The application of strain-cross in commercial breeding of the Pacific abalone in China

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Outline

1 Introduction

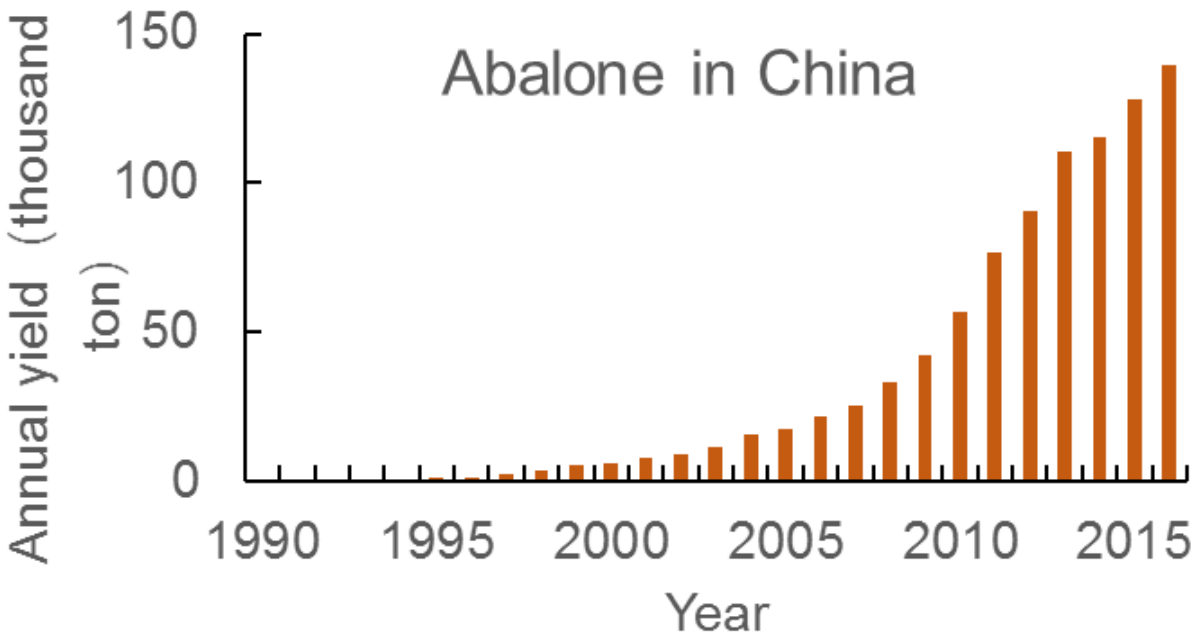
2 Strain-cross

3 Genetic improvement

4 Conclusion

Introduction

- One of the most favorable mollusk in China.
- Annual production is close to 140, 000 tons.
- Genetic and culturing techniques experienced significant improvement in the last 20 years.



