

# GENETIC SIGNATURES of SELECTION & ASSOCIATION ANALYSIS of the DOMESTICATION EVENT in SOUTH AFRICAN ABALONE, *HALIOTIS MIDAE*

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# Introduction: Abalone

- Gastropod mollusc, genus *Haliotis*, with approximately 56 extant species, globally
- Five endemic species in South Africa
  - a) *H. midae*; b) *H. spadicea*; c) *H. alfredensis*; d) *H. parva*; e) *H. queketti*

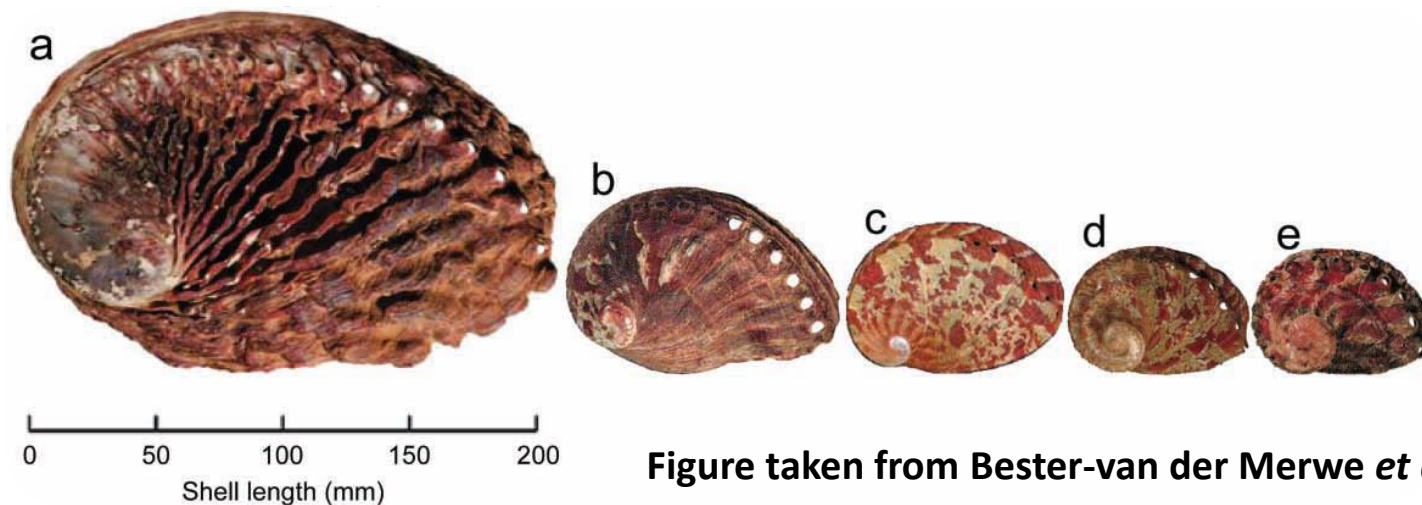
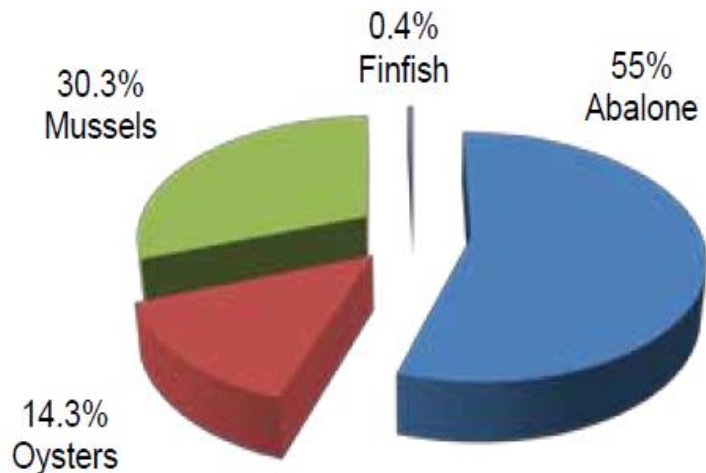


