Technological developments of offshore longline mariculture

Zhang Jihong

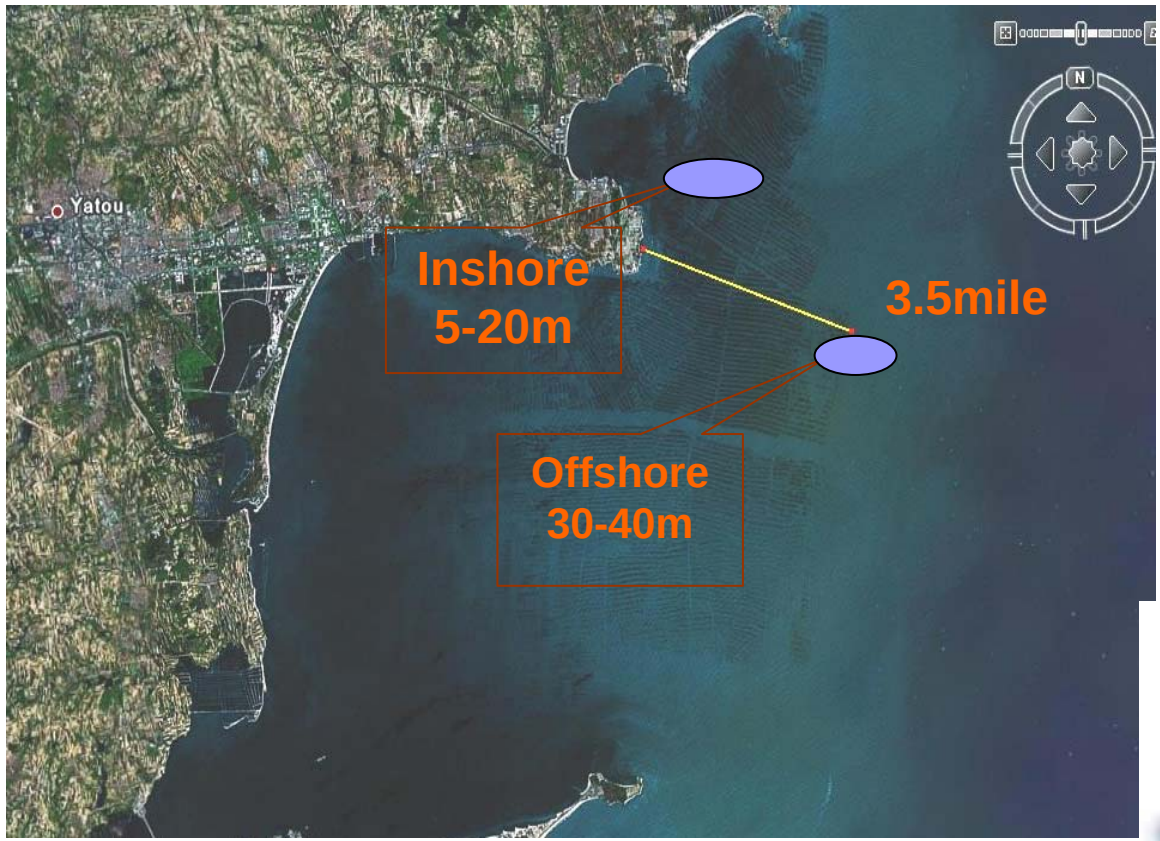
Yellow Sea Fisheries Research Institute,
CAFS Qingdao 266071, China

content

1. Conception of offshore culture
2. Development of longline offshore culture in China
3. Experiment results of longline culture in Sungo Bay
4. Problems and prospect

1. **Conception of offshore culture**

In China



2. **Development of longline offshore culture in China**

Surface floats

In sheltered water ways with surface floats and continuous mussels droppers suspended from backbone ropes.

Submerged floats culture

New Hampshire offshore longline culture

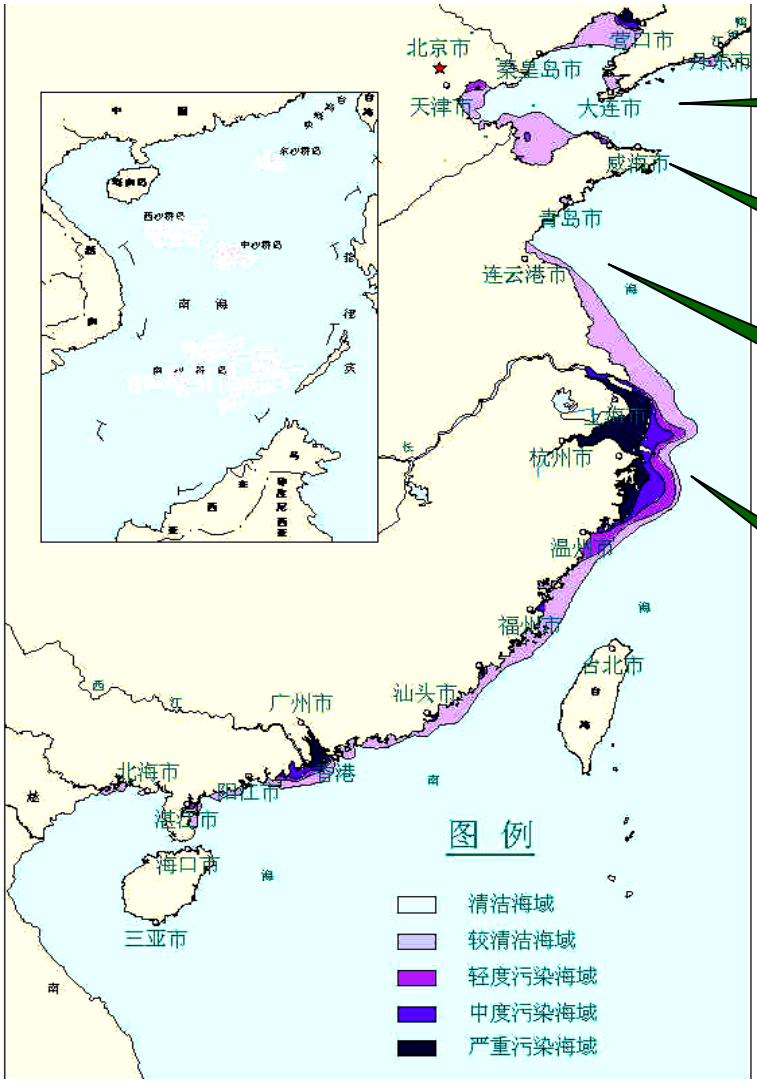
Unlike inshore operations that use floating rafts or surface lines, these new farms are located nearly three miles offshore, and the mussels are grown from submerged longlines — out of sight and safely away from boat traffic.