Introduction

Development of abalone cultivation techniques in China

1997 — 2007 — 2018

Intermediate Culture

Traditional attachment

Novel attachment

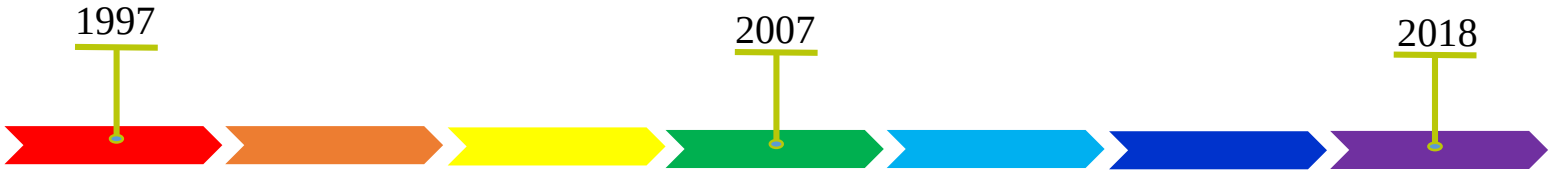
Grow-out

NO transferring

Overwintering in southern China

Introduction

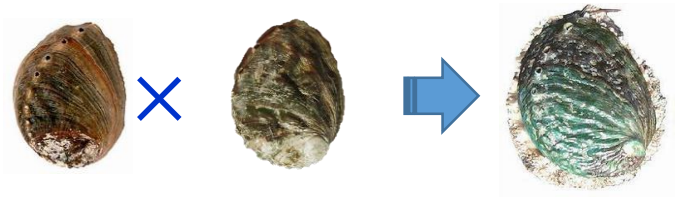
Development of genetic breeding



Before 1997

Wild abalone From China

1997~2006



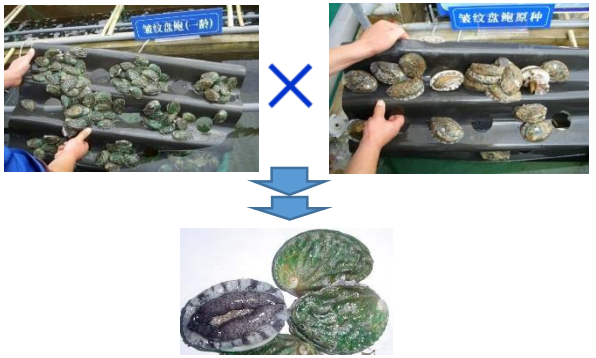
Chinese wild abalone ♀ × Japanese wild abalone ♂ → Hybrid abalone

(Zhang *et al*, 2004)

Cross breeding between Wild abalone From China and Japan

2007~nowadays

Line A × Line B



From pure-bred of cultured abalone to strain-cross

Introduction

Advancement in the production capacity of the world's main livestock and the Pacific abalone



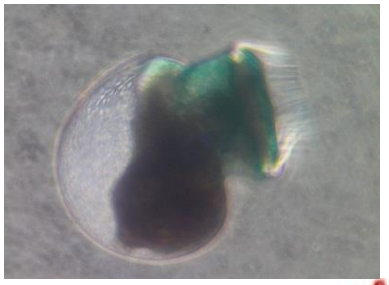


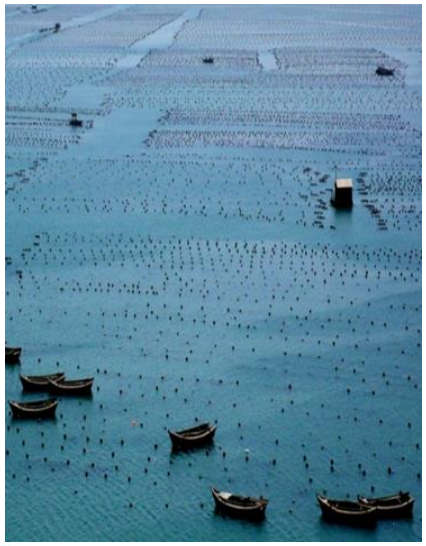

Animal	traits	years	Improvement	Refference
Broiler Chicken	Slaughter weight (g)	45	~400%	Havenstein (2003)
Turkey	Slaughter weight (g)	37	~100%	Havenstein (2004; 2007)
Layer Chicken	Daily egg production (g)	43	43%	Anderson （1996）
swine	Slaughter weight (g)	43	12126g	Chen （2002）
cattle	Slaughter weight (g)	50	62%	USDA
The Pacific abalone	One year shell length（mm）	20	~100%	Zhang et al.,2004; Li et al. , unpublished