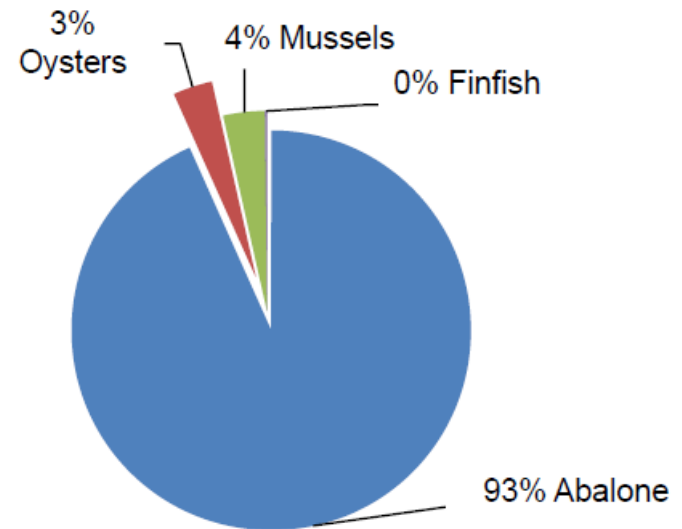
Figure taken from Bester-van der Merwe *et al.* 2012

# Introduction: Abalone

- *Haliotis midae*, i.e. *Perlemoen*
  - Local species of commercial importance
  - Fisheries and aquaculture



% Tonnage of total aquaculture production (Figure taken from DAFF, 2012)



% Revenue of total aquaculture production (Figure taken from DAFF, 2012)

# Introduction: Domestication as an Evolutionary Process

- Selection

- Relaxed natural selection for survival in the wild
- Increased natural selection for adaptation to “humanised environment”
- Increased artificial selection

- Demography

- Founder effect, reduction in effective population size
  - Greater influence of random drift
  - Increased inbreeding
  - Unequal parental contribution



