



CENTRO DE INVESTIGACIONES
BIOLOGICAS DEL NOROESTE, S.C.
(CIBNOR)

SHRIMP BROODSTOCK MANAGEMENT FOR THE CONTROL OF GENETIC DIVERSITY AND INBREEDING

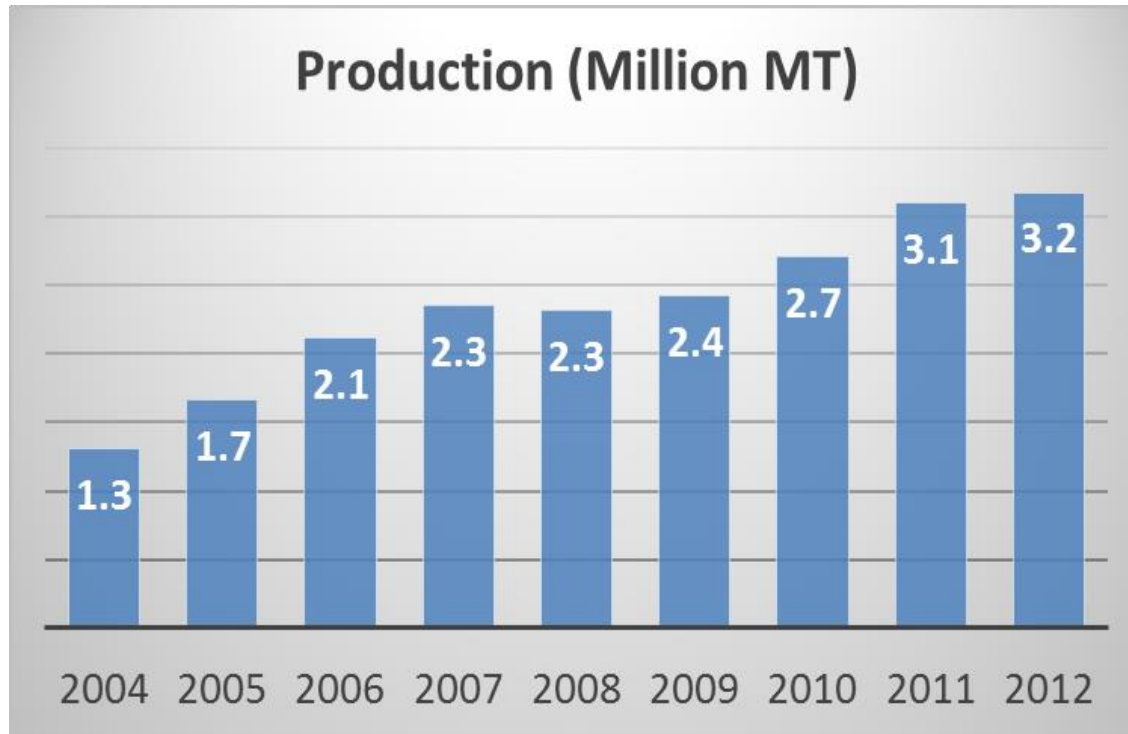
Ricardo Pérez-Enríquez, CIBNOR

Cristhian Robles-Cota, Blue Genetics Mexico

Jesús Peiro-López, Acuacultura Mahr

Pierrick Haffray, SYSAAF

Shrimp (*P. vannamei*) aquaculture



FAO, 2014

- Most important aquaculture species
- Disease issues
- 2014 production ca. 2M tons
- Selected broodstock demand: 1.6 Million shrimp

Acuacultura Mahr

Shrimp Genetic Improvement Program (2009-2010)