When farmed offshore, far from pollution sources, blue mussels (*Mytilis edulis*) are a healthy and nutritious source of protein. To escape the currents, waves and weather, growing ropes are suspended from a long line submerged 40 feet below the surface.

2. **Development of longline offshore culture in China**

- There was no primary scientific data for best site locations, lantern net and mooring designs, species, culture operations and potential environmental effects.
- In addition, very little research was conducted with respect to candidate species' behavior and growth, and environmental impacts.

2. **Development of longline offshore culture in China**



Northern of Yellow Sea
Japanese scallop

Mid of Yellow Sea
Kelp, scallop, abalone

Southern of Yellow Sea
Mussel and seaweed

East China Sea
Mussel and kelp

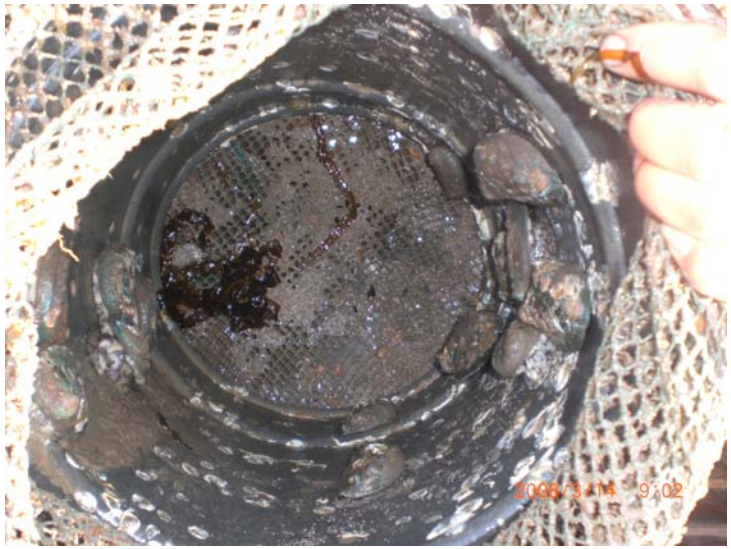
Mooring system

	Inshore area	Offshore area
Wooden stake （length m） （soft bottom）	1.0	1.5
Concrete anchor （ton）	2	3

Concrete anchor block for hard sediment

Lantern net

Abalone *Haliotis discus* Hannai



Abalone lantern net for offshore area

Lantern net

New “frame net” for scallop *Patinopecten yessoensis*

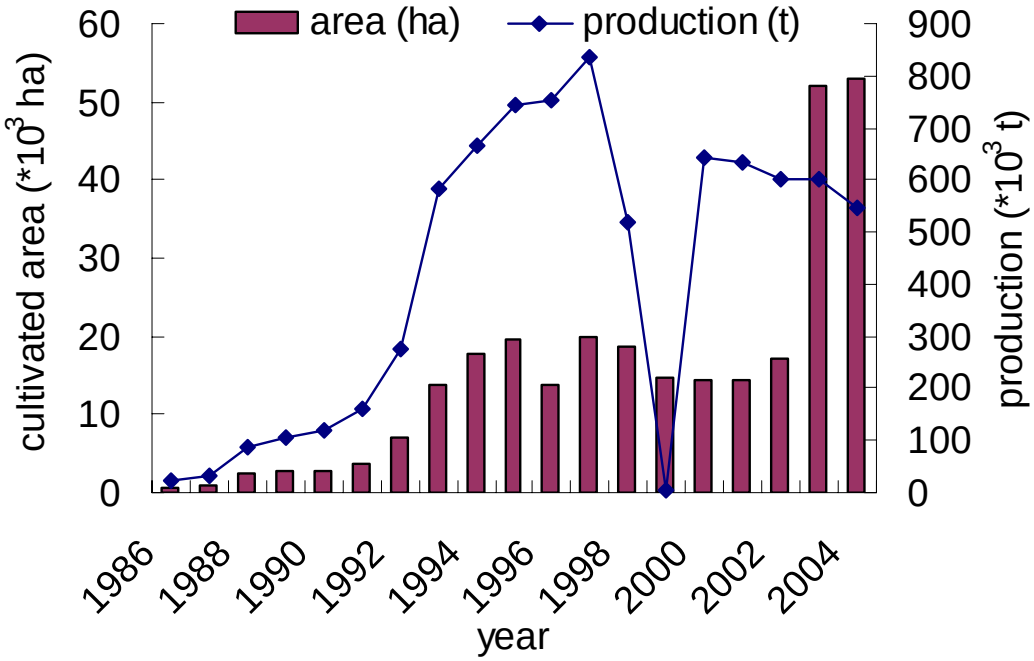
13 line ×9 row，at each side, 117 scallops could be cultured. By this way, the damage between scallops could avoid.