# Introduction: General Observation for South African Abalone

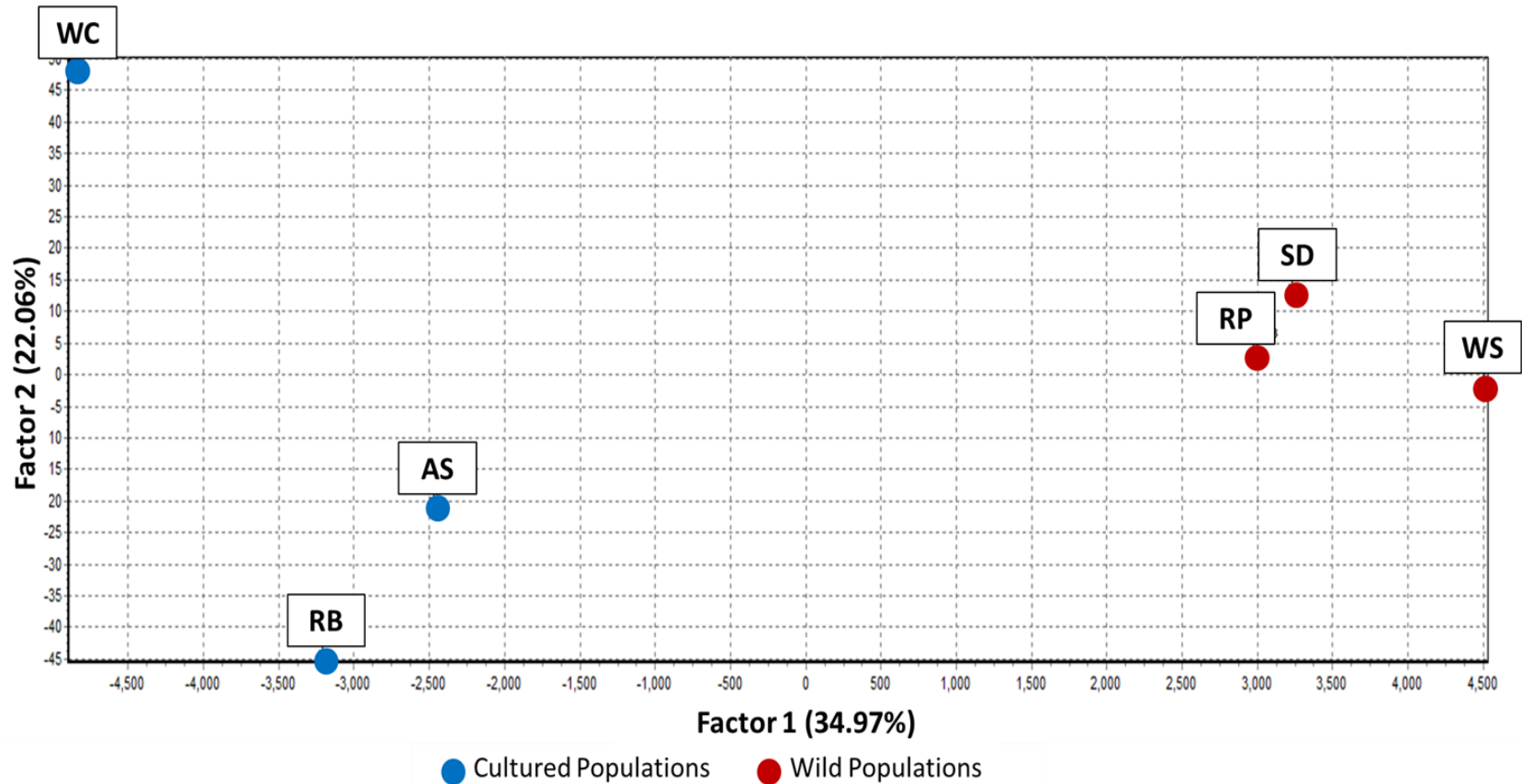


Figure adapted from Rhode *et al.*, 2012

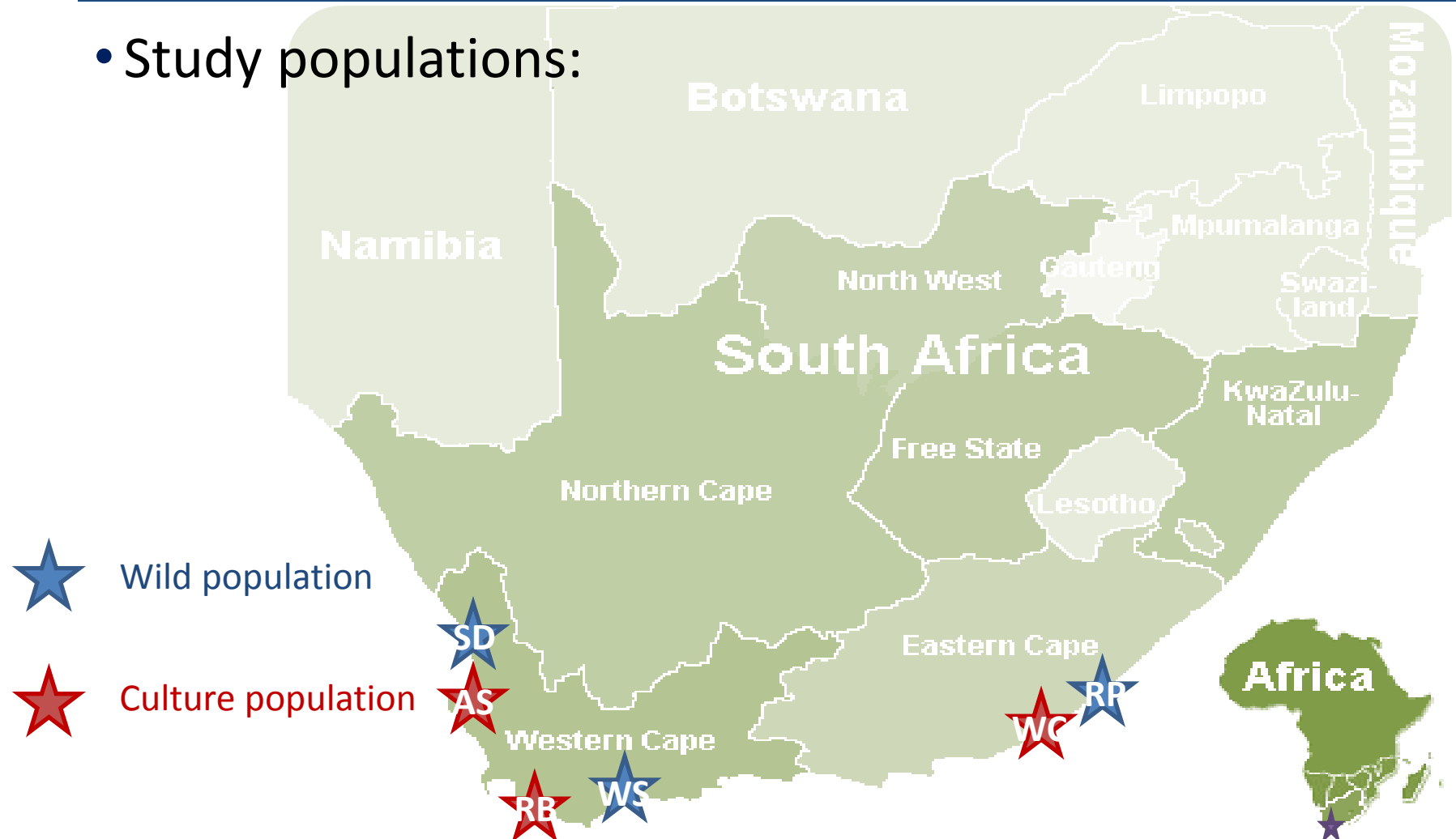
# Research Question

How is selection shaping the observed patterns of genetic variation in cultured populations of abalone?



