Alliance
(https://www.aquaculturealliance.org)

Global Aquaculture Advocate

Health & Welfare

Penaeus vannamei seedstock production

Monday, 1 December 2003

By Jim Wyban, Ph.D.

Recent developments in Asia

Most shrimp hatcheries in Asia keep the males and females in separate tanks.

Shrimp farming in southeast Asia is undergoing a dramatic transformation. The main farmed species is rapidly switching from black tiger shrimp (*Penaeus monodon)* to Pacific whiteleg shrimp (*P. vannamei)*. This changeover started in Taiwan in the late 1990s with imported specific pathogen-free (SPF) *P. vannamei* broodstock from Hawaii, USA, moved to China, and is now in full swing in Thailand.

It is driven by *P. vannamei's* faster growth, higher yields and lower production costs compared to recent results with *P. monodon*. The biological basis of this advantage is derived from the SPF and domestication status of the imported *P. vannamei*. In contrast, many *P. monodon* postlarvae are produced from wild-caught broodstock that can be contaminated with pathogens.

Asian nauplii production

Most procedures in Asian hatcheries producing *P. vannamei* seedstock are similar to those in the West. For example, Asian hatchery operators quickly adopted the use of bloodworms for maturation diets. Most Asian hatcheries use live bloodworms gathered from local seashores.

The bloodworms collected in temperate climates may have superior nutritional value for shrimp maturation when compared to bloodworms from tropical regions. In the West, bloodworms from Panama are not as productive as those from Maine, USA. In Asia, bloodworms from the Shanghai area of China, a temperate source, are reported to produce higher nauplii per spawn than bloodworms from Pattaya, a tropical area.

An interesting innovation in *P. vannamei* nauplii production has evolved in Asia. In most *P. vannamei* hatcheries in the West, male and female broodstock are cultured together in maturation tanks. Natural mating occurs shortly before a mature female is ready to spawn. Around sunset daily, mated females are transferred from the maturation tank to spawning tanks before they spawn. During the night, the females spawn and are returned to the maturation tank the following morning.

In Asia, most hatcheries keep the males and females in separate tanks. Mature females are transferred in the afternoon into all-male mating tanks, where they quickly mate. After dark, the mated females are transferred to spawning tanks. Many Asian operators claim this method results in higher mating frequency than mixed-sex systems. Asian hatchery operators using 200 pairs of broodstock produce 3 to 4 million nauplii per day, with 10 to 15 percent of females mating per night and 135,000 to 225,000 nauplii per spawn.

Asian larval rearing

P. vannamei larval-rearing systems in Asia are typically small, entrepreneurial operations, as opposed to Western industrial-scale facilities. A typical Asian hatchery may produce 2 to 5 million PL per month. These small operators achieve great efficiencies and can produce PL at very low costs.

Asian operators use a variety of microalgae as shrimp larval diets, including *Skeletonema*, *Chaetoceros* and other marine diatoms. While artemia nauplii are used in mysis and PL stages, Asian hatcheries typically feed more artificial diets during larval rearing than Western hatcheries.

Competition among hatcheries has encouraged farmers to demand larger PL, and most hatcheries sell PL_8 or larger. One of the largest concentrations of shrimp hatcheries in the world is near Qinghai on Hainan Island in southern China. More than 500 hatcheries line both sides of the road along the coast outside the city.

These facilities range in size up to 1,000 metric tons (MT) tank volume. They look like typical Asian hatcheries, with a collection of 20- to 30-MT rectangular concrete tanks inside simple buildings. Some facilities produce nauplii only, and some produce only PL, while some produce both stages. Over 1 billion *P. vannamei* PL per month are produced in Qinghai.

Production problems

The main problems for *P. vannamei* PL production in Asia occurs in the zoea stage of larval development. Zoea is the first larval stage dependent on outside feeding and digestion in the newly formed gut.

The most common zoea problem, called zoea II or Z II syndrome, has plagued Western hatcheries and so is no surprise in Asia. In this syndrome, when the larvae metamorphose to stage zoea II, the gut is empty and the larvae never start feeding. Epithelial cells lining the gut are shed into the lumen, and the animals die before reaching zoea III. No single pathogen has been identified as the cause of the problem.

