consequently provides higher prices for the product**
- **Marine finfish cultivation has been rapidly developed and it makes serious self pollution in culture grounds and now newly recognize on that the polyculture with seaweed will be one of the environmentally friendly cultivation method for the future**

In response to the problem, a joint project was established between Ministry of Maritime Affairs & Fisheries of Korea(MOMAF) and National Oceanic & Atmospheric Administration of USA(NOAA)

- **The cooperative researches on the integration of the seaweed aquaculture with the fed aquaculture have been initiated with USA by MOMAF and with China by Ministry of Science and Technology**
- **The international cooperation will play an important role in fisheries management as well as the integrated coastal zone management**

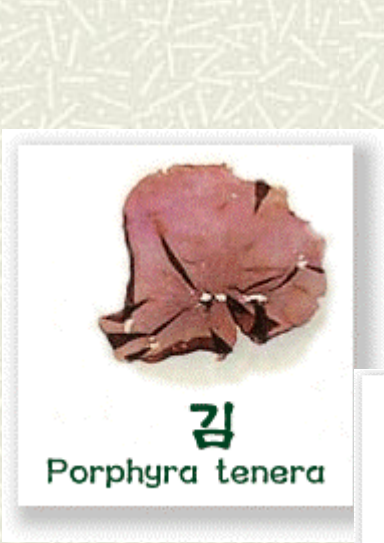
Acts for fishery license & fishing ground management

Revision 1994. 7. 28. Ministry of Agriculture, Forestry and Fisheries – No. 1148

Revision 1995. 12. 30. Ministry of Agriculture, Forestry and Fisheries – No. 1219

Revision 1997. 3. 24. Ministry of Maritime Affairs and Fisheries – No. 15

1. Seaweed culture industry
2. Shellfish culture industry
3. Fish culture industry
4. Polyculture industry
5. Cooperation aquaculture