# Identifying Signatures of Selection

- Study populations:



# Identifying Signatures of Selection

- Molecular markers
- 150 microsatellite markers
- Genome-wide distribution
- On average 10cM interval

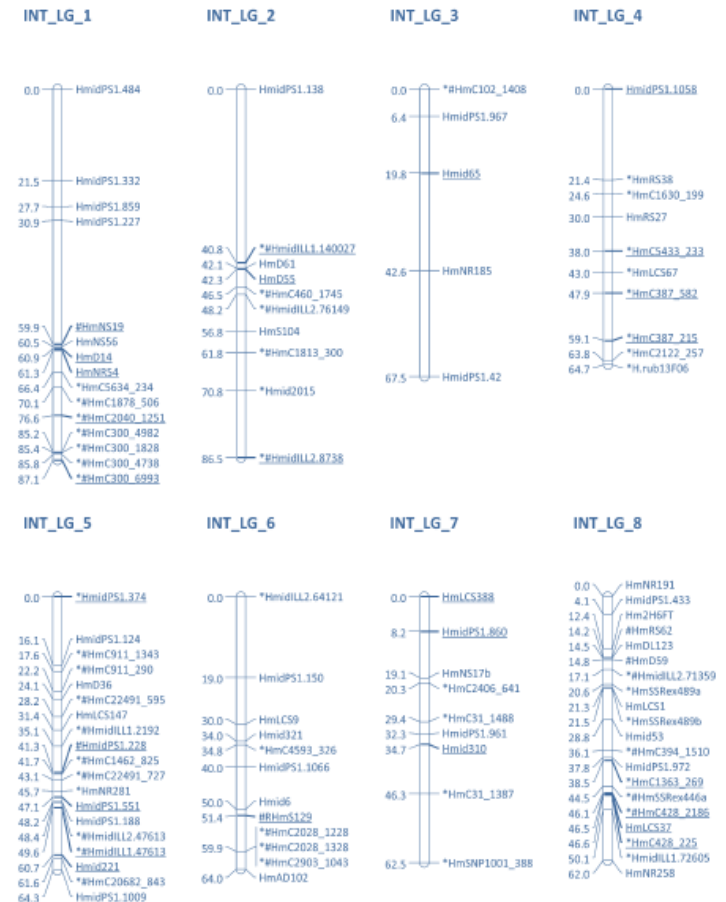
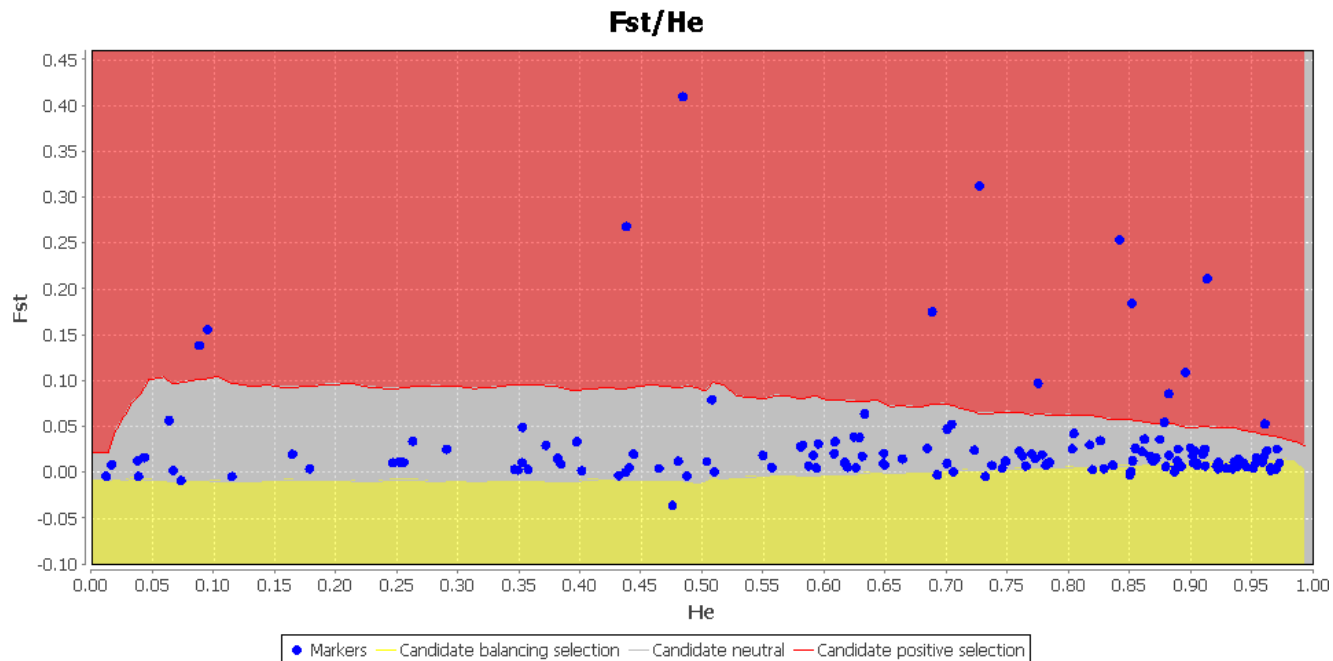