Scientific advisor



BLUE GENETICS MEXICO

Shrimp Genetic Improvement Program Mexico-France companies partnership



Shrimp Larvae producer

← Strategic alliance (2012) →



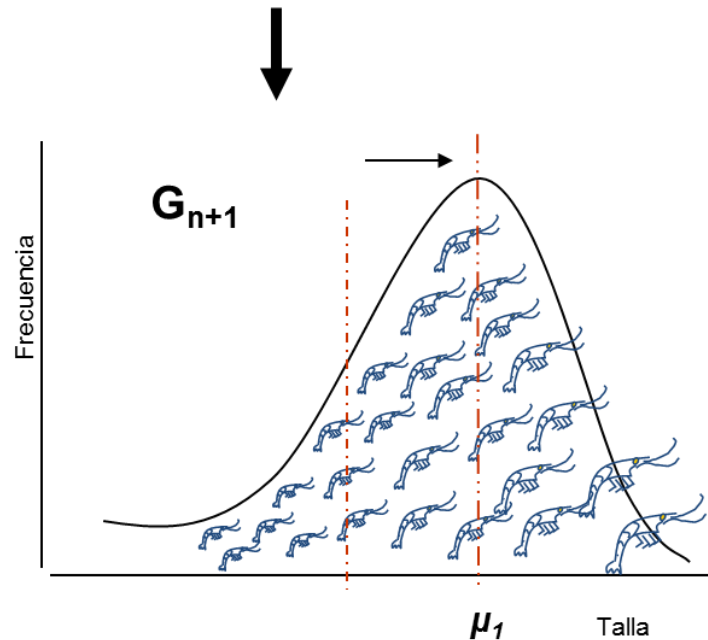
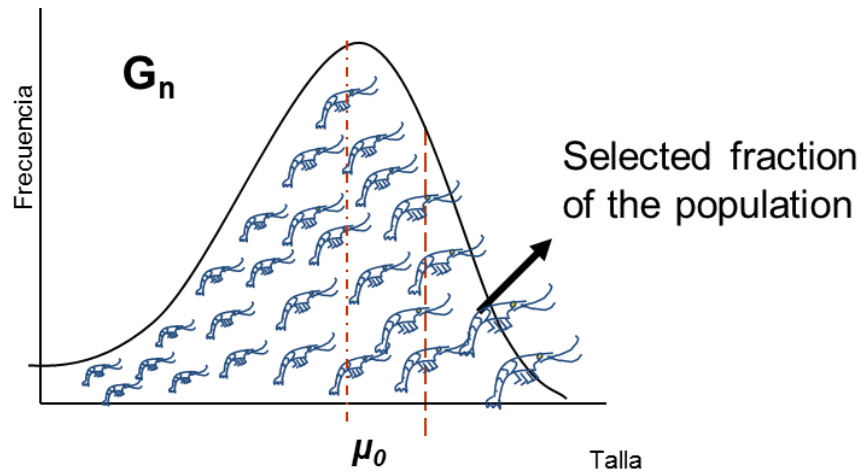
World leader in animal genetics



← Scientific advisors →



Genetic improvement by selection decreases diversity



✓ Genetically similar individuals are usually selected

✓ Loss of genetic diversity and inbreeding increase over generations

✓ The probability deleterious genes expression increases

- $F=0.37$ (Moss et al. 2007)
- Hatch rate (- 47%)
- Hatchery survival (- 39%)
- Pond survival (- 19%)



OBJECTIVE

- Obtaining SPF improved shrimp by selection
 - Minimize loss in genetic variability
 - Maintain low inbreeding





