

**Pacific White Shrimp, *Litopenaeus vannamei*,
Hatchery Industry in China**

by

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Pacific white shrimp *L. vannamei*



A brief history of *L. vannamei* in China

1988

- *L. vannamei* was first introduced into China by Professor Zhang Weiquan of the Institute of Oceanology of Chinese Academy of Sciences from University of Texas Port Aransas Marine Science Laboratory. The postlarvae were provided by Texas A&M University. Nineteen postlarvae survived upon arriving in China.

1989

- First succeeded in maturation and spawning in captivity (up to zoea stage)

1992

- Succeeded in the production of postlarvae

1994

- Succeeded in the mass production of postlarvae

A brief history of *L. vannamei* in China (cont.)

1994 – 1999

- Small scale growout production

1999

- Real start and acceptance of *L. vannamei* farming after the collapse of *Penaeus monodon* farming (mainly due to the epidemic white spot virus disease)

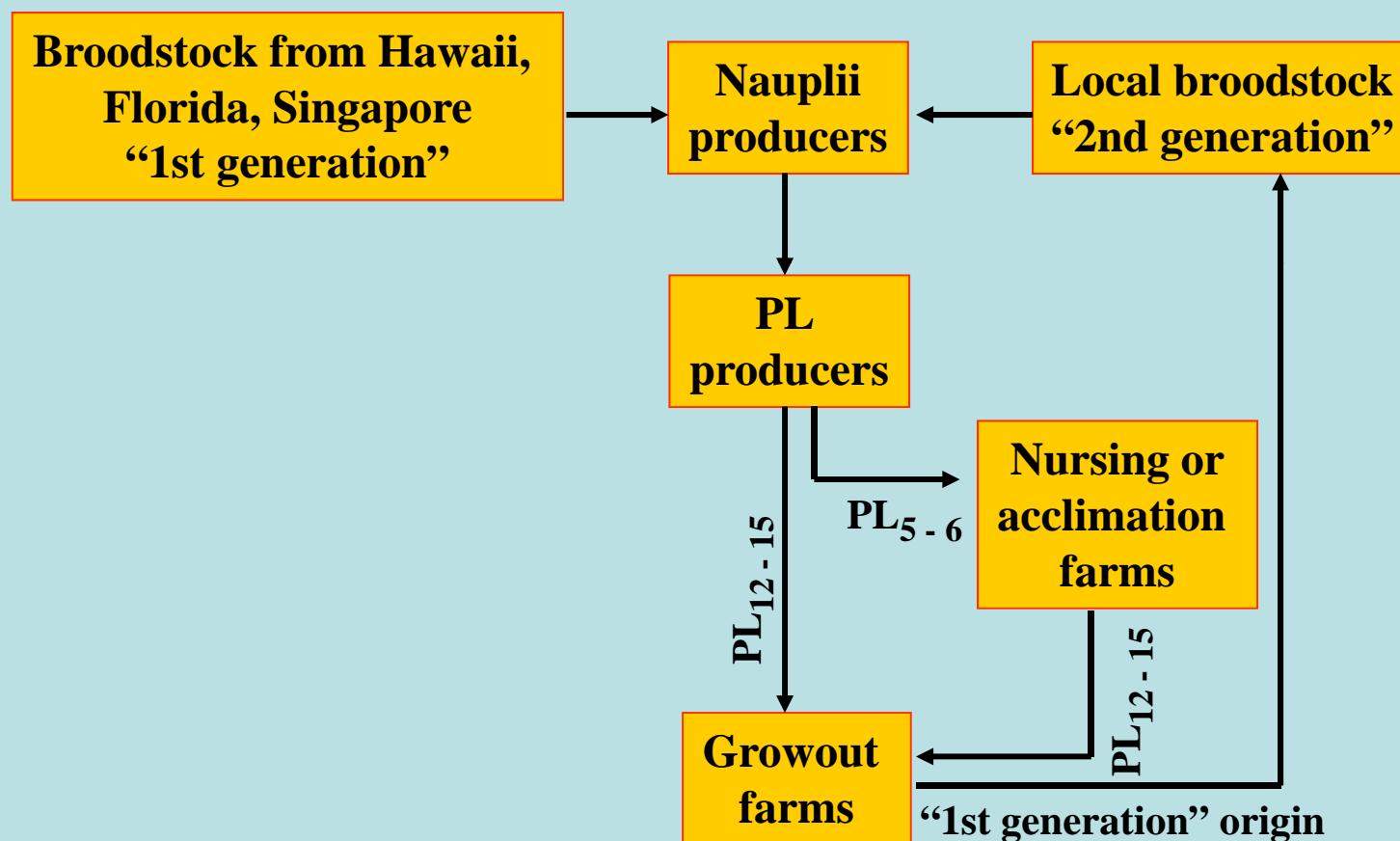
2001

- Farming area for *L. vannamei* started to expand quickly.

