

Abalone Mariculture

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Presentation Outline

- I. Introduction**
 - A. What is an abalone?**
 - B. Abalone species in the world**
 - C. World market, supply and demand**

- II. Hatchery seed production**
 - A. Broodstock management**
 - B. Spawning, egg collection and larval rearing**
 - C. Primary and secondary nursery rearing**

- III. Grow-out culture**
 - A. Site selection**
 - B. Land and sea-based culture methods**
 - C. Modular system of cage culture**

- IV. Constraints and prospects in abalone farming**

What is an abalone?

- Herbivorous marine gastropod of the genus *Haliotis* which means "sea ear"



- Flattened, ovoid or ear-shaped shell
- No operculum
- Shell perforated with holes over gills
- Large muscular foot



Habitat of abalone



- Rocky and coral reefs
- Well-oxygenated sea water (good water movement)
- Stable salinity (no freshwater run-off, far from rivers)

Distribution of abalone

- Rocky and coral reefs of many islands in the Atlantic, Pacific & Indian Oceans
- Australia, Japan and western North America have the greatest number of species and densities
- 100 species of *Haliotis* around the world, with more than 20 species considered commercially important



Haliotis rufescens



Haliotis iris



Haliotis midae



Haliotis gigantea



Haliotis sieboldii



Haliotis discus



Haliotis discus hannai

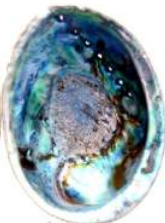


Distribution of abalone

- Larger species generally are found in temperate zones; smaller species in the tropics



Haliotis iris



H. asinina



H. diversicolor supertexta



H. varia



H. glabra



H. ovina





Product Forms & Dishes



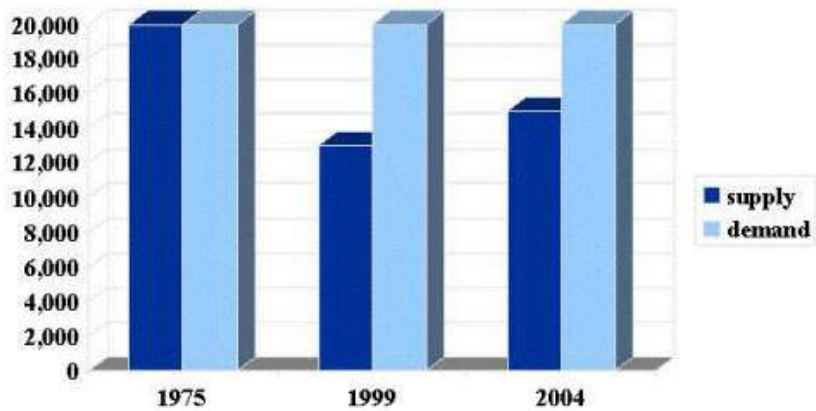
Product Form	Market	Dishes	Customers
Live	Japan, US, HK	Sushi, sashimi, grilled, steamed	Hotels, resorts, restaurants
Fillet (fresh/frozen)	US, France	Traditional US restaurant cuisine (steak)	Restaurants, seafood distributors
Dried	Japan, China	Traditional Chinese cuisine	Restaurants, Inst'l food service Supermarkets
Canned	China, HK, SE Asia		Restaurants, Inst'l food service Supermarkets

Source: Oakes & Ponte, 1996; *Aquaculture* 140: 187-195



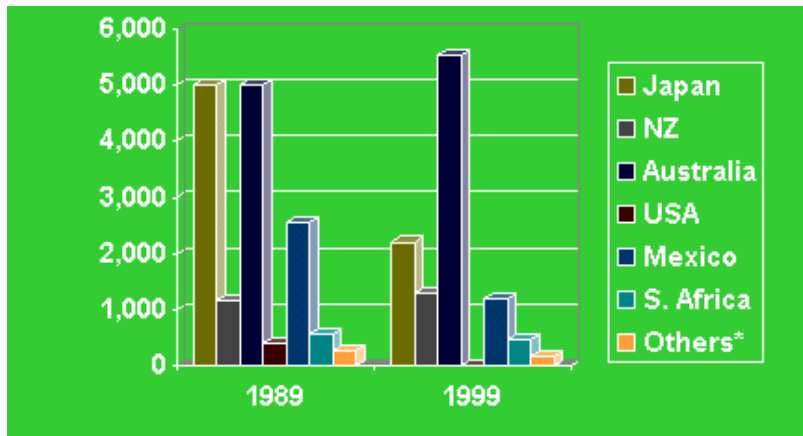
Source: Gordon & Cook, 2001. *J. Shellfish Res.* 20: 567-570