Figure adapted from Vervalle *et al.*, 2012



# Identifying Signatures of Selection

- Frequentist (LOSITAN) and Bayesian (BayeScan)  $F_{st}$ -outlier analysis



# Identifying Signatures of Selection

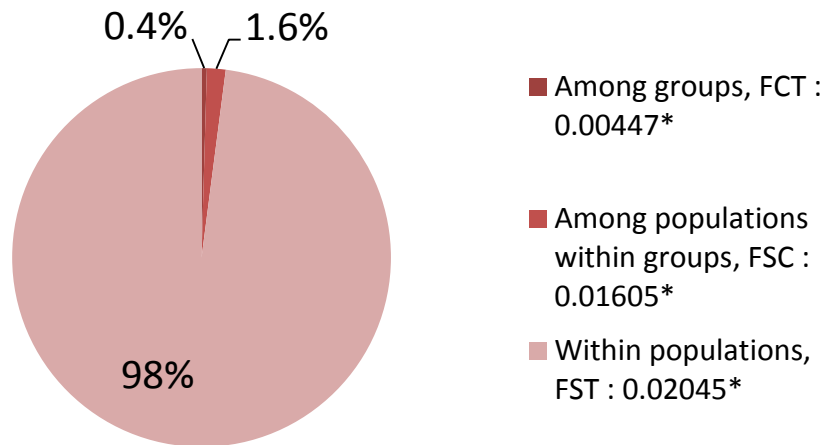
## % Loci under selection

	Across cultured populations	Across wild populations	Across all populations
Directional selection	2-4	3-13	~9
Balancing selection	4-12	2-3	6-18

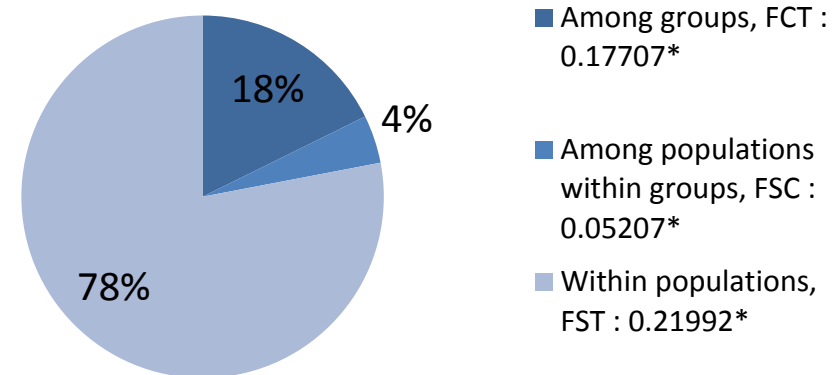
# Identifying Signatures of Selection

- Variance explained due to directional selection

AMOVA based on neutral loci (\* $P < 0.05$ )



AMOVA based on loci under directional selection (\* $P < 0.05$ )



# Marker Association with Growth

- Growth rate currently selected trait
- Artificial phenotypic selection causative to molecular signature of selection?
- Correlation of genetic variants with growth?