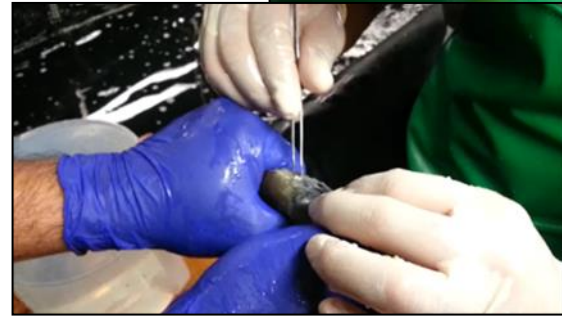
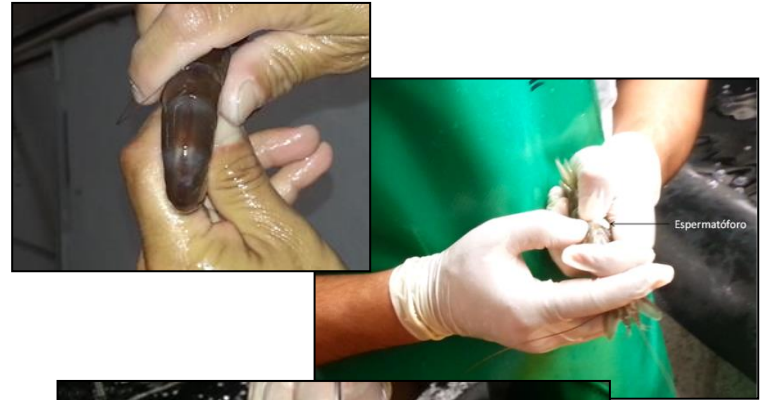
MATERIALS AND METHODS