World Abalone Supply and Demand



Source: Gordon & Cook, 2001. J. Shellfish Res. 20: 567-570

Wild Abalone (mt)



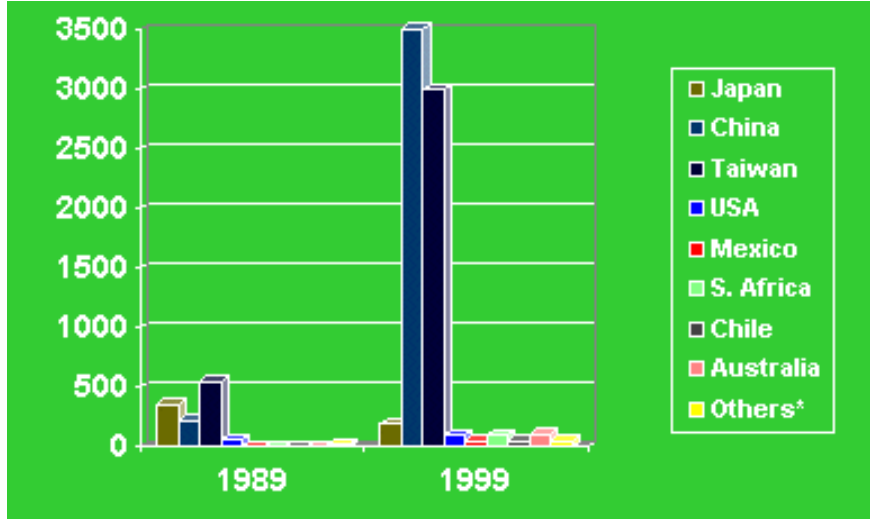
Source: Gordon & Cook, 2001. J. Shellfish Res. 20: 567-570

High market demand

Overexploitation

Depletion

Cultured Abalone (mt)



Source: Gordon & Cook, 2001. J. Shellfish Res. 20: 567-570

The Tropical Abalone *Haliotis asinina*



- Distribution: South Japan to New South Wales, Andaman to New Caledonia. Intertidal to 8m deep, in coral areas.
- Resource status: declining
- Research on culture technology development in SEAFDEC AQD (Philippines), Dept. of Fisheries (Thailand), Chulalongkorn University (Thailand)
- Culture status: Developing

Shell, viscera and meat percentage by species

Species	<i>H. corrugata</i>	<i>H. fulgens</i>	<i>H. diversicolor super texta</i>	<i>H. discus</i>	<i>H. asinina</i>
Shell weight	47%	38%	33%	29%	8%
Visceral Organ weight	18%	22%	21%	23%	8%
Foot muscle weight	35%	40%	46%	48%	84%

<http://www.phuketabalone.com/farm-tropical.html>

H. discus



H. asinina



Tropical abalone product forms



Whole with shell frozen vacuum pack

Whole abalone in the shell, snap frozen in 200 gram clear plastic vacuum packages. Perfect for fresh Sushi



Fillet Vacuum Pak

Cleaned, filleted and snap frozen in 200 gram clear plastic vacuum packages.



Fresh Abalone Meat Canned

Canned Filleted fresh abalone meat cleaned in salt water.
Drained Weight: 160g
Net Weight: 425g

<http://www.absoluteseafoods.com/abalones.html> (Absolute Seafoods, Bali, Indonesia)

Tropical Abalone Exports from the Philippines

Countries of destination:

1. Hong Kong
2. Japan
3. Korea
4. Taiwan
5. Singapore
6. Australia
7. China
8. USA
9. Spain
10. Netherlands
11. Canada
12. Thailand

Prices & Market Demand

Live: US\$5-6/kg

Shucked & blanched:

Buying price: US\$8/kg

Selling price: US\$10/kg

Canned: US\$12/can (223g)

Supply and demand gap: 40%

Source: Foreign Trade Statistics of the Phil. 1990-2000

Overview of Tropical Abalone Seed Production & Grow-out Culture

Broodstock Management

Conditioning of wild broodstock (1-2 months)