Scallop	Experiment date	Survival rate （%）	Shell height （cm）	Wet weight (g)
Small size group	17 May	100	6.04	24
	16 June	100	6.46	30
Large size group	17 May	100	7.80	53
	16 June	96.15	7.93	62

3. Experiment results of offshore longline culture in Sungo Bay

Scallop *Chlamys farreri* is one of most important species that is farmed in the northern coast of China. In Shandong province, the mariculture industry of the scallop developed very quickly since 1992.

Introduction



The annual production and cultivated area of scallop *Chlamys farreri* in Shandong province

Mainly culture species shifts from *Chlamys farreri* to bay scallop *Argopecten irradians* for the reason of high summer mortality rate.

Introduction

- The cause of the high mortalities in summer has not been entirely identified, environment problem is one of the hypothesized causes.

Introduction

To avoid spatial competition and serious environmental impacts in inshore region, mariculture industry had to try to utilize the offshore area. The aim of this paper is to ensure the potential of long-line culture of scallop *Chlamys farreri* in offshore areas and to make up the optimized culture mode for the offshore culture.

Experiment of scallop culture in different water depth

Material and methods

Two kinds of lantern cages were designed.

Small lantern

Disk diameter: 300 mm

Large lantern

Disk diameter: 500 mm

Material and methods

Experiment design

group	Inshore (ind./disk)	Offshore (ind./disk)	Scallop Density (ind./m^2)
Small lantern	20	20	280
	30	30	425
	40	40	565
Large lantern	40	40	200
	60	60	305

Material and methods

20 scallops were sampled at random for each experimental groups every month from May 2007 to April 2008. Shell height, wet weight and dry weight of shell and soft body tissue were recorded.

Meanwhile, environmental parameters: temperature, salinity, chlorophyll a, suspended particle materials, particle organic materials and dissolved inorganic nutrients were measure monthly. The current velocity at inshore and offshore were measured at spring tide of Aug.

- Instantaneous growth rate (G) was calculated as：
- $G=(\ln W_{t2}-\ln W_{t1})/\Delta t \times 100$
- W_{t1} and W_{t2} is the soft body weight at time t_1 and t_2 respectively.

Results

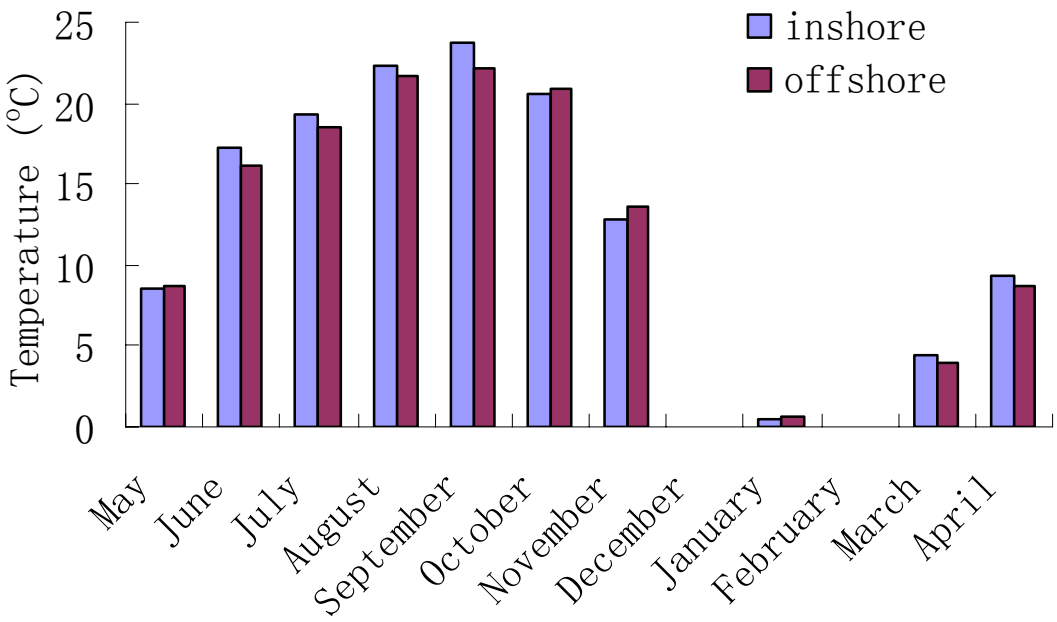


Fig.1 Sea water temperature at inshore and offshore areas

There were not significant different at the temperature between inshore and offshore areas (t=1.643, df=9, *p*=0.135>0.05).

