GENETIC IMPROVEMENT STRATEGY IN SMALL AQUACULTURE INDUSTRIES : THE NEW CALEDONIAN SHRIMP EXPERIENCE

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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 caledonian 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 domestication process). Another population of *L. stylirostris* available in Hawaii was identified as an interesting source of domesticated genetic variability as the 2 populations shared no alleles on the 3 microsatellite loci studied (Fig 1 - Goyard et al., 2003).

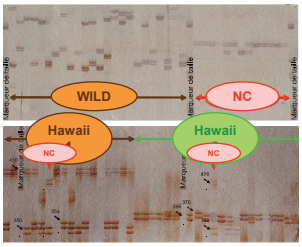

Fig 1 : microsatellite genotyping gels for the New Caledonian and Hawaiian domesticated lines in comparison with wild animals from Ecuador : most of the alleles have been lost during the domestication process

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, the local Development Authorities 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).

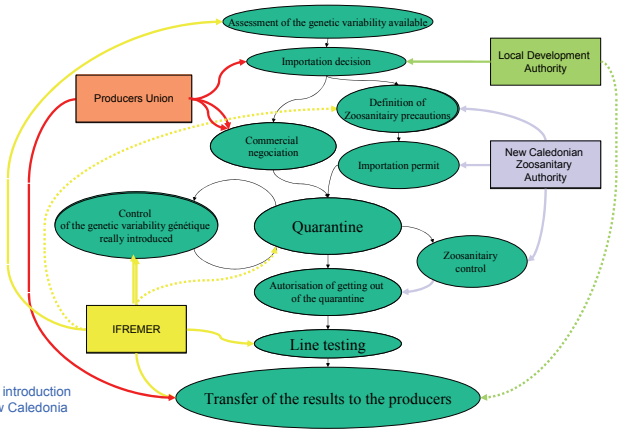

Fig 2 : multi institution organization for introduction and testing of the Hawaiian line in New Caledonia

Step 3 : Quarantine

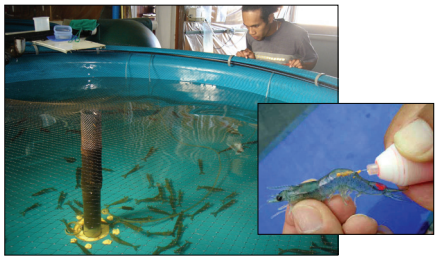

Fig 3 : Indoor quarantine facilities were run for 5 months before releasing the animals in outdoor earthen ponds. Juveniles were tagged by injection of elastomer to identify the pedigree of their descent.

As no pathogens were found in quarantine (fig 3 – Patrois 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 step were present among the different families introduced in New Caledonia (fig 4 – Goyard et al., 2007).

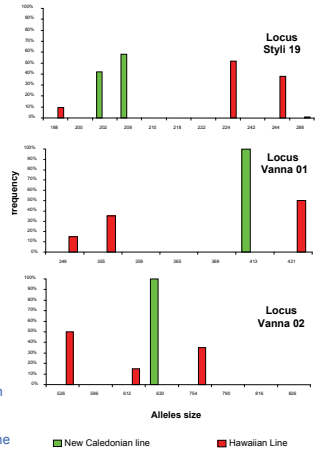

Fig 4 : No common allele were found at 3 microsatellite loci between the New Caledonian line and the Hawaiian animals at the end of the quarantine

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 conceptually simple approach aimed at eliminating inbreeding, the first genetic limiting factor of improvement in captive populations. Tests were conducted on pure Hawaiians, F1-hybrids and pure Caledonians during 3 years in multiple conditions with mixed tagged populations : grow-out in earthen ponds (Fig 5a), grow-out in cage cultures (Fig 5b), artificial infection with vibrios in controlled biosecure facilities (Fig 5c).

Figures 6a, 6b and 6c show the main results obtained in ponds during the first two years. They were consistent with those obtained in floating cages and infection 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).

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

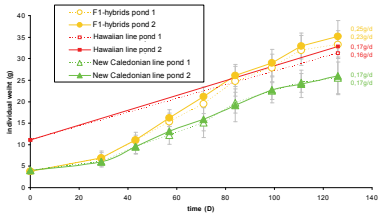

Fig 6a : growth rates observed in earthen ponds during the first year of testing
(the percentage in the yellow star indicates the relative gain of the F1-hybrids in comparison with the control caledonian line)

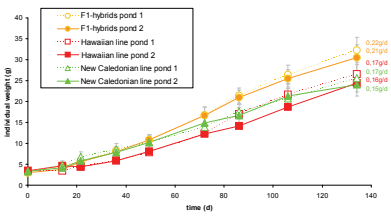

Fig 6b : growth rates observed in earthen ponds during the second year of testing
(the percentage in the yellow star indicates the relative gain of the F1-hybrids in comparison with the control caledonian line)

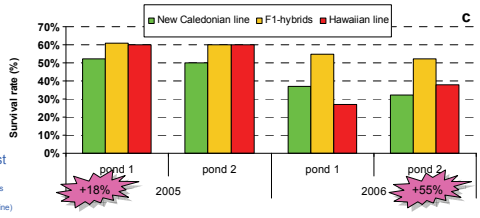

Fig 6c : survival rates observed in earthen ponds during the two first years of testing
(the percentage in the pink star indicates the relative gain of the F1-hybrids in comparison with the control caledonian line)

Step 5 : Necessary development of large scale biosecurity

Nevertheless, these results could not be reproduced during the third year of testing when IHHN 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 caledonian 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 caledonian 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

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Poster présenté au 11th Pacific Science Inter-Congress / 2nd Symposium on French Research in the Pacific. Papeete, Tahiti 2– 5 march 2009