2007

- Annual production of shrimp reached a record-high of 1.28 million metric tons among which the majority were *L. vannamei*.

L. vannamei hatchery industry in China: diversification



***L. vannamei* hatcheries in China**

Estimated number of hatcheries in China

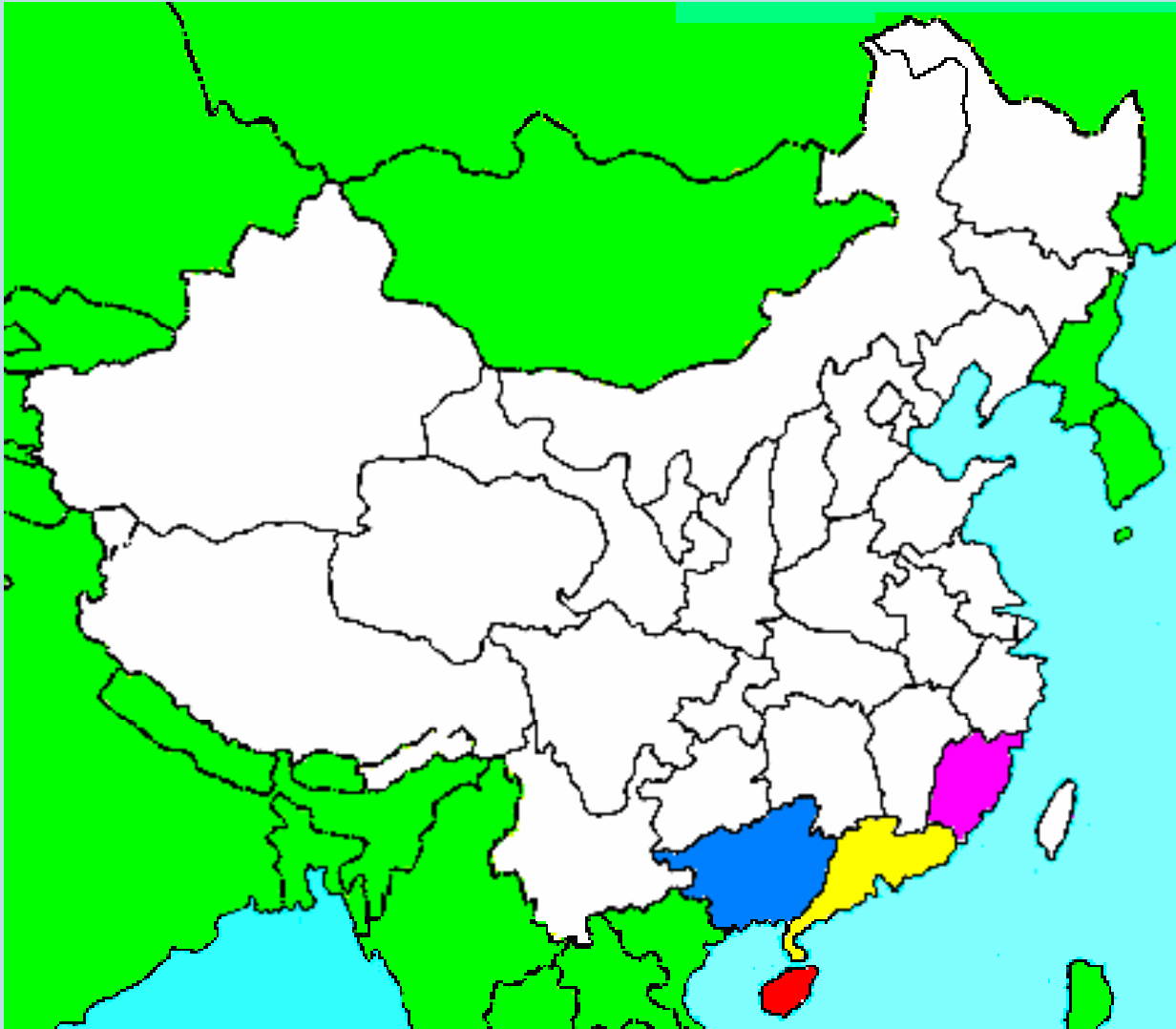
Between 2,600 and 2,700 established and 1,500 to 1,600 in production and at least 90% of them are situated in the provinces of Guangdong, Guangxi, Fujian and Hainan.

Sizes of hatcheries

From 500 m³ to 2,000 m³ larvae-rearing area per hatchery and production from 50 millions to 500 millions of postlarvae each year per hatchery.