Introduction

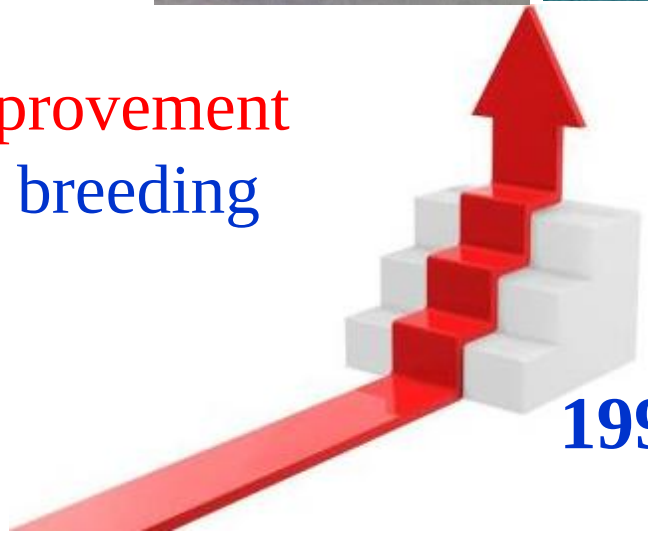
Application of strain-cross and genetic improvement

- Example of strain-cross in commercial breeding of the Pacific abalone





- Contribution of genetic improvement in advancement of abalone breeding in the last two decades



1997~2017

Strain-cross

Parental strain

Strain	Selection age	Genetic background	Advantages	Disadvantages
Sire	One year old	Descendants of Chinese and Japanese wild population hybrids	One year/generation; Fast growing; High survival rate	Low-fecundity of female abalone; Low success rate of embryonic development
Dam	Three years old	Chinese wild population	High-fecundity of female abalone; High success rate of embryonic development	Three years/generation

