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Black tiger shrimp domestication advances

Responsible Seafood Advocate logo

1 July 2009 Nigel Preston, Ph.D. Greg Coman, Ph.D.

Biosecure production, genetic markers assist development

Black tiger shrimp long dominated Asian production due to their rapid growth, large harvest size and attractive market prices. Limited success in their domestication and selective breeding saw the species displaced by white shrimp.

Over the past decade, the global production of farmed white shrimp (*Litopenaeus vannamei*) has continued to expand throughout the major shrimp-farming regions of the world. The most dramatic increases have been in Asia, particularly in China, Thailand and Vietnam, where *L. vannamei* have progressively replaced native species such as the black tiger shrimp (*Penaeus monodon)*, which was the dominant farmed species until 2003.

The dominant place that *P. monodon* held in global shrimp farm production was due to a number of factors, including their rapid growth rate, large harvest size and relatively high market price. While these characteristics are still very favorable for shrimp farmers, the Achilles heel for *P. monodon* has been the lack of success in its domestication and selective breeding.

The reliance of *P. monodon* farmers on wild broodstock and associated risks of lack of adaptation to the production environment and susceptibility to pathogens contributed to the move away from the species. In contrast, the domestication and selective breeding of specific pathogen-free stocks of *L. vannamei* has had a phenomenal impact on the adoption of this species by the global shrimp farming industry.

Pond rearing

A key factor that may have hampered progress in the domestication of *P. monodon* has been the many attempts to produce the earliest generations of domesticated broodstock in open-environment ponds. The transition from the natural environment to shrimp production ponds, particularity high-intensity ponds, is a challenge for any shrimp species.

For most species, the progeny of wild broodstock survive and grow reasonably well in ponds until they are harvested as young adults. In this respect, *P. monodon* outperform other farmed shrimp species, being able to reach commercial harvest sizes of 30 to 35 g in a shorter time. This was a main reason for the popularity of *P. monodon* in an era when the global shrimp industry relied almost entirely on wild broodstock.

However, the capacity for undomesticated shrimp stocks to survive and develop into healthy, reproductively mature adults in production ponds is a significant challenge for all shrimp species, particularly *P. monodon*. It is possible that the progeny of wild *P. monodon* are particularly susceptible to viral infections, especially when they are coupled with rapid fluctuations in environmental conditions.

Five-month-old domesticated *P. monodon* broodstock.

Controlled, biosecure rearing

The alternative to producing shrimp broodstock in open ponds is to rear the progeny from egg to reproductive adults in biosecure, controlled environment facilities that more closely mimic the natural environment of wild broodstock. A critical component of this strategy is to screen the parent broodstock for pathogenic viruses. This strategy resulted in the highly successful domestication of *L. vannamei* and the subsequent progressive gains in genetic improvement via selective breeding.

More recently, biosecure rearing led to significant progress in commercial-scale domestication and selective breeding of *P. monodon* in Australia. Australian stocks of *P. monodon* reared for five generations in controlled-environment tanks and raceways had a 10-fold higher nauplii production than first-generation broodstock. Furthermore, yields from ponds stocked with the progeny of fifth-generation *P. monodon* broodstock were up to 60 percent higher than from adjacent ponds stocked with the progeny of wild broodstock.

Costs, comparisons

The success achieved in *P. monodon* has the potential to rapidly increase the availability of high-health, specific pathogen-free stocks and to develop specific pathogen-resistant stocks. Although these developments would provide farmers with an option to switch back to *P. monodon* or trial the species with lower risks than stocking ponds with the progeny of wild broodstock, the future for *P. monodon* will ultimately be determined by production costs.

In the absence of domesticated, selectively bred *P. monodon*, it has not been possible to rigorously test assumptions about the relative benefits of farming *L. vannamei* and *P. monodon*. Comparison of the performance of the progeny of wild broodstock with that of the progeny of domesticated stocks would clearly favor the latter.

With the emerging opportunity to test like with like, comparisons between selectively bred *L. vannamei* and *P. monodon* for basic production traits such as survival, growth and disease tolerance may soon be possible. There is also increasing interest in evaluating the amenability of both species to intensive culture technology and the ability to perform well on lower-protein feeds.

These latter traits are currently the domain of *L. vannamei*. Nevertheless, the inherent capacity for rapid growth, large harvest size and associated high market price of *P. monodon* may yet provide farmers with an opportunity to emulate the global success that *L. vannamei* producers have achieved via selective breeding.

Genetic opportunity

As the future of farmed *P. monodon* unfolds, there is an opportunity to track the genetic changes that take place using molecular tools and techniques that were simply not available when *L. vannamei* domestication and breeding programs developed. In Australia, genetic markers are currently being used to assess genetic diversity in wild stocks, track changes in diversity in domesticated stocks and assign pedigrees within selective-breeding programs.

Genetic markers are also being used to explore the potential of natural mating as a practical alternative to artificial insemination without compromising effective genetic management of the breeding stocks. The application of genetic markers should enhance the capacity of the *P. monodon* industry to optimize selective-breeding programs for the species.

Editor's Note: This article was partly based on the review paper "Advances in Penaeusmonodon *Breeding and Genetics" included in the proceedings of the Sustainable Shrimp Farming session of World Aquaculture 2009 in Veracruz, Mexico.*

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Now that you've finished reading the article ...

Authors

- Nigel Preston, Ph.D.

  Nigel Preston, Ph.D.

  CSIRO Food Futures Flagship
  CSIRO Marine and Atmospheric Research
  P.O. Box 120
  Queensland 4163 Australia

  [117,97,46,111,114,105,115,99,64,110,111,116,115,101,114,112,46,108,101,103,105,110]

- Greg Coman, Ph.D.

  Greg Coman, Ph.D.

  CSIRO Food Futures Flagship
  CSIRO Marine and Atmospheric Research

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