Estimated total requirement of postlarvae

Between 300 billions and 400 billions each year to satisfy the growout production of 800,000 to 1 million metric tons of shrimp.



- Fujian
- Hainan
- Guangxi
- Guangdong

Major *L. vannamei* PL producing areas in China



Wenchang and Qionghai, the major *L. vannamei* PL producing areas in Hainan



Fangcheng, Beihai and Dongxing, the major *L. vannamei* PL producing areas in Guangxi



Longhai, Zhangpu, Xiaman and Xiapu, the major *L. vannamei* PL producing areas in Fujian

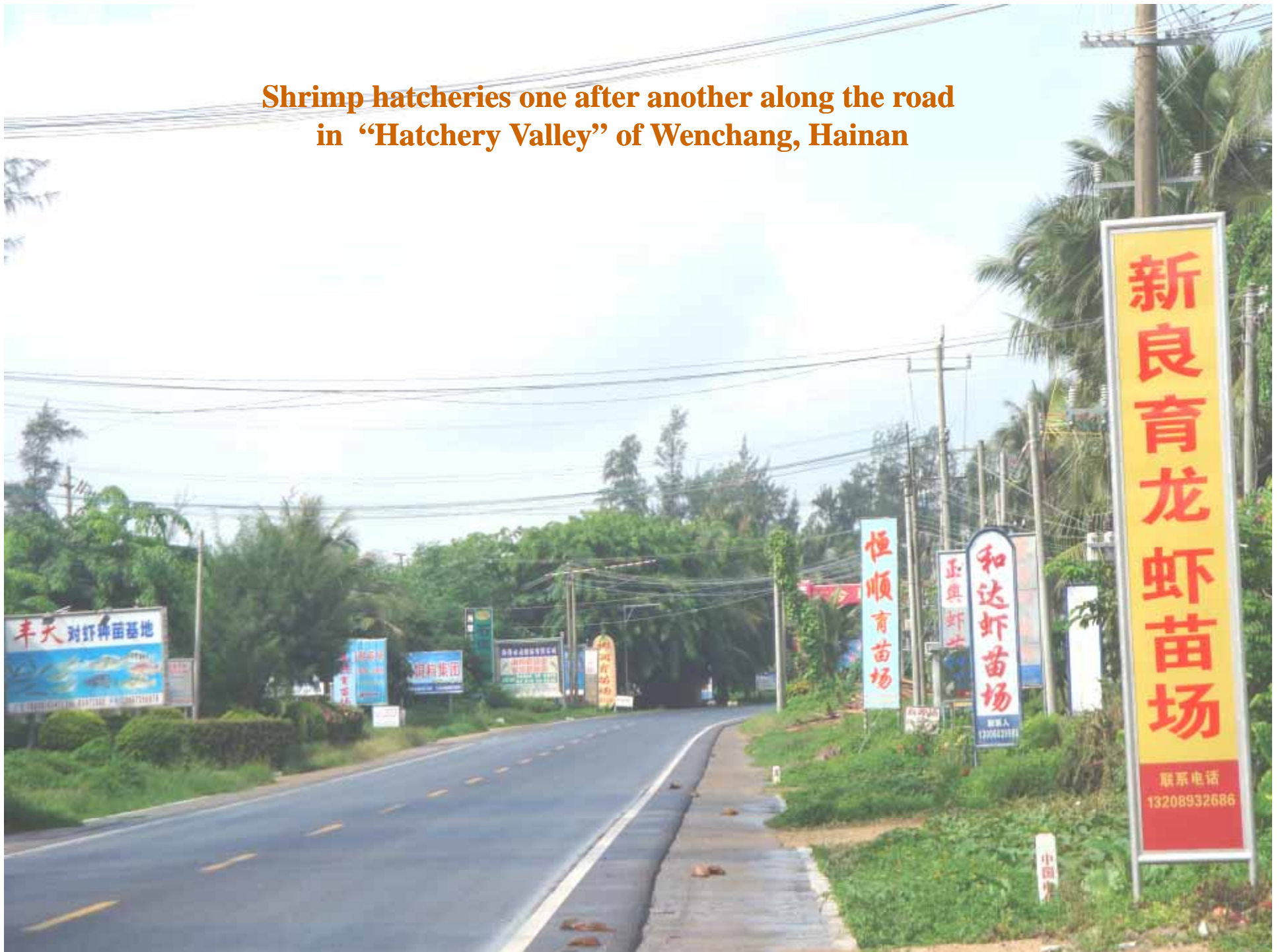


Zhanjiang (Donghai Island), the major *L. vannamei* PL producing area in Guangdong

Shrimp hatcheries one after another along the road
in “Hatchery Valley” of Wenchang, Hainan



**Shrimp hatcheries one after another along the road
in “Hatchery Valley” of Wenchang, Hainan**



***L. vannamei* hatcheries: water treatment**

Filtration

- Sand filter (most commonly used)
- Cartridge filter
- Bag filter (most commonly used)

Removal of organic matters

- Foam fractionator (protein skimmer)
- Activated carbon filter (most commonly used)

Sterilization

- Ozonation
- UV sterilization
- Chlorination (most commonly used)
- Formalin (becoming popular)

***L. vannamei* hatcheries: water treatment**

Adjustment of alkalinity

It is a common practice to bring up the alkalinity of seawater to a minimum of 130 ppm. The effect on the survival is significant.