: Seaweed culture, Shellfish culture, Fish culture, Polyculture

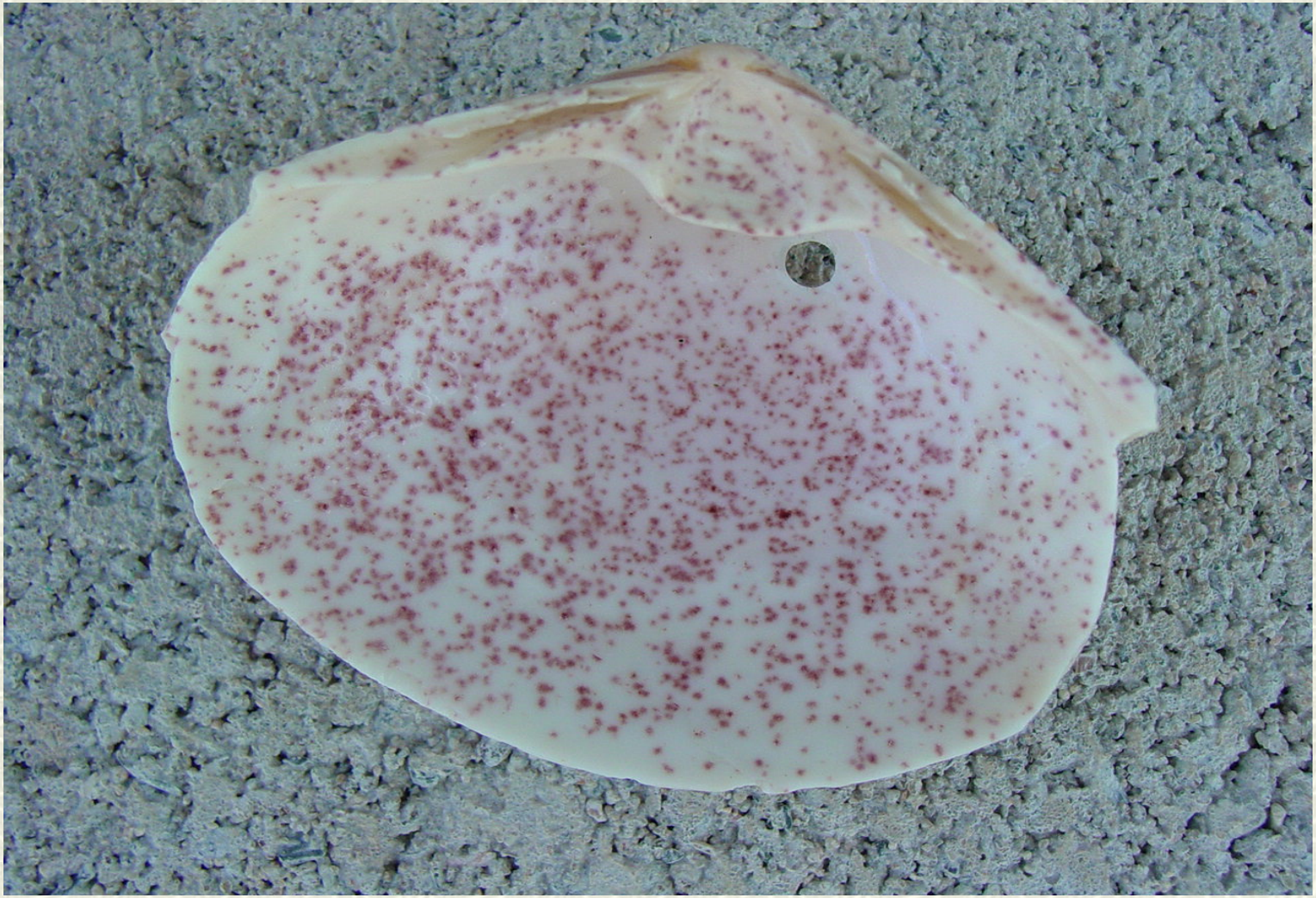
Polyculture

Culture species

Culture Methods	
Hanging culture	*Undaria*-*Laminaria*, *Undaria*-*Hizikia*, *Laminaria*-*Hizikia*, *Undaria*-*Laminaria*-*Hizikia*, *Undaria*-Sea squirt, *Laminaria*-Sea squirt, *Laminaria*-Abalone, *Hizikia*-Abalone, *Undaria*-Abalone, *Undaria*-Scallop, *Porphyra*-Scallop
Bottom culture	Sea cucumber-Sea urchin, Oyster-Short neck clam
Mixed culture	*Porphyra*-Short neck clam, *Porphyra*-Surf clam, *Porphyra*-Hen cockle, *Hizikia*-Abalone, *Laminaria*-Abalone, *Undaria*-Abalone

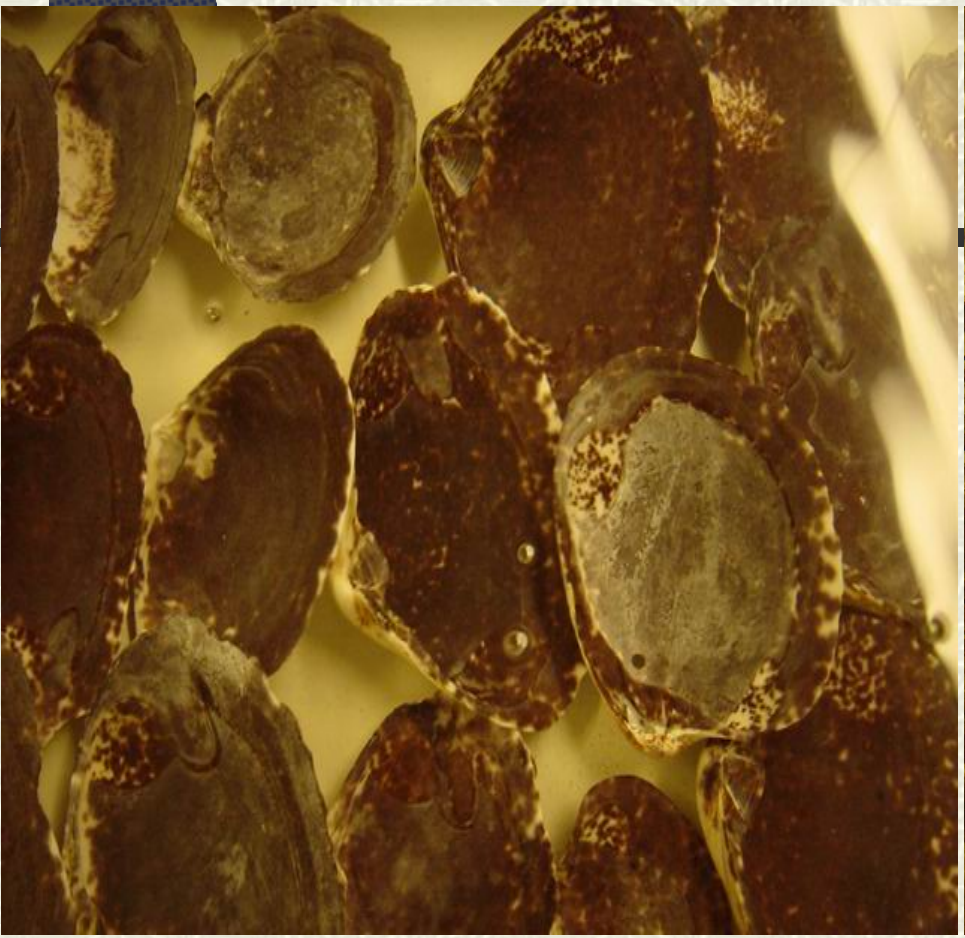
Growth and development of conchocelis were monitored every day in BRVAS and UCONN lab.