# Marker Association with Growth

- Commercial cohort of 661 F1 animals phenotyped
- Top and bottom  $\pm 15\%$  selected for genotyping
  - 13 loci under directional selection
- Parentage analysis to correct for family size bias (final cohort: 80)

# Marker Association with Growth

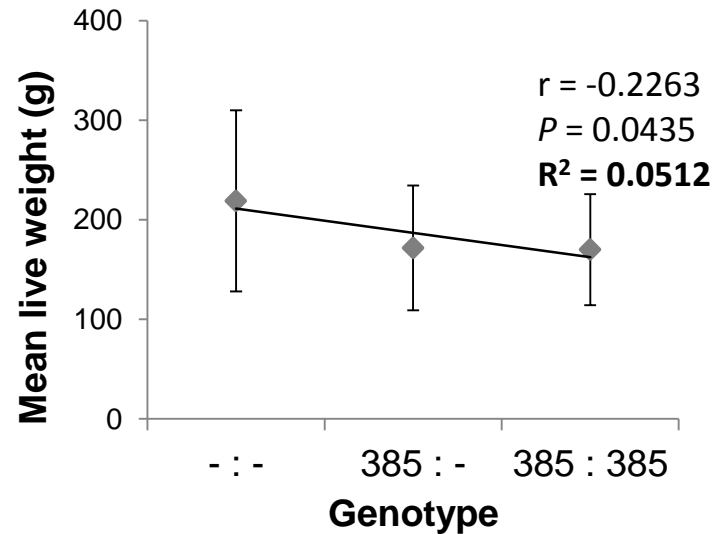
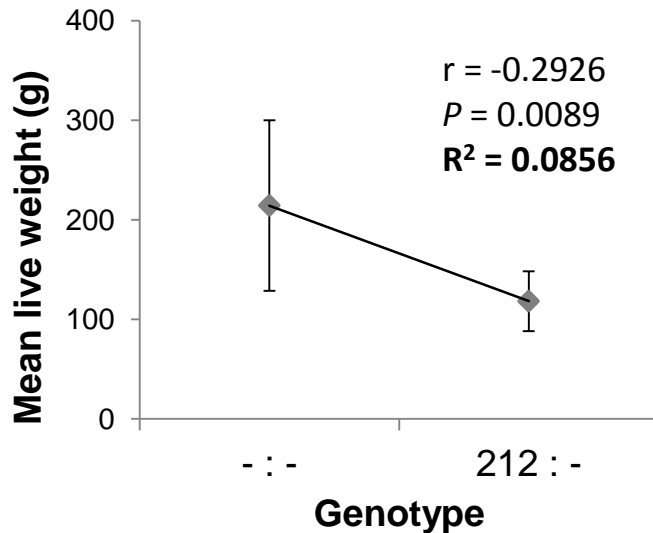
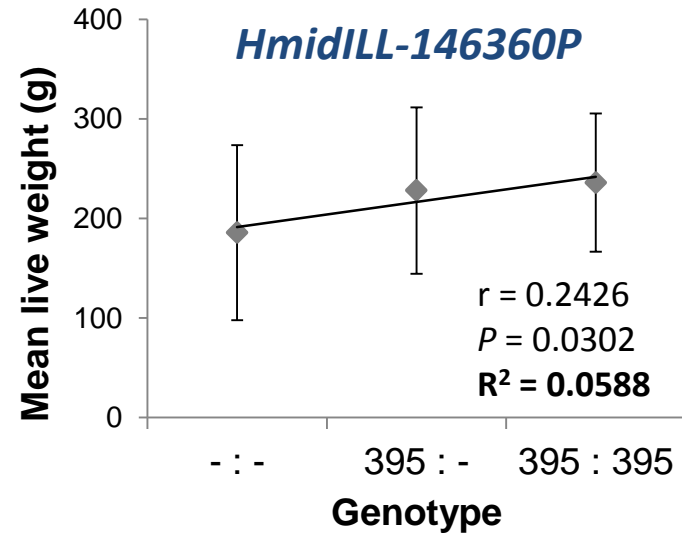
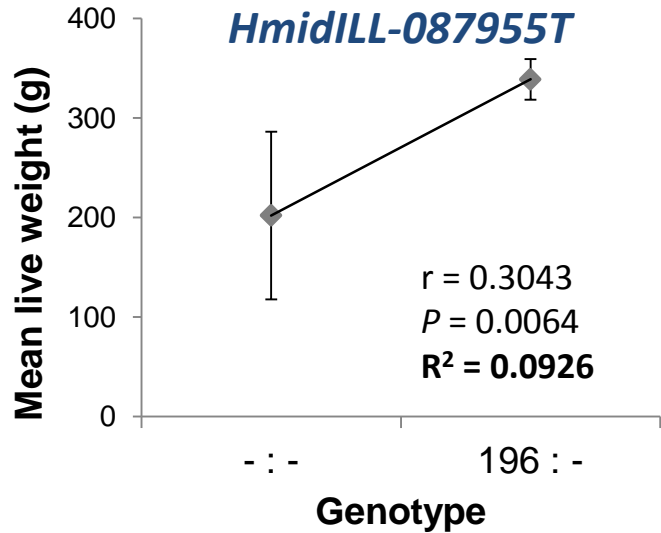
- Association tests:
  - Case/Control analysis
  - Quantitative analysis
- Simple correlation analysis
  - Allelic correlations with size
- BLAST – putative functional analysis