BGM BREEDING SCHEME

Individual family reproduction



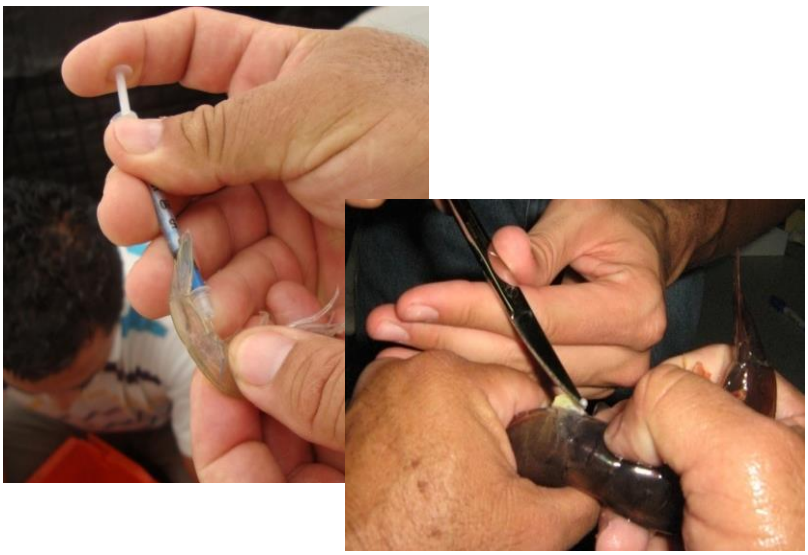
Artificial Insemination



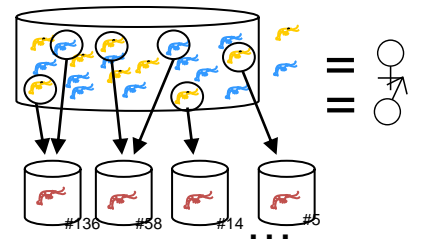
PIT-tags for individual ID



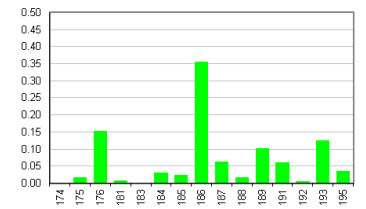
Genetic markers



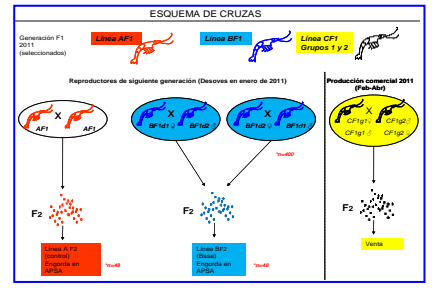
Pedigree follow-up



Genetic diversity surveys



Crossbreeding design