The shell conchocelis cultivation was carried out on two species, CT-23-1 (*Porphyra leucosticta*) and ME-7-6 (*Porphyra amplissima*) which had been seeding with free-living conchocelis.



To our knowledge, the strain ME-7-6 was first attempt for shell culture however it was not successful due to rack of the information on this strain culture technique and natural habitat

Culture tanks were designed about 300L in seawater capacity with cooling water recycling system for temperature control

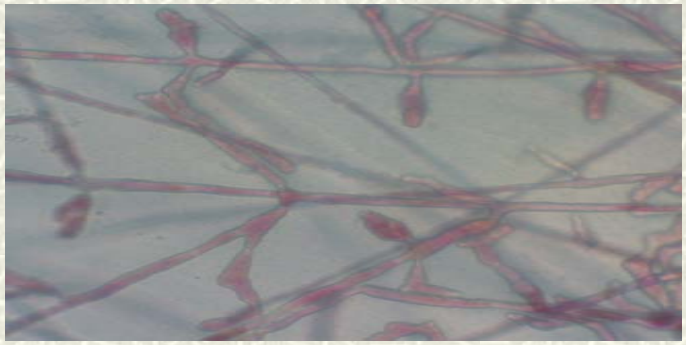


The cultivation was progressed according to basically method of shell culture such as controlling temperature, light intensity, photoperiod and water quality etc.

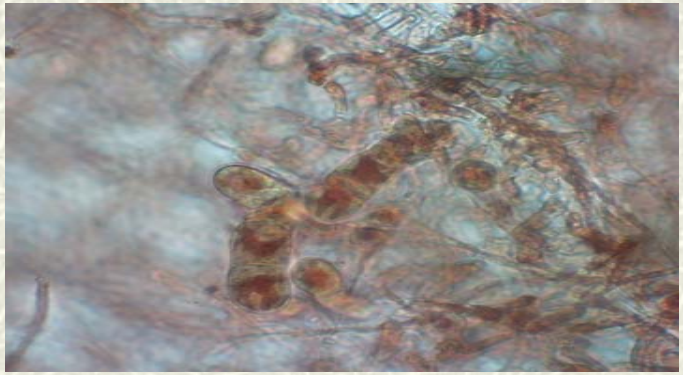
Summarized table for conchocelis indoor culture

	Factors	ME	CT
Conchocelis Growth	Temperature	10-12℃	10-15℃
	Illumination	1,000-1,500 lux to 1,500-3,000 lux	
	Photoperiod	14L:10D (6 week) and 12L:12D (2-4 weeks)	
	Nutrient	N: 7 ppm, P: 1 ppm	
	Seawater change	Every 3-4 weeks	
Conchocelis Sporangium Formation	Temperature	5-10℃ to 10-15℃	15℃ to 20℃
	Illumination	1,000-3,000 lux to 700-1,000 lux	
	Photoperiod	14L:10D to 10L:14D	
	Nutrient	N: 5 ppm, P: 5 ppm – keeping 4-6 weeks	
	Seawater change	Every 3-4 weeks	

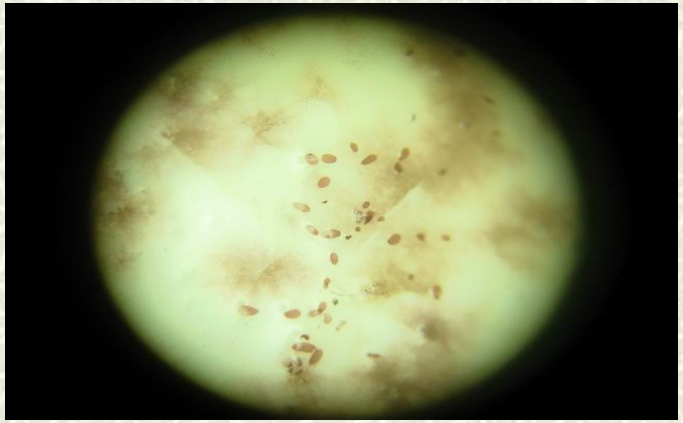
Culture of conchocelis filaments in shells were processed mainly three steps



1.Shell culture for conchocelis growth



2. Shell culture for conchosporangial formation



3. Conchospore maturation and the seeding method were designed two ways such as conchospore attaching on net and free-living

Conclusion

- The ecophysiological and biotechnological studies of cultivars species, development and productivity studies of coastal ecosystems, studies of food organism and artificial feeds should be conducted for the development of aquaculture industry and the socio-economical viability and the environmental impacts also should be considered to get its sustainability

- An overview of these new maricultures technologies that have lead to the successful expansion of the seaweed industry in Korea will be presented.

Contributions of seaweed cultivation technique

* Reconstruction of seaweed bed
* Environmentally friendly aquaculture system…Polyculture