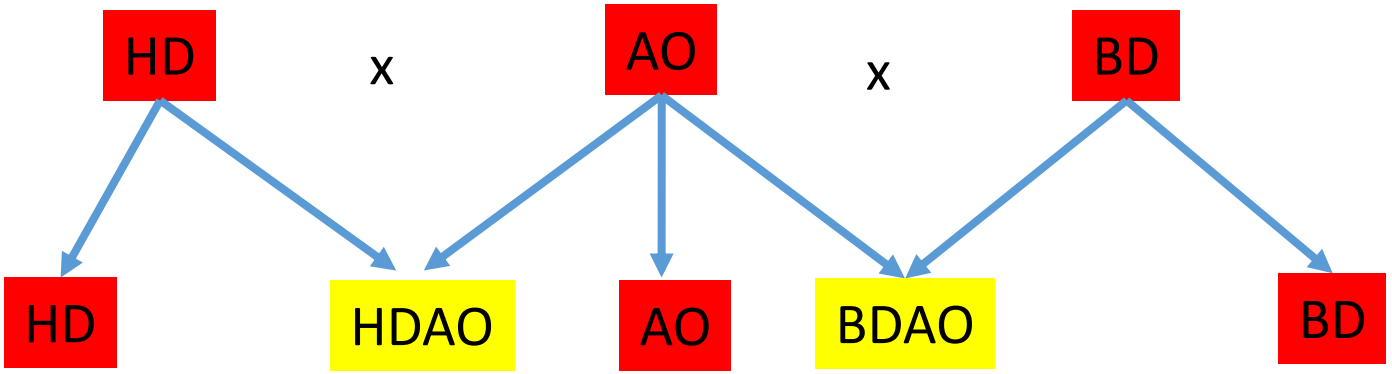
Different genetic background

Complementary production trait

Strain-cross

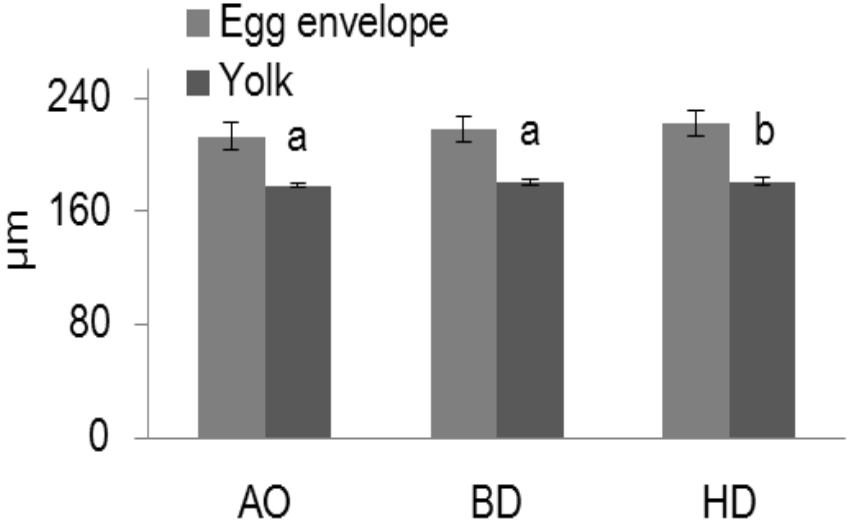
Parents and offspring production

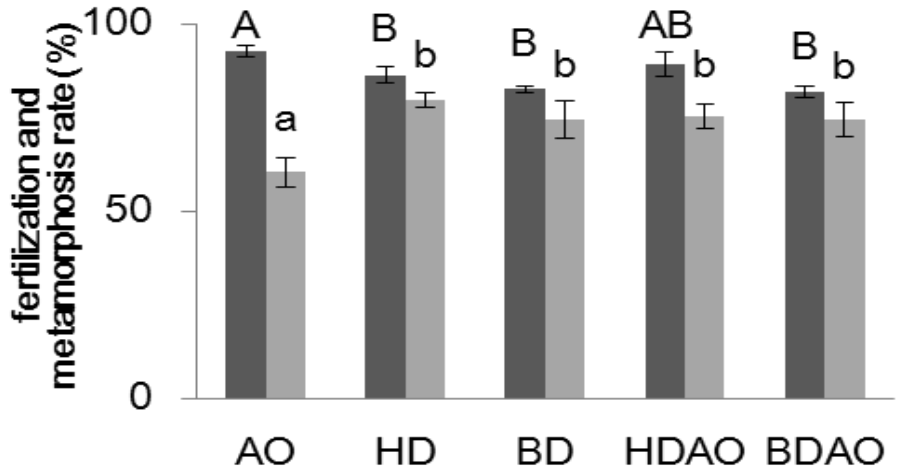
Strain	Average shell-length (mm)	Average bodyweight (g)	Age (month)
AO	57.29±5.69	24.42±6.83	12
HD	87.31±9.64	85.39±15.30	36
BD	86.67±9.35	84.20±14.16	36