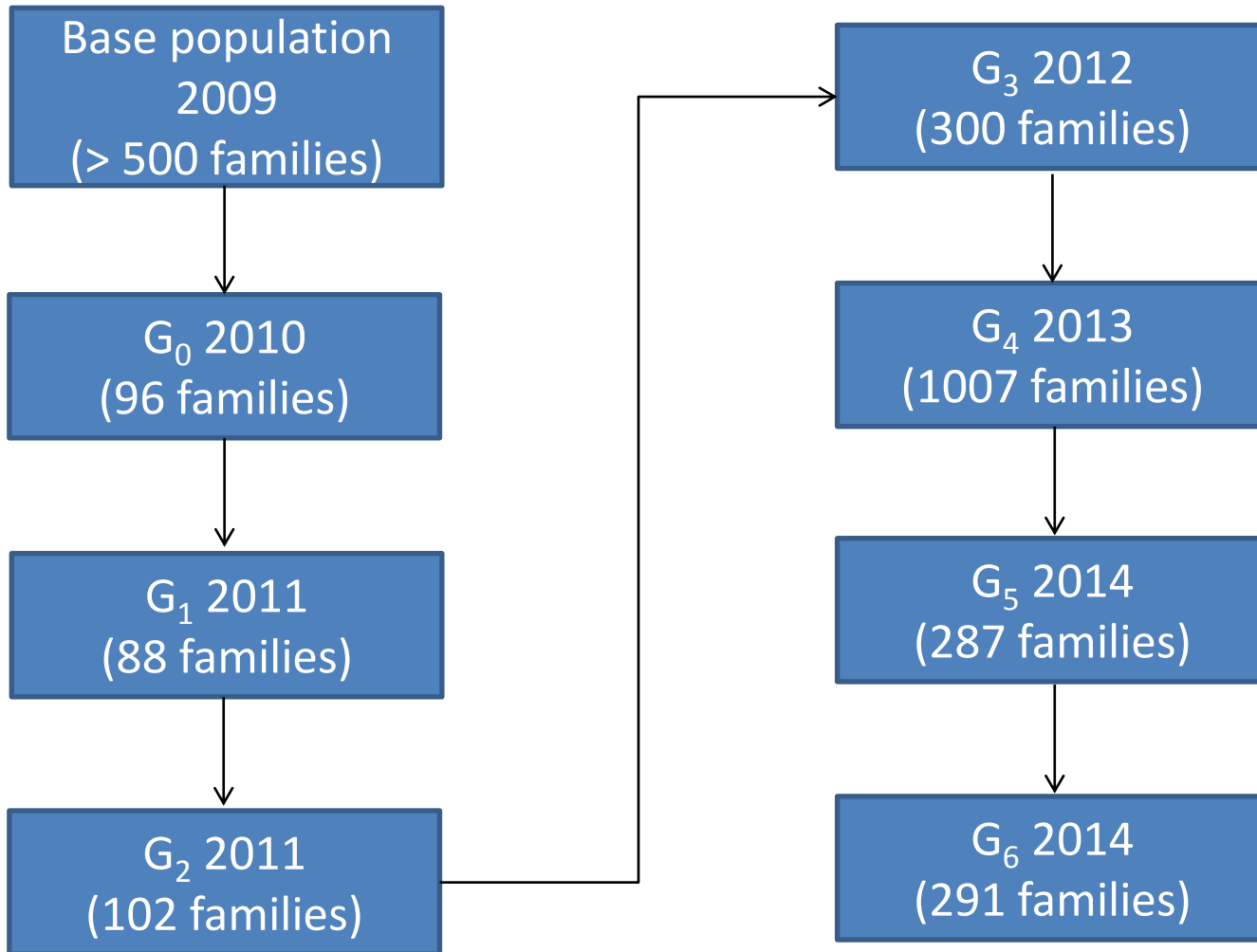


INFAQUA*: Database for genetic breeding programs

*Software property of SYSAAF/Hizkia



FAMILY PRODUCTION PER GENERATION



Inbreeding estimations by

1. Fluctuation of population size

$$F_t = 1 - \left(1 - \frac{1}{2N_e}\right)^t$$

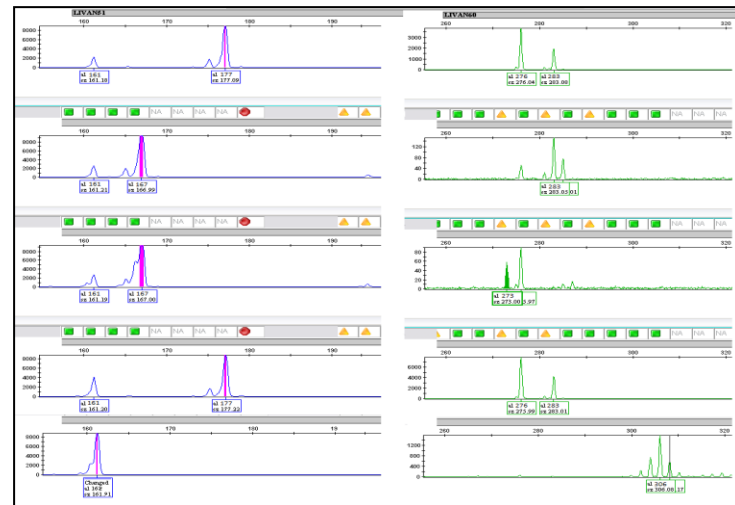
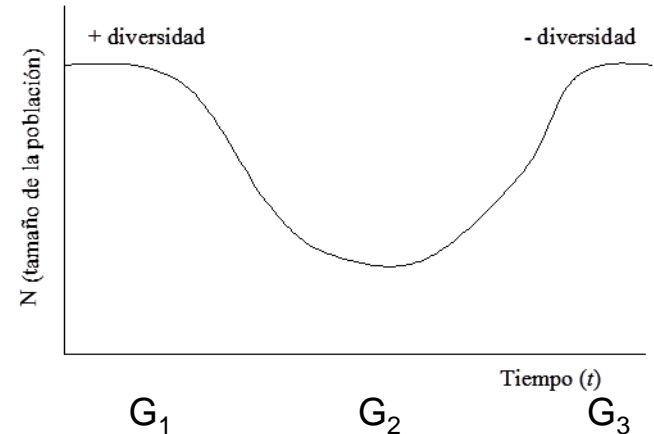
Family size: 40,000 np; $V_k \approx 0$