Application of EDTA

Constant application of EDTA at 10 - 20 ppm is generally required. Heavy metals often exist in the seawater source.



**The water treatment system in Evergreen's shrimp hatchery
(Sand filters, protein skimmers and ozonators)**

***L. vannamei* hatcheries: broodstock**

Source of broodstock

- 1. Imported, so-called “1st generation” SPF broodstock**
- 2. Locally-raised, so-called “2nd generation” broodstock**

Size of broodstock

Males: > 40 g each

Females: > 45 g each

Age of broodstock

> 8 months and < 12 months

Cost of broodstock

- 1. Imported: >US\$ 40 each male or female**
- 2. Locally-raised: US\$ 2 - 3 each male or female**

***L. vannamei* hatcheries : broodstock**

Density of broodstock

10 – 15 shrimp/m², males and females separated

Induced maturation

- **Unilaterally eyestalk ablation on female**
- **Highly nutritive feed, mainly squid, polychaete worms, oyster and calf liver (formulated feeds, not popular)**

Reproductive performance of broodstock

Expectation: 200,000 to 300,000 nauplii per spawn and a minimum of 14 spawns within 5 months after eyestalk ablation, totaling a minimum of 3 millions of nauplii per mother shrimp (imported broodstock)

***L. vannamei* hatcheries: nauplii to postlarvae**

Capacity of larvae-rearing tank

10 - 20 m³ per tank

Initial density of nauplii

150 – 200 per liter of water

Survival rates

Naupliar stage: 0 – 90%

Zoea stage: 0 – 70% (most critical stage)

Mysis stage: 50 – 90%

PL stage: 80 – 90%

Overall from nauplii to PL_{12 - 15}: 0 - 50%

Production of PL

Up to 100,000 PL_{12 - 15} per m³ of water

***L. vannamei* hatcheries: nauplii to postlarvae**

Feeding

Zoea stage:

- **Live algae (mainly *Skeletonema sp.* and *Chaetoceros sp.*)**
- **Algal powder**
- **Formulated feed (in microencapsulated, flake or microbound form)**
- **Newly-hatched Artemia nauplii (cold or heat-shocked, starting from Zoea II or Zoea III stage)**

Mysis stage:

- **Formulated feed**
- **Live newly-hatched Artemia nauplii**

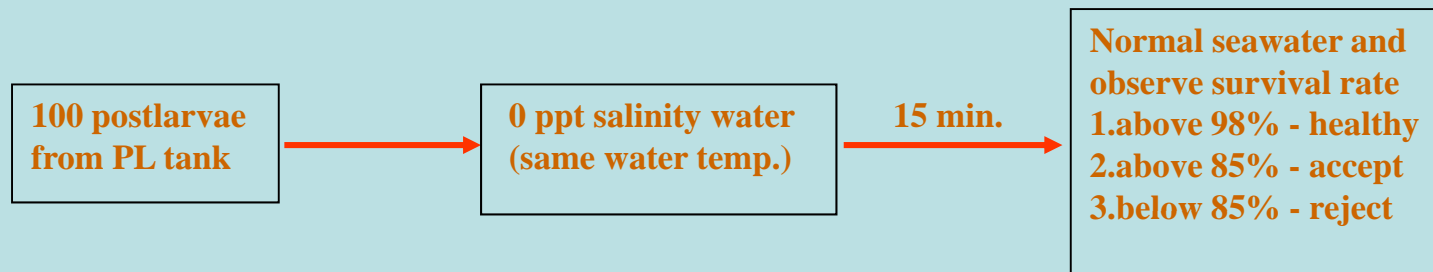
PL stage:

- **Formulated feed**
- **Live newly-hatched Artemia nauplii**

L. vannamei hatcheries: quality assurance of PL

Before harvesting PL, the following steps are taken to ensure quality of PL:

- 1. PCR check for viral infection**
- 2. Microscopic observation on abnormality**
- 3. Stress test (salinity shock)**