Strain-cross

embryonic development





AO strain

Lower fecundity
lower yolk volume
lower metamorphosis rate

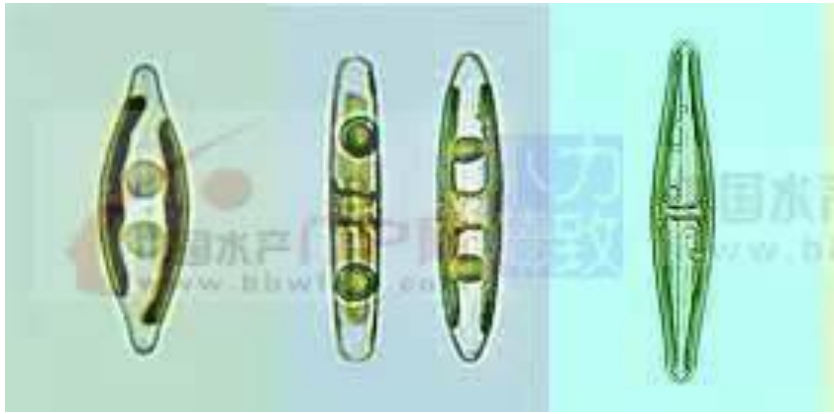
HD and BD strain

Higher fecundity
Higher yolk volume
Higher metamorphosis rate

Strain-cross

Cultivation procedure

40 days benthic diatom feeding stage



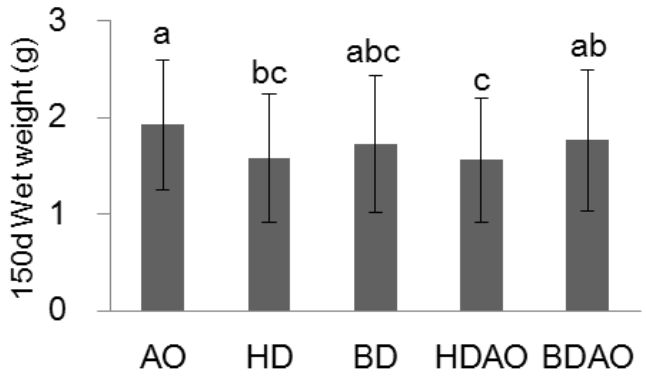
140 days artificial diets feeding stage

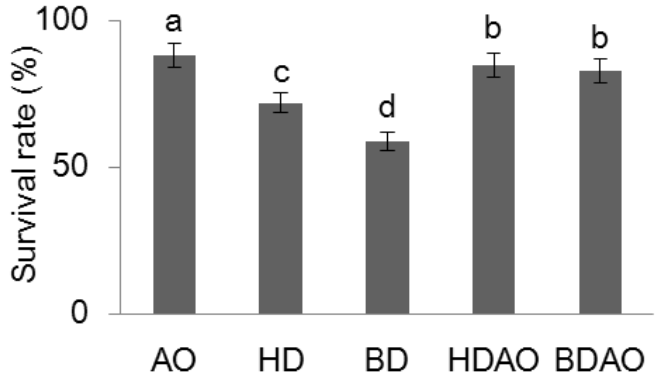
180 days over-wintering stage

Strain-cross

Juvenile growth and survival

Age (day)	Experimental group				
	AO	HD	BD	HDAO	BDAO
15	0.47±0.04^{a*}	0.52±0.05^{b}	0.51±0.06^{b}	0.53±0.06^{b}	0.51±0.06^{b}
40	2.71±0.37^{a}	3.09±0.44^{b}	2.78±0.44^{a}	3.00±0.43^{b}	2.90±0.39^{ab}
120	18.25±2.87^{a}	17.51±2.52^{bc}	17.30±2.53^{bc}	16.99±2.46^{b}	17.76±2.29^{ab}
150	24.23±2.98^{a}	23.10±3.24^{b}	23.42±3.16^{ab}	22.98±3.34^{b}	23.78±3.47^{ab}





AO: slow early stage shell growth rate; fast shell growth and survival rate during artificial feeding stage.

Crossbred: Fast shell growth and higher survival rate than purebred dam strains

Strain-cross

Heterosis

Production Traits	Mid-parent heterosis (H_M)		single-parent heterosis (H_D)	
	HDAO	BDAO	HDAO	BDAO
15d ASL*	7.2	4.3	2.1	0.4
40d ASL	3.3	5.4	-3	4.1
120d ASL	-5	-0.1	-3	2.6
150d ASL	-2.9	-0.2	-0.5	1.5
150d ASL	-10.8	-3.2	-1	2.3
Survival rate	5.9	12.9	17.8	41.4