# Marker Association with Growth

## Locus-by-locus AMOVA: Large vs Small

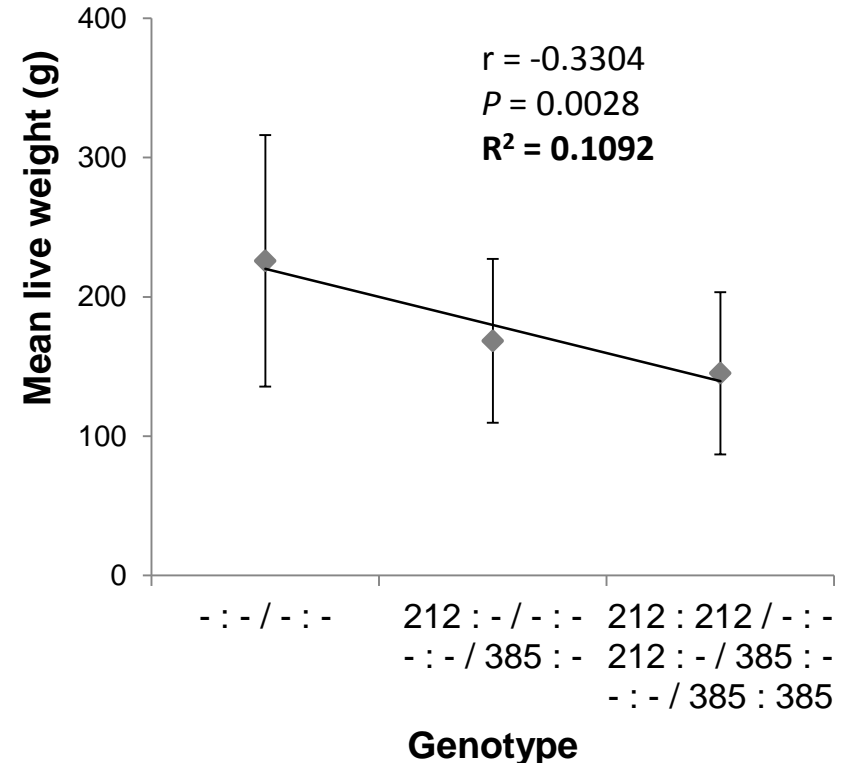
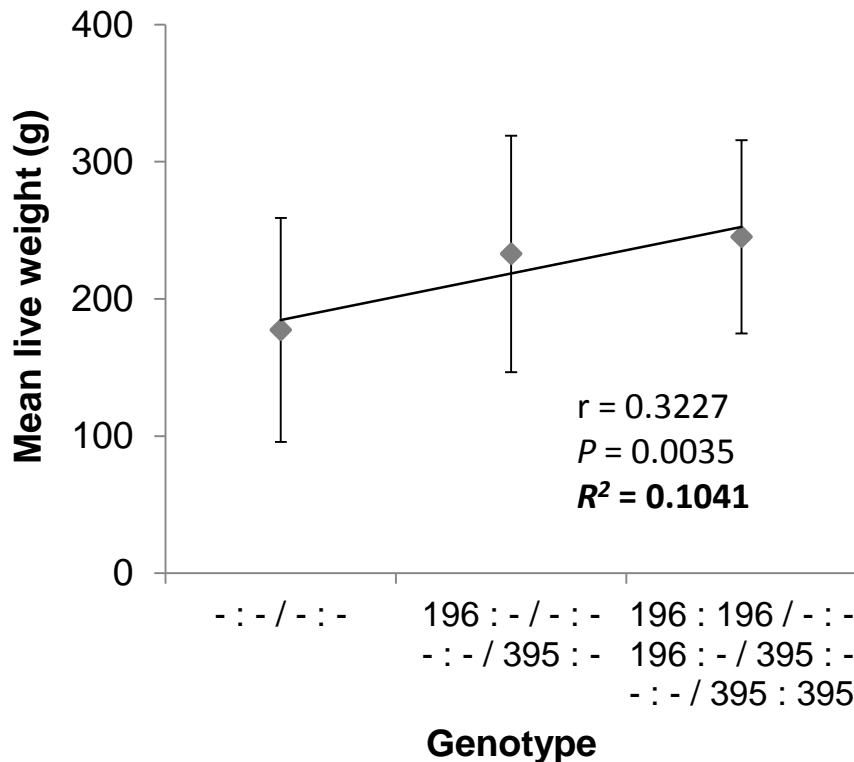
Marker	SSD <sup>a</sup>	Df	Variance	% Variation	F <sub>st</sub>	G'' <sub>st</sub>
<b>HmidILL-087955T</b>	<b>0.3091</b>	<b>1</b>	<b>0.0004</b>	<b>0.1179</b>	<b>0.0064</b>	<b>0.0051</b>
HmLCS5M	0.1293	1	0.0000	0.0000	0.0024	-0.0330
HmLCS48M	0.1453	1	0.0000	0.0000	0.0036	-0.0200
<b>Hm-NS18M</b>	<b>0.5574</b>	<b>1</b>	<b>0.0055</b>	<b>1.4459</b>	<b>0.0117*</b>	<b>0.0355*</b>
<b>HmidILL-146360P</b>	<b>1.4740</b>	<b>1</b>	<b>0.0133</b>	<b>3.2478</b>	<b>0.0232*</b>	<b>0.1569*</b>
HmidILL-064192P	0.0264	1	0.0000	0.0000	0.0005	-0.0313
HmNR106D	0.3132	1	0.0000	0.0000	0.0026	-0.0577
HmidPS1.559	0.2919	1	0.0020	1.8547	0.0238*	0.0395*