*** Postlarvae have to be PL₁₀ or older for 0 ppt salinity shock test.**

L. vannamei hatcheries: costs of larvae-rearing

Nauplii (1st generation)

- Selling price: RMB 10 – 15 (US\$1.5 – 2.2) per 10,000 nauplii
- Cost per 10,000 PL_{12 - 15} based on 30% survival: RMB 33 – 50 (US\$ 4.8 – 7.3)

Feeding cost

RMB 27 - 30 (US\$ 4.0 – 4.4) per 10,000 PL_{12 - 15}

Other cost

RMB 20 - 25 (US\$ 2.9 – 3.7) per 10,000 PL_{12 - 15}

Total cost

RMB 80 - 100 (US\$ 11.7 – 14.6) per 10,000 PL_{12 - 15}

Selling price

RMB 120 - 160 (US\$ 17.6 – 23.4) per 10,000 PL_{12 - 15}

* Note: One US dollar is equivalent to RMB 6.83

L. vannamei hatcheries: costs of larvae-rearing

Nauplii (2nd generation)

- Selling price: RMB 1 - 2 (US\$ 0.15 – 0.30) per 10,000 nauplii
- Cost per 10,000 PL_{12 - 15} based on 30% survival: RMB 3.3 – 6.7 (US\$ 0.48 – 0.98)

Feeding cost

RMB 17 - 20 (US\$ 2.49 – 2.93) per 10,000 PL_{12 - 15}

Other cost

RMB 10 - 15 (US\$ 1.46 – 2.20) per 10,000 PL_{12 - 15}

Total cost

RMB 30 - 40 (US\$ 4.39 – 5.86) per 10,000 PL_{12 - 15}

Selling price

RMB 60 - 90 (US\$ 8.78 – 11.71) per 10,000 PL_{12 - 15}

* Note: One US dollar is equivalent to RMB 6.83

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Constraints

1. Inadequate supply of quality SPF broodstock

While the demand for “1st generation” PL is on the rise, some imported broodstocks perform poorly (low maturity rate, low fertilization rate, poor quality nauplii). Quality SPF broodstocks are in short supply and expensive.

2. Inferior quality of locally-raised broodstocks

Locally-raised broodstocks are not properly selected. The reproductive performance is poor and the growth of the offspring is slow with much size variation.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Problems

- 1. Zoea II syndrome often occurs, resulting in low survival.**
- 2. Unknown causes of empty gut during mysis stage.**
- 3. The use of formalin in water treatment, which has become popular, may impose some side effects on shrimp health and possibly cause environmental hazards.**
- 4. The use of antibiotics still exists, though the incidents have been greatly reduced.**

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Problems

- 5. The use of probiotics, prebiotics, and immunoenhancers becomes popular. However, the effect is inconsistent. The commercially available health products are unreliable in qualities.**
- 6. The overall survival rate from nauplii to PL is too low (< 25%). The technique of larvae-rearing needs to be further improved.**
- 7. The contamination of pathogens especially protozoan parasites in mass culture of algae.**

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Problems

- 8. The contamination of pathogens in live feed for broodstock.**
- 9. The majority of the hatcheries operate without bio-security setup. The importance of the bio-security has been overlooked. Potential consequence is the viral infection in the hatchery. Many incidents of the viral infection in the hatchery have been diagnosed.**

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

1. The extension of the duration of the hatchery operation

Due to the establishment of the enclosure ponds in Northern Guangdong, Fujian and Zhejiang provinces, especially Yangtze River delta and Pearl River delta areas, demands for PL are now almost all year round. The hatcheries can thus operate on a non-stop basis. The operational costs are therefore significantly reduced.

2. Awareness of the importance of PL quality

The demand for good quality “1st generation” PL is expected to increase. The hatcheries, which produce low quality PL, will be phased out and those, especially major producers with well-established brand names will prevail.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

3. Stock improvement and selective breeding

China has to expedite its research and development on the stock improvement and selective breeding of *L. vannamei* in order to solve the existing problem of inadequate supply of quality broodstock .

4. The abuse or misuse of antibiotics

Effective measures has to be tightened on the control of illegal use of antibiotics and other prophylactic chemicals.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

5. Zoea II syndrome

The causes of Zoea II syndrome need to be identified and the problems resolved so that the overall successful rate of PL production can be ensured.

6. The use of formalin in water treatment

Though it is the most effective method in sterilization, research is urgently required to define the advantages and disadvantages of using formalin in water treatment.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

7. The use of probiotics, prebiotics and immunoenhancers

More research is required to justify the use of probiotics, prebiotics and immunoenhancers in larvae-rearing. The correct way of using those health products (eg. dosage and time of application) is yet to be defined. The governmental regulations on the production and sales of those products are anticipated.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

8. The use of formulated feed for broodstock

Partial replacement of live feed with formulated feed for broodstock needs to be encouraged and promoted.