Efforts to prevent zoea II usually include improved hygiene throughout the larval-rearing process. Improved algae quality using a serial dilution per batch culture method often helps. An elegant solution to the zoea II problem was described by Garriques et al in 1995.

In it, a probiotic is developed at the hatchery facility. The probiotic is isolated from the local environment and cultured much like microalgae. Daily addition of the probiotic, with sugar as a nutrient, prevents the establishment of pathogenic bacterial strains by competitive exclusion.

Another common cause of zoea mortality is metal contaminants in the water, which result in setae deformities at the zoea stage. Addition of 10 ppm EDTA to hatchery water eliminates this problem.

Another cause of zoea problems is related to broodstock nutrition. During high rates of maturation, spawning, and rematuration, female spawners require very high levels of certain nutrients. High Health Aquaculture, an SPF *P. vannamei* broodstock and technology supplier to several large hatchery projects in Asia, showed that inadequate pigments in broodstock diets result in a pigment deficiency, which appears as a bleaching of ovarian color from red/orange to grey/white.

At the zoea stage, the yolk of larvae from pigment-depleted spawners lacks color. The larvae have setal deformities and show low survival at zoea II-III. This problem can be solved by pigment addition to the broodstock diet. A simple method to add pigment is to topcoat squid with paprika.

Seedstock prices

In China, where *P. vannamei* farming developed in 1999 and has since gone through a boom and bust cycle (described below), prices during the spring of 2003 were rock bottom at U.S. $0.50 to 1.50 per 1,000 PL. A three- to fourfold premium was paid for “Hawaii” stock PL, but there is widespread confusion about what is meant by “Hawaii” stock.

In Thailand, *P. vannamei* nauplii were U.S. $0.15 per 1,000 in September. *P. vannamei* PL were U.S. $3.75 to $6.50 per 1,000, with the total Thai *vannamei* PL market reported at 3 billion PL per month. Head-on 20-g shrimp received U.S. $4.00 per kilogram at pond side, while 16-gram animals got $3.00 per kilogram and 12-gram shrimp received $2.50 per kilogram.

Since then, pond-side prices for *P. vannamei* declined to about U.S. $2.50 per kilogram for 20-gram shrimp. PL prices also declined sharply, resulting from both lower shrimp prices and an increase in PL supply from abundant home-grown broodstock.

Boom and bust

Home-grown *P. vannamei* broodstock typically become available in Asian countries within one year of the first wave of SPF *P. vannamei* pond production. Widely available at lower costs than imported SPF broodstock, the home-grown animals result in huge quantities of nauplii and PL flooding the market. PL prices can plunge to U.S. $1.00 per 1,000 or less.

Because the home-grown broodstock are inbred and not pathogen-free, their use results in increasing viral loads and other problems for the industry. This starts a virtual cycle of declining performance, which leads to cost-cutting efforts that pressure hatcheries to reduce costs, which forces them to buy cheaper local broodstock.

This pattern first occurred in Taiwan, then in China, and is now happening in Thailand. In Thailand, it has been exacerbated by the government’s ban on *P. vannamei* broodstock imports, which began in March 2003. The ban was intended to prevent the introduction of shrimp diseases to Thailand, but actually increased the volume of noncertified stocks smuggled into Thailand from China and Taiwan, and infused the Thai industry with massive quantities of infected shrimp carrying White Spot Syndrome Virus and other viral pathogens.

Conclusion

Despite problems, the Asian shrimp industry has made tremendous strides in producing *P. vannamei*. In fact, their production success is their biggest problem, because the massive production of *P. vannamei* in Asia is driving shrimp prices to their lowest levels in history.

To overcome this problem, the industry must expand its markets and use sustainable production systems that are reliable, cause no environmental impacts, and produce healthy, contaminant-free products. In the near term, introduction of SPF *P. monodon* could provide the industry with a new, fast-growing option that will allow Asian growers to produce 35- to 40-gram shrimp in 120-day crops.

(Editor's Note: This article was originally published in the December 2003 print edition of the Global Aquaculture Advocate.*)*

Author

JIM WYBAN, PH.D.

High Health Aquaculture, Inc.
P.O. Box 1095
Kurtistown, Hawaii 96760 USA

wyban@gte.net (mailto:wyban@gte.net)