Results

The annual concentration of chlorophyll a in inshore and offshore area were 2.67±2.35 and 1.90±1.56 mg/m³, respectively.

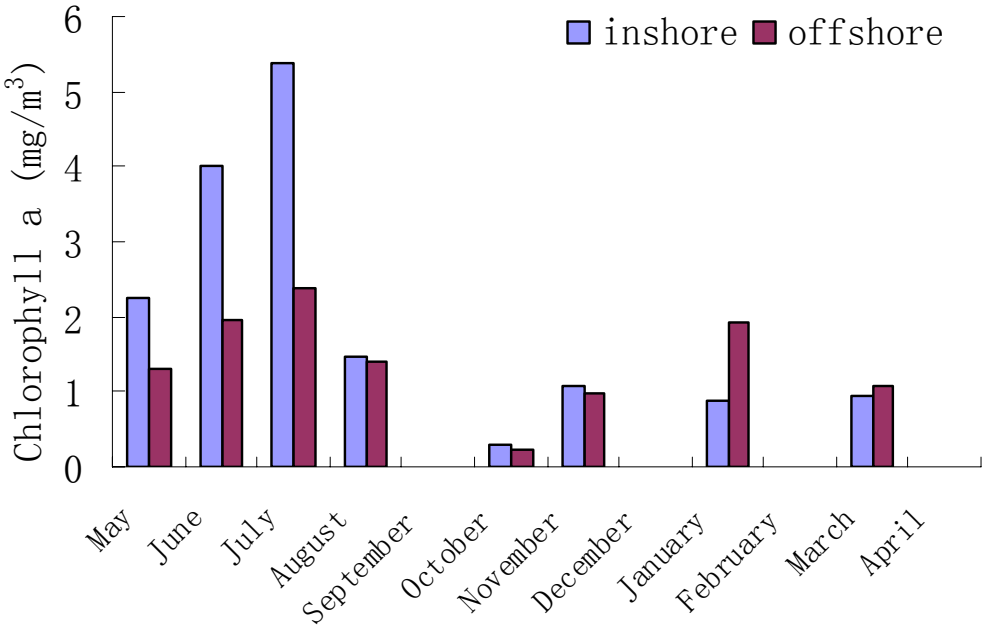


Fig.2 Concentration of chlorophyll a at inshore and offshore areas

Results

The water flow velocity at inshore and offshore is significant different .The average current velocities at spring tide (August) of inshore and offshore area were 4.57±1.47 and 17.91±10.94 cm/s, respectively