9. Contamination in mass culture of algae

Method for solving the problem of the contamination of pathogens in mass culture of algae needs to be developed.

***L. vannamei* hatchery industry in China: constraints, problems, and perspectives**

Perspectives

10. Contamination in live feed for broodstock

Potential pathogenic contamination of live feed, such as polychaete worms and oyster, deserves more attention.

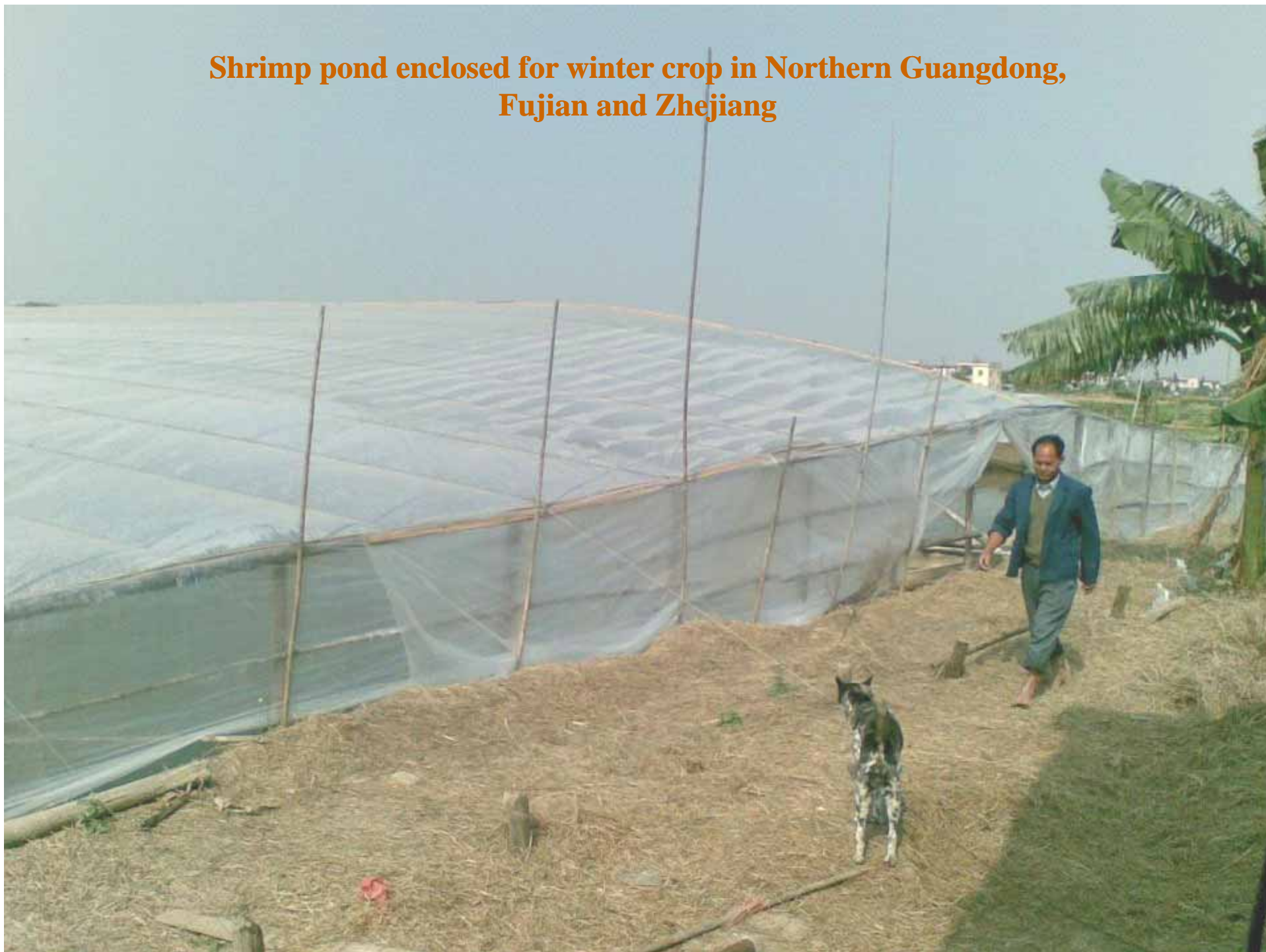
11. The establishment of the bio-security systems

The importance and significance of the bio-security systems for the shrimp hatchery industry needs to be highlighted.

