Step 0 : Arguments for genetic improvement

Shrimp farming in New Caledonia relies on the culture of a strain of Litopenaeus stylirostris introduced from Mexico and then domesticated at a time when genetic principles were of little or no consideration. Since then, advances in agriculture and for some aquatic species of importance led calédonian shrimp farmers to reconsider the appropriateness of a genetic improvement strategy adapted to local biotechnical and economical constraints.

Step 1 : Genetic variability assessment

The genetic variability available among the cultured population was first assessed. The strain appeared to be highly inbred and with low allelic variability (90% of the alleles had been lost during the industry. Its implementation will need the development of a strategy of seed quality through an SPF program which will also protect the third year of testing. The genetic strategy tested here which was efficient as long as the prevalence of the virus was low could not be transferred to the industry. Its implementation will need the development of a strategy of seed quality through an SPF program which will also protect the third year of testing.

Step 2 : Organization for introduction and testing of new strains

A complete organizational plan and work schedule was defined by the producers, the Zoosanitary Authority, and Ifremer (as a Research Institute) to import and test the Hawaiian population as pure or crossbred stocks in New Caledonia (Fig 2). This schedule involved many different and interrelated aspects: scientific and technologic (genetics, biosecurity, quarantine), economic and organizational (financing, diffusion of genetic improvement) and pedagogic (awareness of farmers).

Step 3 : Quarantine

As no pathogens were found in quarantine (Fig 3 – Goyard et al. 2007), Hawaiian animals were allowed to be transferred in earthen ponds to become breeders. A control study of the microsatellite loci confirmed that all alleles which had been identified in the Hawaiian population during the first test were present among the different families introduced in New Caledonia (Fig 4 – Goyard et al. 2007).

Step 4 : Testing of the « 2 way Hybrid » strategy

The genetic strategy chosen to be tested in priority was based on the cross of the two different strains of L. stylirostris which were maintained separately. This conceptual simple approach aimed at eliminating inbreeding, the first genetic limiting factor of improvement in captive populations. Tests were conducted on pure Hawaiian, F1-hybrids and pure Calédonian during 3 years in multiple conditions with mixed tagged populations - grown out in earthen ponds (Fig 5a), grow-out in cage cultures (Fig 5b), artificial infection with vibrios in controlled biosecure facilities (Fig 5c).

Figures 5a, 5b and 5c show the main results obtained in ponds during the first two years. They were consistent with those obtained in floating cages and injection rooms (data not shown) : F1-hybrids demonstrated better growth and survival than the 2 pure lines, and this could be interpreted either as the demonstration of an heterosis effect or as the demonstration of the effect of inbreeding in the 2 parental populations (Goyard et al., 2008).

Step 5 : Necessary development of large scale biosecurity

Nevertheless, these results could not be reproduced during the third year of testing when IHHNV Virus induced very poor growth and survival rates (near 0%) in the Hawaiian line, while the F1 hybrids were mainly affected in growth. These results were unexpected as preliminary tests following OIE recommendations conducted before the importation had not concluded to a high susceptibility of the Hawaiian line to IHHNV. In the meantime the calédonian line confirmed its tolerance to IHHNV. An hypothesis is that the Hawaiian line, which was checked free of virus at the time of importation, may have been contaminated during the first two generations and vertical transmission of the virus may have led to very high viral load and prevalence which induced disease during the third year of testing.

The genetic strategy tested here which was efficient as long as the prevalence of the virus was low could not be transferred to the industry. Its implementation will need the development of a strategy of seed quality through an SPF program which will also protect the calédonian line from any new viral disease which could arise locally. This strategy and organization, tested in New Caledonia, could possibly be of benefit to other small scale aquaculture activities in the Pacific islands.

Litterature cited


Figure 5a : Tagged animals of different genetic populations (Caledonian, Hawaiian and Hybrids) were tested in earthen ponds, cages and under experimental infection conditions