Spawning

Egg Collection & Larval Rearing



Larval stocking and settlement

Primary Nursery Rearing (2-3 months)



Secondary Nursery Rearing (1-2 months)



Grow-out Culture (9-10 months)

Seed Production Techniques



Broodstock management



Egg collection



Larval rearing



Larval settlement



Primary nursery rearing



Secondary nursery rearing

Seed Production Techniques

Diet-tagging & Secondary Nursery Rearing

- Artificial diet feeding for 3-4 weeks to produce a bluish-green shell band, followed by seaweed feeding



1-cm juveniles before feeding with artificial diet



Juveniles with bluish-green shell band after feeding with artificial diet followed by seaweed feeding



Diet-tagged abalone (top) 6 mos. after release

Gallardo et al., 2003. Aquaculture Research 34, 839-842

Seed Production Techniques

- Seaweed or artificial diet feeding



For tank or cage culture

For sea ranching or stock enhancement

- Open cages in indoor concrete tanks
- Flow-thru w/ aeration
- Continuous feeding with *Gracilaria*



Summary of Seed Production Process

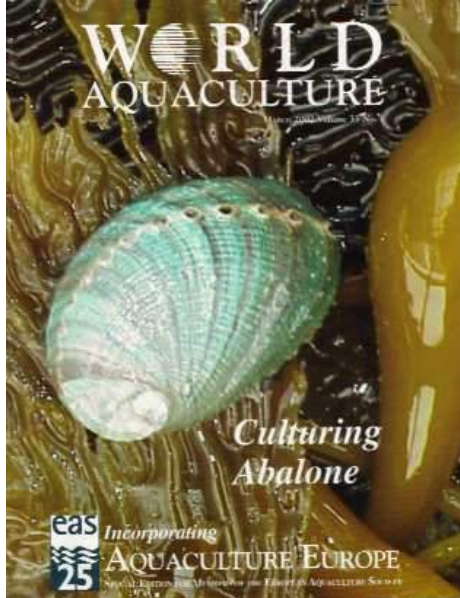
Primary nursery rearing

- Day 1-4: Static water with mild aeration
- Day 5-7: Start flow-thru
- Day 8-90: Outdoor tank; diatom-feeding

Secondary nursery rearing

- Day 60-90: Harvest juveniles > 1 cm
- Day 60-120 or 90-150: Seaweed or artificial diet feeding in trays in indoor tanks

GROW-OUT CULTURE



Land-based:

- Tanks
- Trays in tanks
- Cages in tanks

Sea-based:

- Plastic barrels & trays
- Cages
- Sea ranching

Site Selection

Land and Sea-based Culture

- Far from rivers or freshwater sources
- Clean, clear, high salinity (32-35ppt) seawater
- Rocky or sandy bottom (not muddy)
- Availability of the seaweed *Gracilaria*

Sea-based culture

- Good water circulation
- Protection from typhoons and poaching
- Water depth: at least 2 m at low tide (for floating net cage culture)