Sex ratio 1:1

2. Genetic markers (microsatellites)

$$F = 1 - \frac{H_o}{H_e}$$

Genetic bottleneck

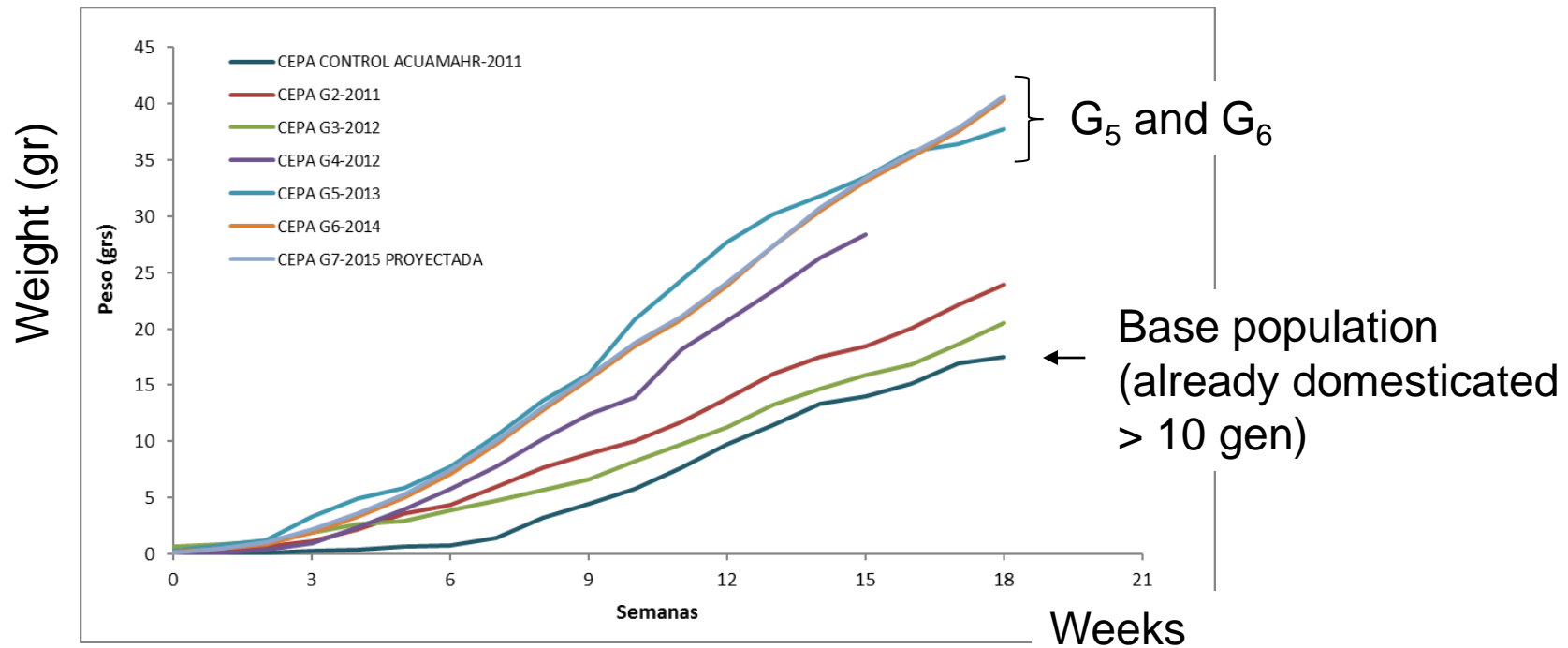




RESULTS



INCREASE IN GROWTH RATE



- Mass selection: 10-20% per generation
- G6 vs Base pop estimated gain in growth rate \approx 40%
- Estimation of Genetic Gain is in process

Table 1. Effective population size (Ne) and inbreeding coefficient (F) per generation in genetically selected line during 6 generations.