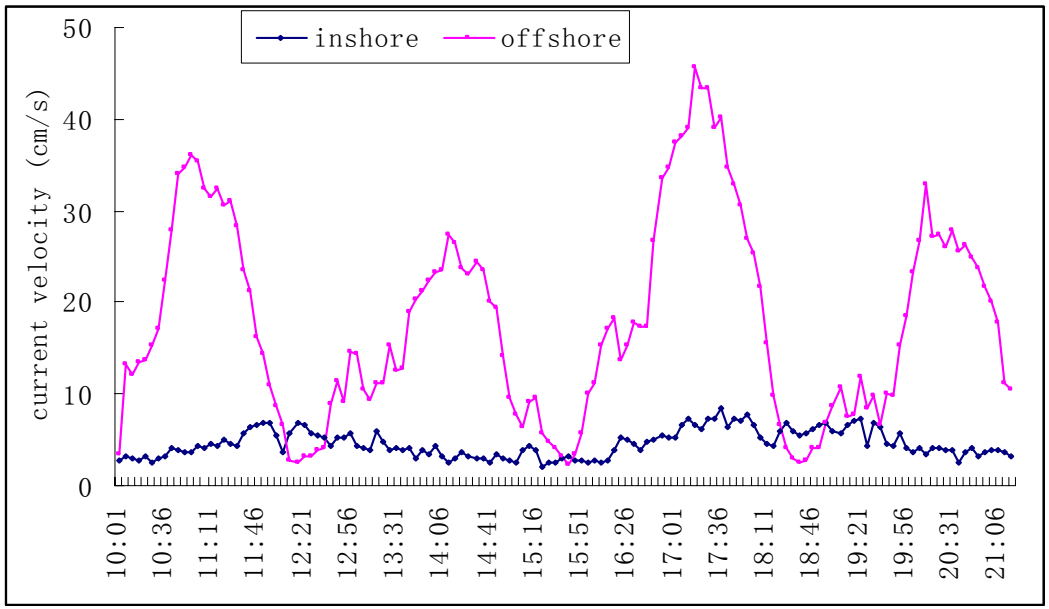


Fig.3 Current velocity of inshore and offshore area in Sungo Bay

Results

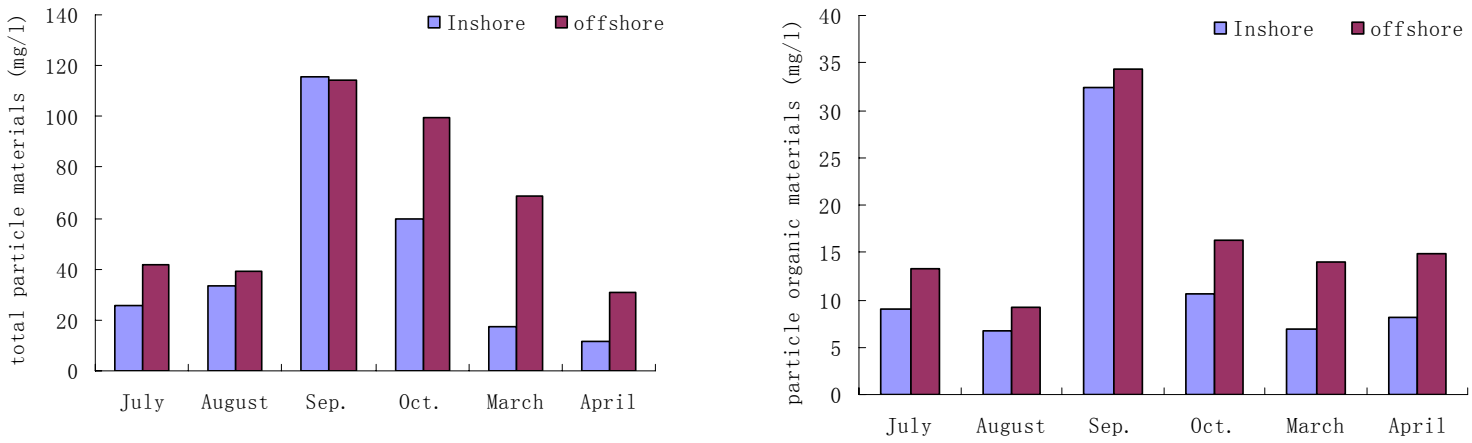


Fig.4 Concentration of particles at inshore and offshore areas

The annual concentration of TPM in inshore and offshore area were 43.98±35.56 and 65.82±31.61 mg/L, respectively. The average concentration of POM in inshore and offshore area were 12.29±9.07 and 16.99±8.09 mg/L, respectively.

Paired sample test shown:

TPM: t=-2.640, p=0.046<0.05

POM: t=-5.344, p=0.003<0.01

Scallop cultivated in offshore area

Scallop cultivated in inshore area

Comparing the growth rate of scallop at large lantern in inshore and offshore

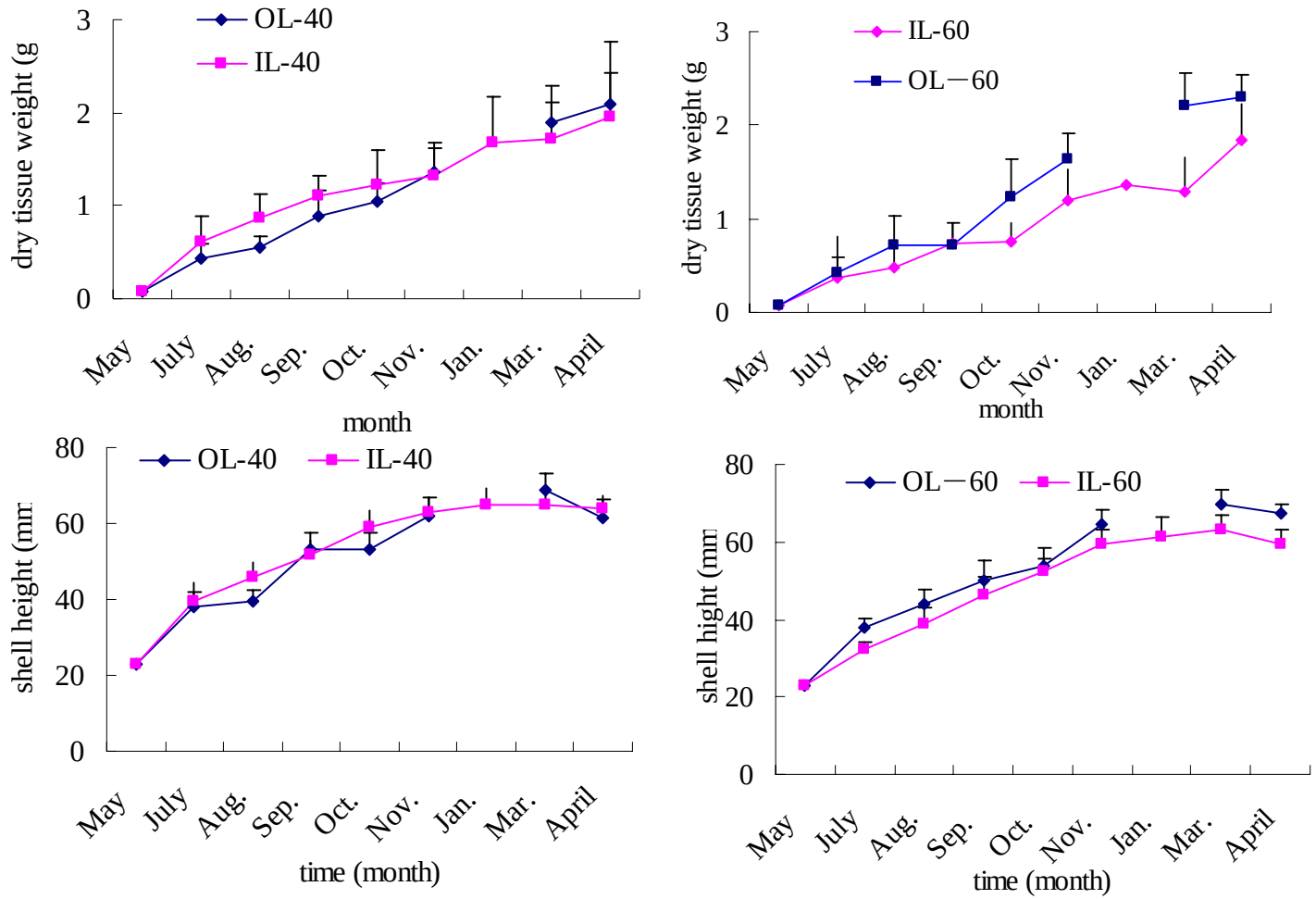
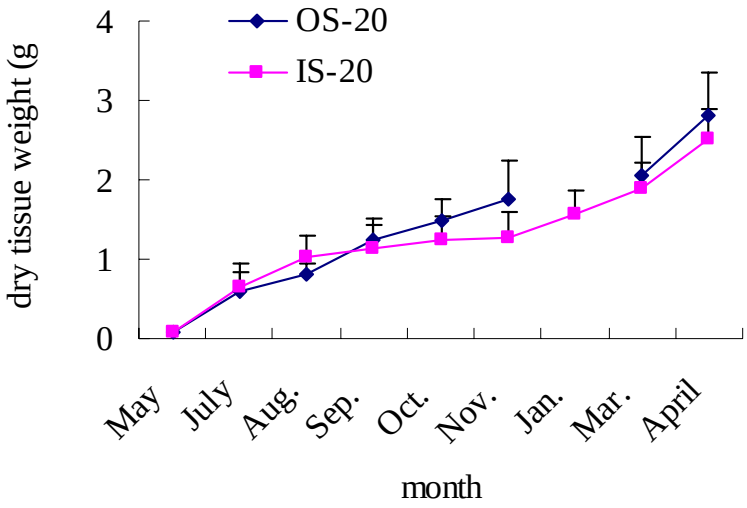
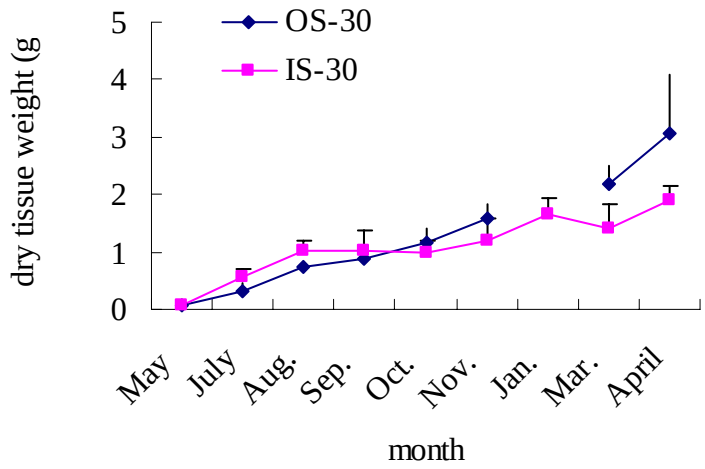