GROW-OUT CULTURE – Tank-based



Open cages in indoor tanks

SEAFDEC AQD, Iloilo, Philippines

GROW-OUT CULTURE – Tank-based



Release in outdoor flow-through tanks with naturally growing seaweeds

SEAFDEC AQD, Iloilo, Philippines

GROW-OUT CULTURE – Tank-based



Trays in tanks

SEAFDEC AQD, Iloilo, Philippines

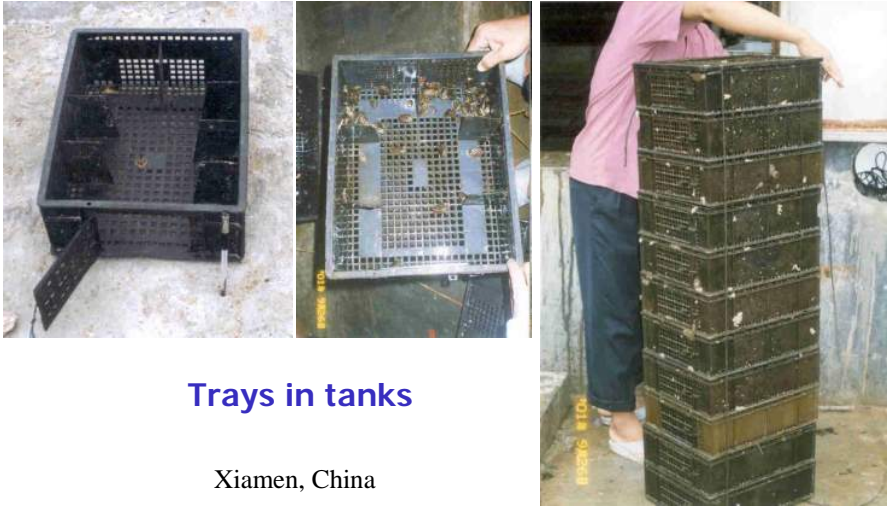


GROW-OUT CULTURE – Tank-based



Xiamen, China

GROW-OUT CULTURE – Tank-based



Trays in tanks

Xiamen, China

GROW-OUT CULTURE – Tank-based



Open cages in indoor tanks

Nagasaki, Japan

GROW-OUT CULTURE – Tank-based



Phuket, Thailand



Sichang Island, Thailand

GROW-OUT CULTURE – Tank-based



Open cages
in indoor tanks



Trays in outdoor
or indoor tanks



Release in
outdoor tanks

Advantages of land or tank-based culture:

- Allows greater control over the culture process
- Simplifies animal maintenance (no need for diving)

Disadvantages:

- Requires large initial investment in land, facilities & equipment
- High pumping and operation costs

GROW-OUT CULTURE – Sea-based



Plastic barrel, tray, cage



GROW-OUT CULTURE in Floating Net Cages



Advantages:

- Ease of monitoring, feeding, cleaning, handling & harvesting
- Naturally growing seaweeds on net cages serve as add'l food

Disadvantage:

- Shorter life span of net cages

GROW-OUT CULTURE in Floating Net Cages

Bamboo frame with floats: 7x7 m or 10x10 m

Net Cages: 1x1x1.4m, 25 units or 49 units

Shelters: PVC pipes (24 pcs./cage)

Feed: seaweed (*Gracilaria*)

Modular System

Principle: Increasing space for increasing animal size

No. of units: 1 ⇒ 2 ⇒ 4 ⇒ 7

Stocking density: 600 ⇒ 300 ⇒ 150/m²

Culture period: 9-10 mos.; 50-60 g (initial 1.5 g/pc)

Survival rate: 90-95%

Stock Transfers (25-unit module)

Cage raft: 7x7m

Net cages: 1x1x1.4m

Stock & transfer
every 3 months

Harvest every
3 months after
the first 9 months

600				
	300			
			150	

Stock Transfers (49 unit-module)

Culture month

1-3 → 4-6 → 7-9

Stocking density

600	300	300	150	150	150	150

Stock & transfer every 3 months

Harvest every 3 months after the first 9 months

Cage raft: 10x10m

Net cages: 1x1x1.4m

Abalone Growth

Culture months	Age (months)	Shell length (cm)	Body weight (g)
1	6	1.7	1.5
2	7	2.4	4
3	8	3.1	8
4	9	3.7	14
5	10	4.2	21
6	11	4.6	28
7	12	5.0	35
8	13	5.3	42
9	14	5.6	50

GROW-OUT CULTURE – Sea-based



Sea Ranching & Stock Enhancement

- in protected areas (marine reserves) with dead corals encrusted with algae
- No feeding required if seaweeds are abundant
- Problem: predation, low recovery rate

GROW-OUT CULTURE – Sea-based



Advantage of sea-based culture:

- Generally requires lower capital investment and maintenance costs

Disadvantage:

- Little control over environmental conditions



Constraints to abalone culture

Problem	Solution
1. Scarcity of juveniles for grow-out culture	Produce seed in hatchery
2. Lack or inadequate supply of suitable seaweeds (<i>Gracilaria</i>) as food for abalone	Culture <i>Gracilaria</i> in ponds

Prospects

Tropical abalone culture could grow and expand because:

1. Wild populations could be depleted if not properly managed.
2. There is a high market demand.
3. Small abalones are preferred by the Asian market (biggest).
4. *Haliotis asinina* grows faster than temperate species.
5. Hatchery seed production is feasible.
6. Different grow-out culture methods are available.
7. There are many suitable sites for abalone culture.

Reference: Gallardo W.G. & Salayo, N.D., 2003. Abalone culture – a new business opportunity. SEAFDEC Asian Aquaculture Vol. 25 No. 3.