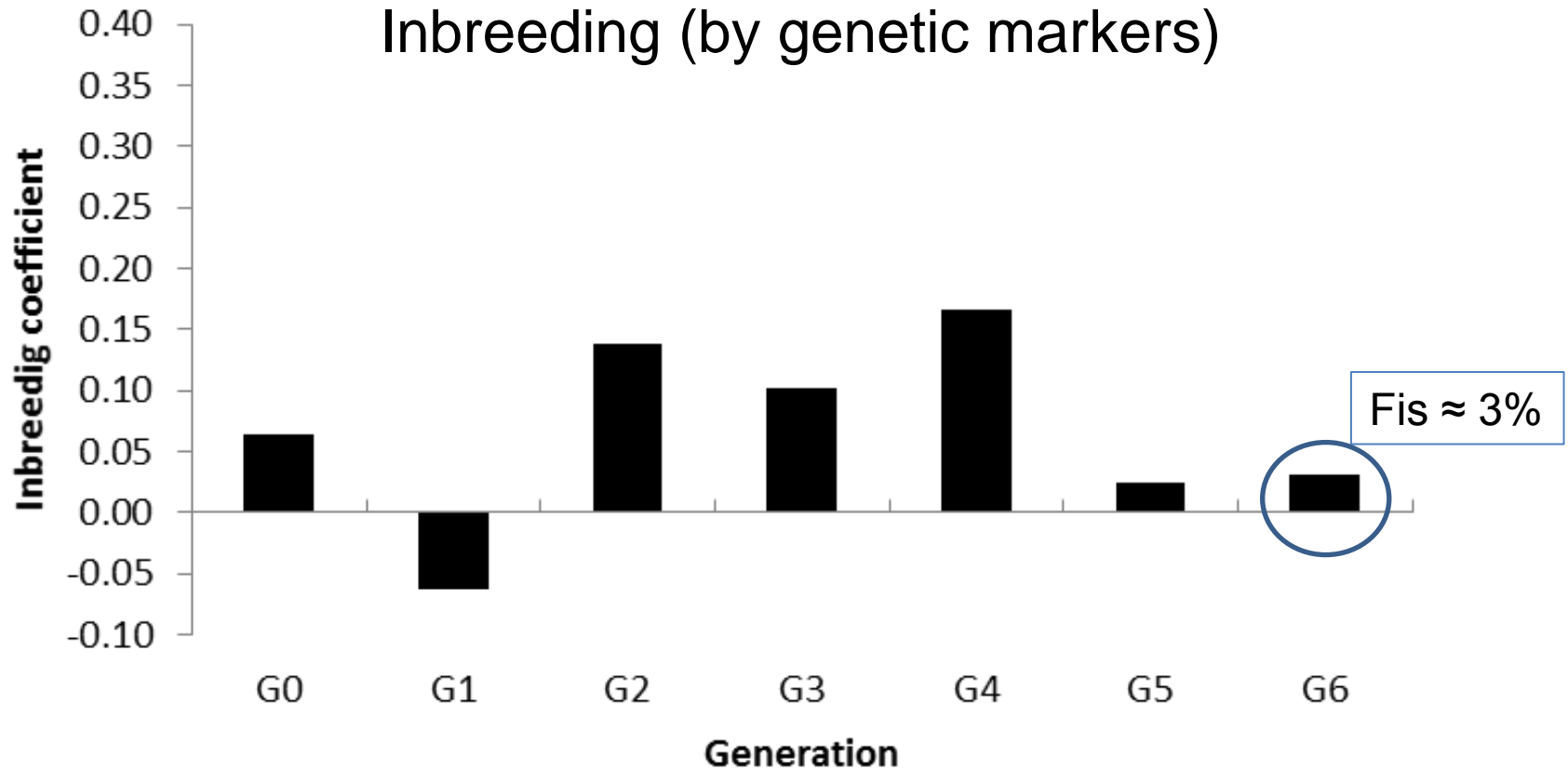
Generation	Number of Families	Ne	F
Base	500	1000	0.05%
G ₀	96	192	0.26%
G ₁	88	176	0.28%
G ₂	102	204	0.25%
G ₃	300	600	0.08%
G ₄	1007	2014	0.02%
G ₅	287	574	0.09%
G ₆	291	540 ^a	0.09%
Mean or total ^b		310.4	1.28%

^a Adjusted value due to a differential in the number of females (252) and males (291)

^b Ne and F values obtained by equations (1) y (2), respectively

Inbreeding (based upon population size fluctuation)