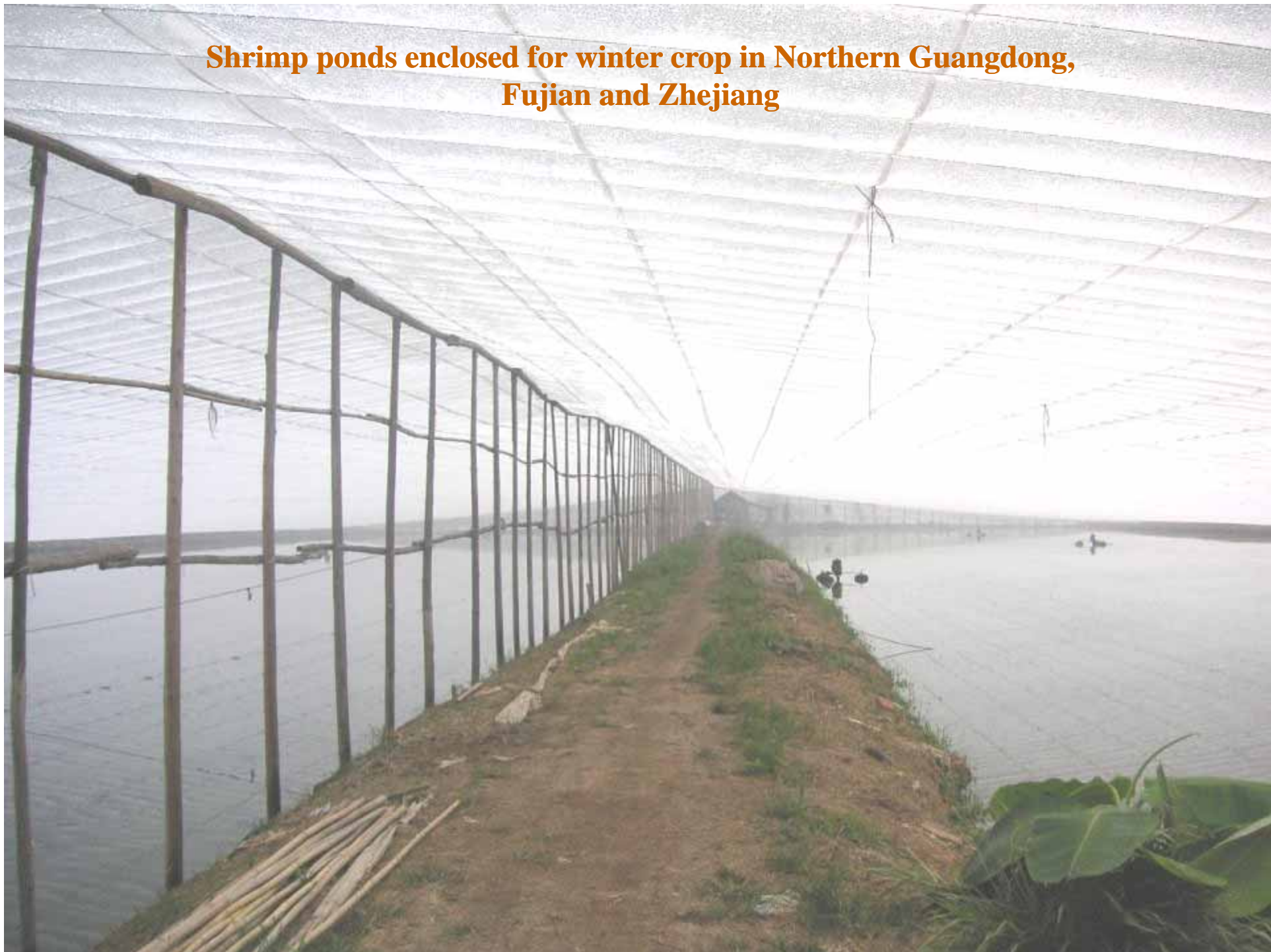
Typical *L. vannamei* intensive farm (Evergreen Group)



**Shrimp pond enclosed for winter crop in Northern Guangdong,
Fujian and Zhejiang**



**Shrimp ponds enclosed for winter crop in Northern Guangdong,
Fujian and Zhejiang**



**Shrimp pond enclosed for winter crop in
Northern Guangdong, Fujian and Zhejiang**



**Shrimp pond enclosed for winter crop in Northern Guangdong,
Fujian and Zhejiang**



**Shrimp pond enclosed for winter crop in Northern Guangdong,
Fujian and Zhejiang**



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Larvae-rearing room (Evergreen Group)



Typical *L. vannamei* larvae-rearing tanks in China



Broodstock room (Evergreen Group)

L. vannamei spawners



Fully matured female *L. vannamei*



**Tight bio-security:
three steps in sterilization
(Evergreen hatchery)**



Vehicle washing basin at the gate



**Foot and hand sterilization before
entering larvae-rearing complex**



**Foot and hand sterilization before
entering larvae-rearing room**



Algal inocula in solid medium



Algal inocula in test tubes and flasks



Algal stock (left:Chlorella sp., right:Chaetoceros sp.)