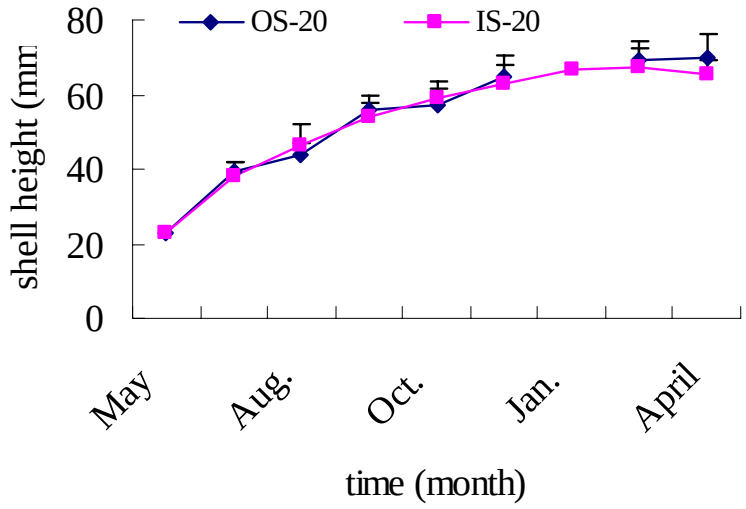
Fig. 5 The effect of culture site on the shell height and dry tissue weight

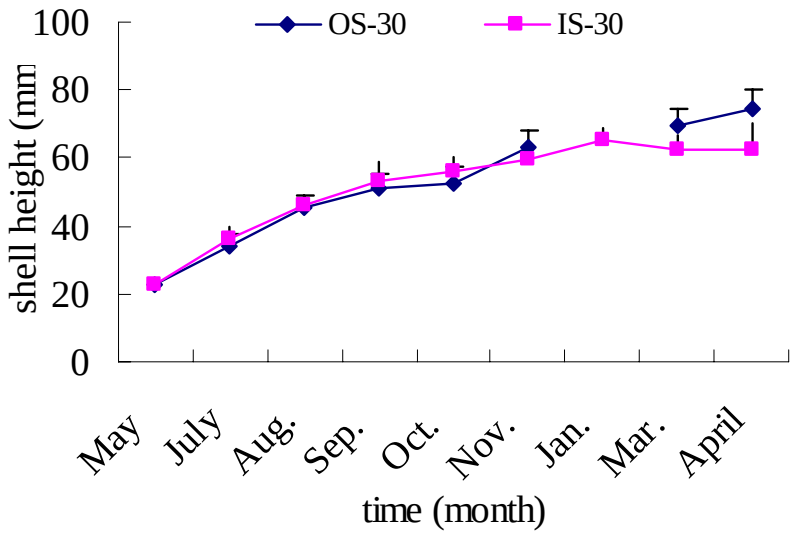
Student–Newman–Kuels procedure showed: significant different for the shell height and dry tissue weight between group of OL-60 and IL-60 at April 2008 ($p<0.05$).