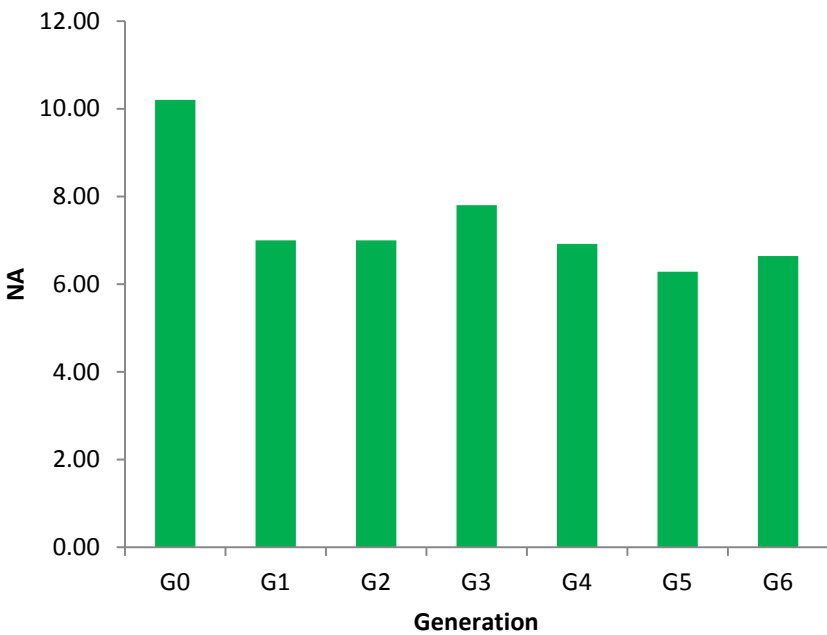
$$F = 1.28\%$$



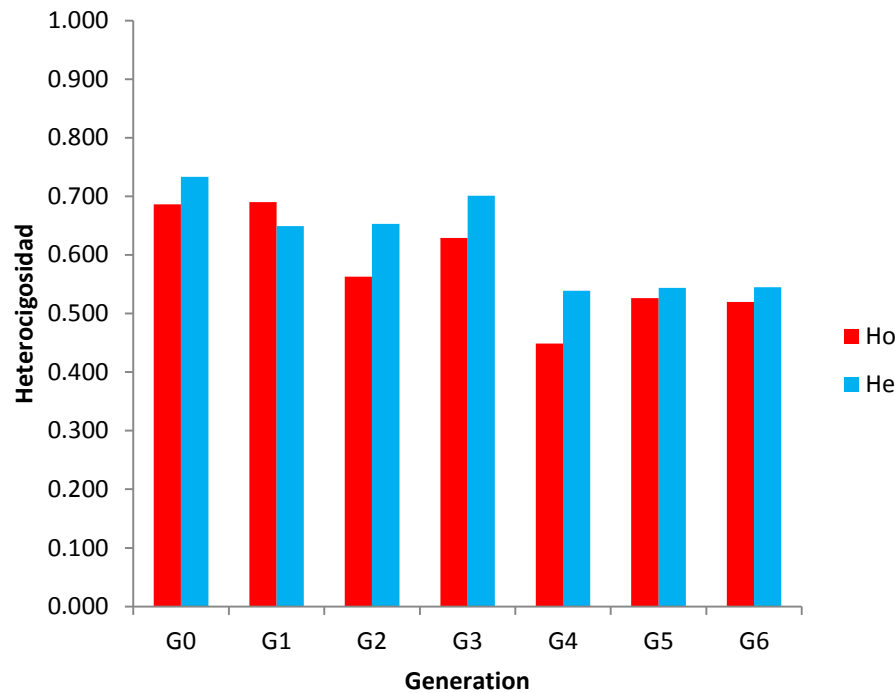


GENETIC DIVERSITY

Number of alleles per locus



Heterozygosity



*On G0 to G3 genetic markers of Perez-Enriquez et al. (2009); G4 to G6: markers sets of Labogena

CONCLUSIONS AND ONGOING WORK

- Breeding strategy succesful to keep inbreeding < 5% after 5 generations of selection and estabilized genetic diversity.
- G x E in progress
- Heritability estimations for fatty acids content (human health; immune response?) and color
- Paternity assignment with SNP markers
- Evaluation of hybrid vigor between growth and disease resistance (EMS, WSSV from Ecuador) lines

ACKNOWLEDGEMENTS

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¡Gracias por su atención!