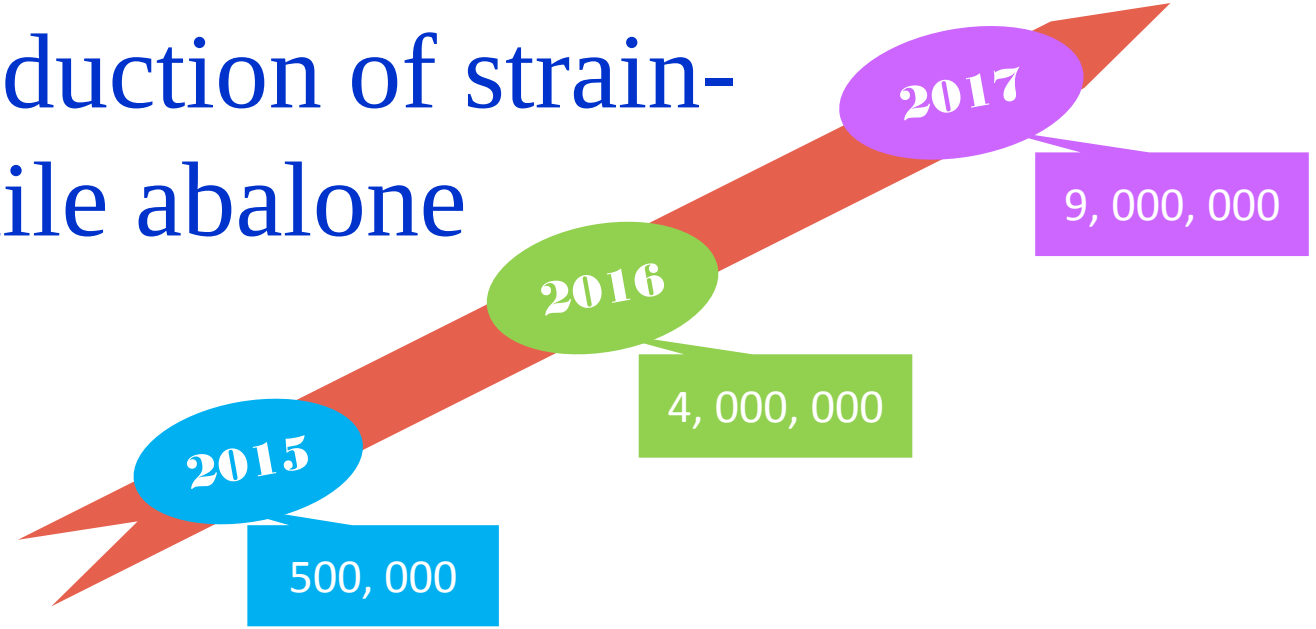
* ASL represents Average Shell Length

The mid-parent heterosis for shell length and body weight was not obvious, and the survival rate of the single parent (relative to the female parent) was obvious.

Strain-cross

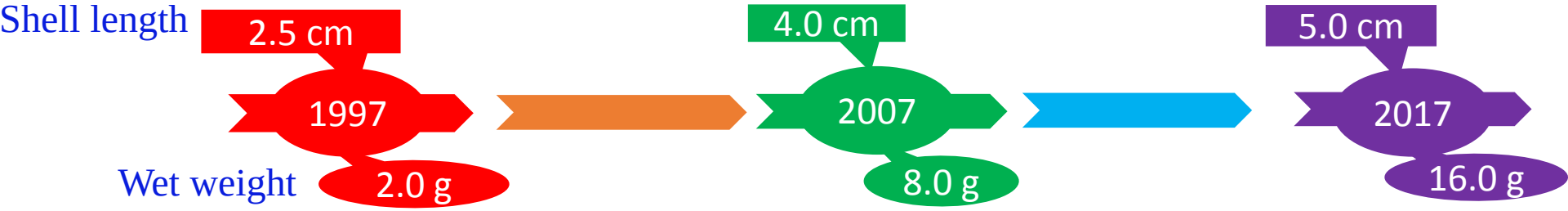
Commercial application

Annual production of strain-cross juvenile abalone



Genetic improvement

Production traits of one year old juveniles



2 times longer

8 times heavier

Both genetic breeding programs and improvements in cultivation techniques have contributed to this advancement

Conclusion

- Production traits of dam and sire strain can be complementary
- Strain-cross is useful in improving production traits
- In the last 20 years, the contribution of genetic improvement is over 40%

Thank you!