Algal stock (*Chaetoceros sp.*)



Algal stock (*Chaetoceros* sp. and *Chlorella* sp.)



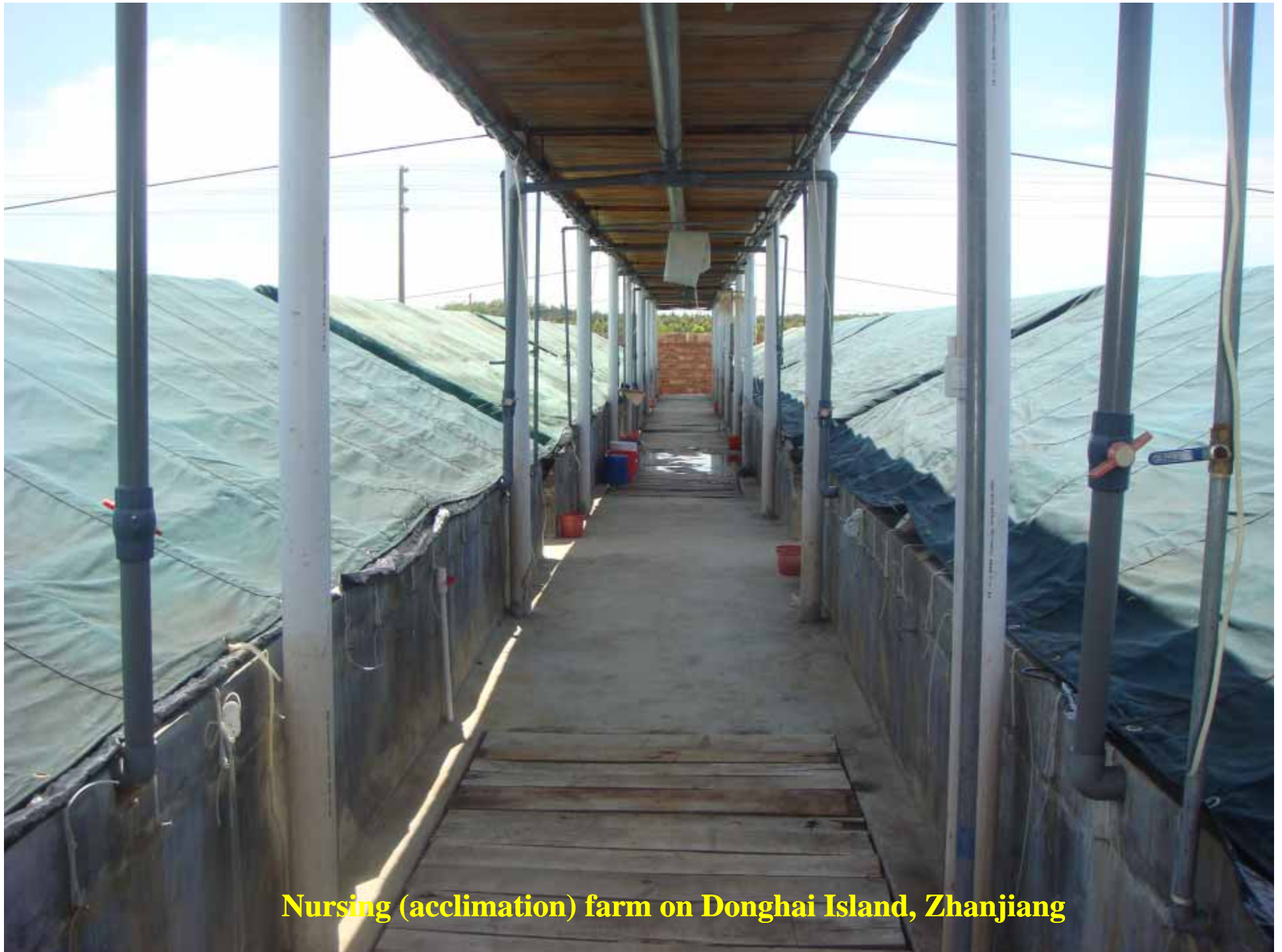
Mass culture of algae in outdoor concrete tanks



***L. vannamei* postlarvae**



***L. vannamei* postlarvae**



Nursing (acclimation) farm on Donghai Island, Zhanjiang

Nursing (acclimation) tanks equipped with heaters



**Thank you
For
Your Time and Patience**



Evergreen Aquaculture Research Center on Donghai Island



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