

Genetic improvement of pacific white shrimp *Litopenaeus vannamei*

Breeding program, progress and prospects

Fernando S. S. Ralden¹, Greg J. Cowan², Scott Cooper², Peter Rube³ and Harry King²

Pacific white shrimp (*L. vannamei*) is the world's most important cultured species on both the Atlantic and Pacific coast of the Americas and in Asia. Viet Uc Seafood Joint Stock Company is a Vietnam-based *L. vannamei* producer, breeder and seedstock supplier that since 2011, in collaboration with CSIRO, has completed 30 breeding cycles of selection (~8 generations) with the primary objective of increasing growth rate.

Breeding program

A breeding cycle has consisted of spawning and rearing 40 families, produced over three days (Figure 1). Families are reared separately during the hatchery and nursery phases and are elastomer-tagged at the end of the nursery phase (i.e. spawn/hatch and larval-rear steps shown in Figure 1), when the animals are approximately 2-5g in weight, to allow identification of families. Tagged individuals from each family are then weighed and stocked into raceways to form the different breeding cohorts; these being one or multiple brood and progeny testing cohorts (i.e. tag & mix step shown in Figure 1).

Progeny test cohorts are reared at densities typical of commercial conditions (approx. 150 individuals/m²) and brood and backup brood cohorts at densities appropriate for broodstock growth (approx. 20 individuals/m²). Progeny tests are stocked with 2,000 elastomer-tagged individuals (50 individuals per family), with an additional 18,000 untagged animals so stocked to enable 20,000 animals per raceway – which achieves the commercial densities. Brood cohorts are each stocked with 2,640 elastomer-tagged individuals (66 individuals per family). Progeny tests are harvested at an age typical of commercial farming harvest (approx. 100 days after nursery age), at which time elastomer-tagged individuals are measured for weight (i.e. genetic test measure shown in Figure 1).

ASReml[®] was employed to analyse data using a bivariate model with broodstock and progeny test weight data. The outcomes of the genetic analysis guide the subsequent broodstock selection process, with the first stage involving selection of the appropriate families, and the second stage the selection of appropriate individuals within each selected family to propagate families in the future progeny generation breeding cycle. Recommendations include permitted crosses among currently and genetic link cycles.



Figure 1. Schematic showing the animal workflow in the breeding program.

Progress and Prospects

Very high heritability estimates of 0.52 (±0.10) for progeny test weight were estimated here. It is important to highlight that common environmental effects of nursery rearing were statistically significant, but always small explaining 7% of the total variation.

The increasing genetic trend for growth indicates strong positive improvements (around 1.8% per cycle, which equates to 5.8% per generation) in the harvest body weight performance of the breeding population (Figure 2, broken lines).

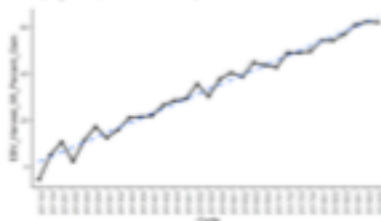


Figure 2. The average genetic gain for growth in the breeding population (cycles full breeding) over 30 cycles.

The phenotypic trend for harvest weight adjusted to a standard 140 days indicated a gain of approximately 40%, or an increase from 19 g to 27 g at 140 days (Figure 3, broken line), demonstrating that gains predicted from the genetic trends are being realised and indicates that genetic trends are sound.

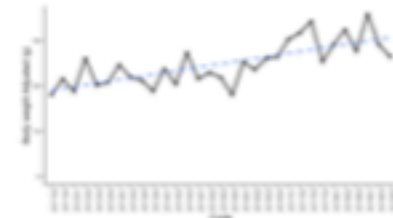


Figure 3. Phenotypic trend for growth in the breeding population (cycles full breeding) over 30 cycles.

From 2020 the Viet Uc program is planned to undergo significant expansion in scope changing from family-based to individual-based genetic management of the breeding population. This change will enable a significant increase in opportunity for genetic gain. Other significant developments are considered for the program, such as the application of genomic selection. Importantly, the strong current base of the animal, genetic and data resources of the Viet Uc *vannamei* program, which have been developed in the period from 2011 to 2019, positions the program well for future opportunities, and to significantly evaluate the genetic performance of the program in the coming years.