Comparing the growth rate of scallop at small lantern in inshore and offshore









Comparing the growth rate of scallop at small lantern in inshore and offshore

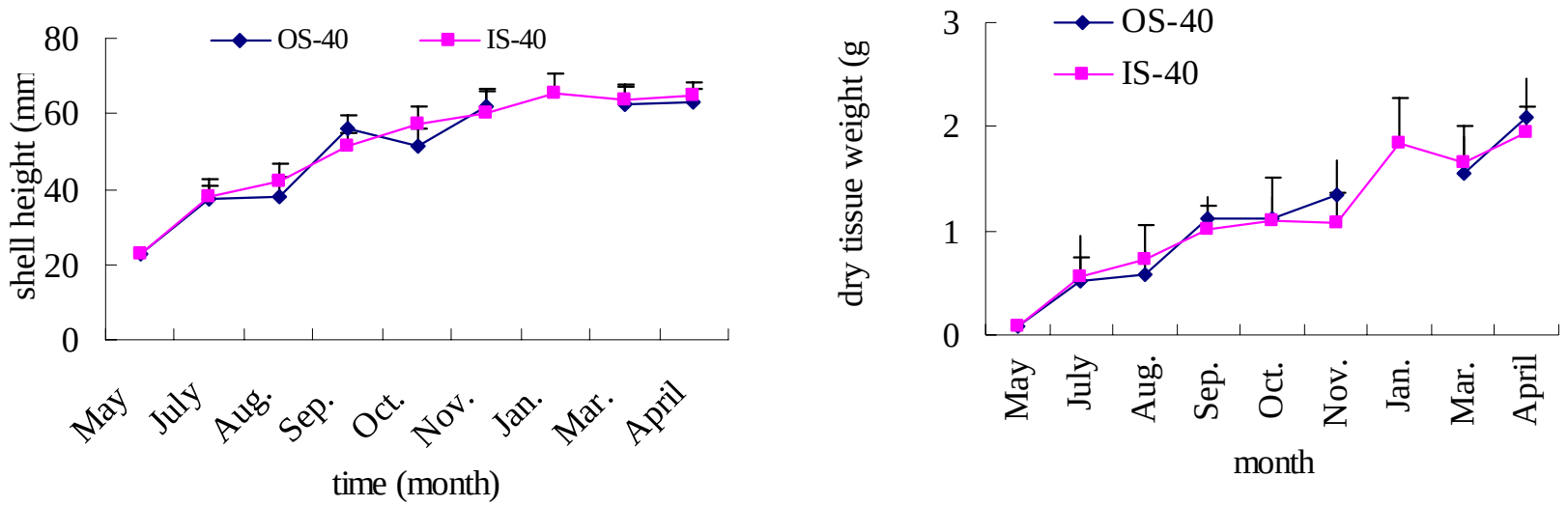


Fig. 6 The effect of culture site on the shell height and dry tissue weight

Student–Newman–Kuels procedure showed: significant different for the shell height and dry tissue weight between groups of OS-30 and IS-30 at April 2008 ($p<0.05$).