# Marker Association with Growth





# Marker Association with Growth



***HmidILL-087955T & HmidILL-146360P***

# Marker Association with Growth

- HmidILL-087955T :
  - 3' UTR of retinol dehydrogenase 14a gene
  - Activation of retinol (vitamin A) to retinoic acid
  - Associated with development
- HmidILL-146360P :
  - 3' UTR of malectin gene
  - N-linked glycosylation / carbohydrate binding
  - Carbohydrate metabolism / transmembrane / signalling

# Conclusions

- Rapid divergence between wild progenitor and cultured populations
  - Role of selection
  - Artificial vs Natural selection
- Application in marker assisted breeding
  - Confirm in independent and larger cohorts
  - Larger genome project in future

# Acknowledgements





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Aquaculture

journal homepage: [www.elsevier.com/locate/aqua-online](http://www.elsevier.com/locate/aqua-online)



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A population genetic analysis of abalone domestication events in South Africa:  
Implications for the management of the abalone resource

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Aletta Elizabeth Bester-van der Merwe, Rouvay Roodt-Wilding

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Detection of molecular signatures of selection at microsatellite loci in the  
South African abalone (*Haliotis midae*) using a population genomic approach

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**ANIMAL GENETICS** Immunogenetics, Molecular Genetics  
and Functional Genomics



SHORT COMMUNICATION

doi: 10.1111/age.12142

Comparison of population genetic estimates amongst wild, F1 and  
F2 cultured abalone (*Haliotis midae*)

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*Journal of Shellfish Research*, Vol. 32, No. 1, 89–103, 2013.

**INTEGRATED LINKAGE MAP OF *HALIOTIS MIDA*E LINNAEUS BASED ON  
MICROSATELLITE AND SNP MARKERS**

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# Thank You!

## Questions?