Comparing the growth rate of scallop at different initial density

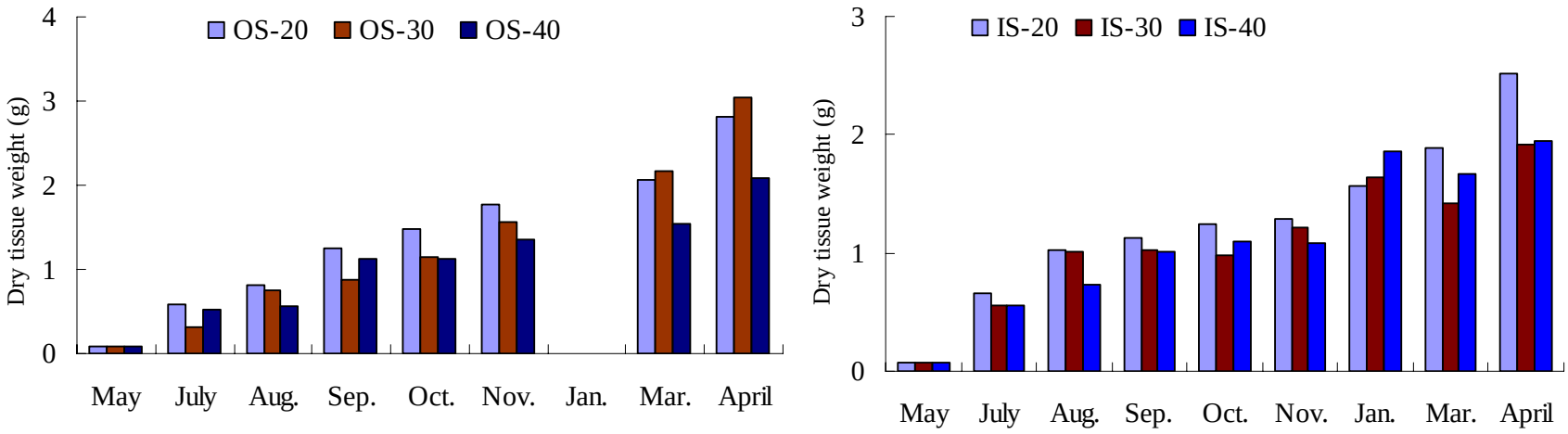


Fig.7 The effect of initial culture density on the dry tissue weight

Offshore: significant different between the groups of OS-20 and OS-40, or OS-30 and OS-40 ($p<0.05$).

Inshore: significant different between IS-20 and IS-40; or IS-20 and IS-30 ($p<0.05$).

Tab.1 Instantaneous growth rate of the scallop (dry tissue weight)

	OS-20	OS-30	OS-40	IS-20	IS-30	IS-40	OL-60	IL-60	OL-40	IL-40
July	3.34	2.28	3.10	3.52	3.22	3.25	2.75	2.53	2.82	3.40
Aug.	1.05	2.86	0.35	1.46	2.00	0.88	1.81	0.89	0.76	1.18
Sep.	1.44	0.59	2.23	0.34	0.06	1.08	-0.03	1.46	1.63	0.77
Oct.	0.58	0.87	0.00	0.30	-0.14	0.28	1.85	0.04	0.52	0.34
Nov.	0.58	1.05	0.64	0.12	0.69	-0.07	0.93	1.58	0.88	0.25
Jan.				0.66	1.01	1.80		0.44		0.81
Mar.	0.13	0.27	0.11	0.32	-0.25	-0.18	0.25	-0.10	0.28	0.00
April	1.03	1.13	0.99	0.95	1.01	0.52	0.15	1.19	0.32	0.42

Tab.2 Scallop survival rate over 1 year

	Initial density	offshore	inshore
Small lantern	20	92%	86%
	30	90%	83%
	40	86%	82%
Large lantern	40	92.5%	87.3%
	60	90%	86%

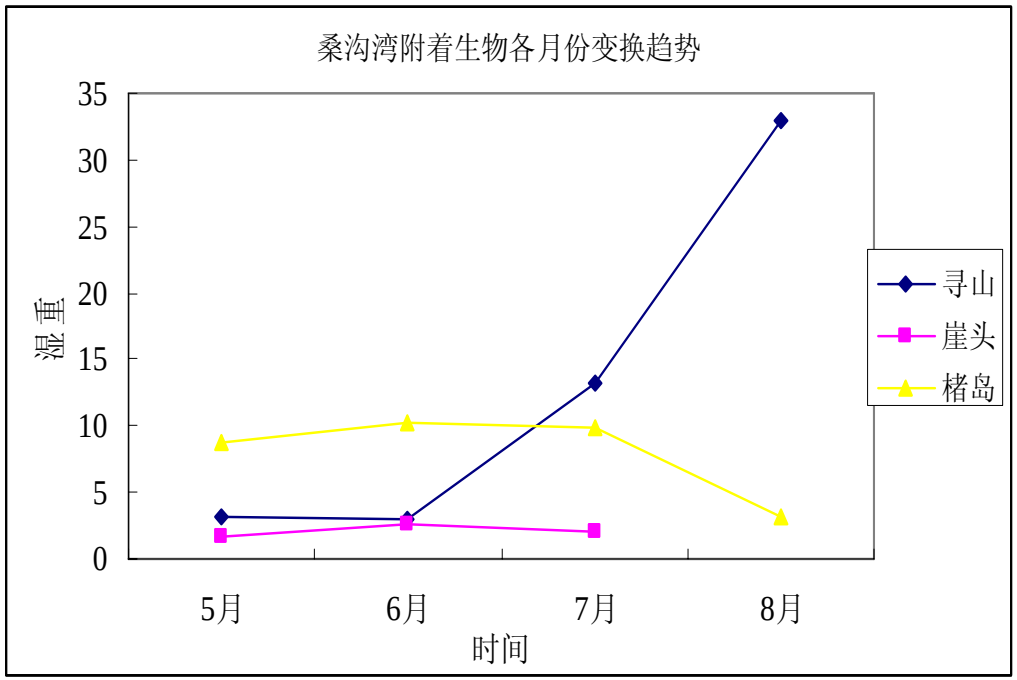
Conclusion

- **Offshore long-line culture of scallop *Chlamys farreri is successful.***
- **Large lantern cage did not show advantage in the growth rate and survival rate. But It is too heavy to operate without harvest machinery.**
- **There is not significant different at the growth and survival rate between the group of OS-20 and OS-30, therefore, for the offshore long-line culture of the scallop, OS-30 are recommended, so as to get more production and benefit.**

Prospect

A major problem with longline culture of lantern cage is the biofouling, which may reduce growth rates in scallop culture.

Work is going …..



Biomass of biofouling in summer

Work is going …..

- **The individual filtration rate, excretion rate and respiration rate of the scallop at inshore and offshore area had been measured, we will try to evaluate the carrying capacity in the offshore.**

Biodeposit trap

Thanks for you attention