Centre for Sustainable Tropical Fisheries & Aquaculture

JAMES COOK UNIVERSITY AUSTRALIA

Farming of the black tiger prawn – Challenges and Opportunities

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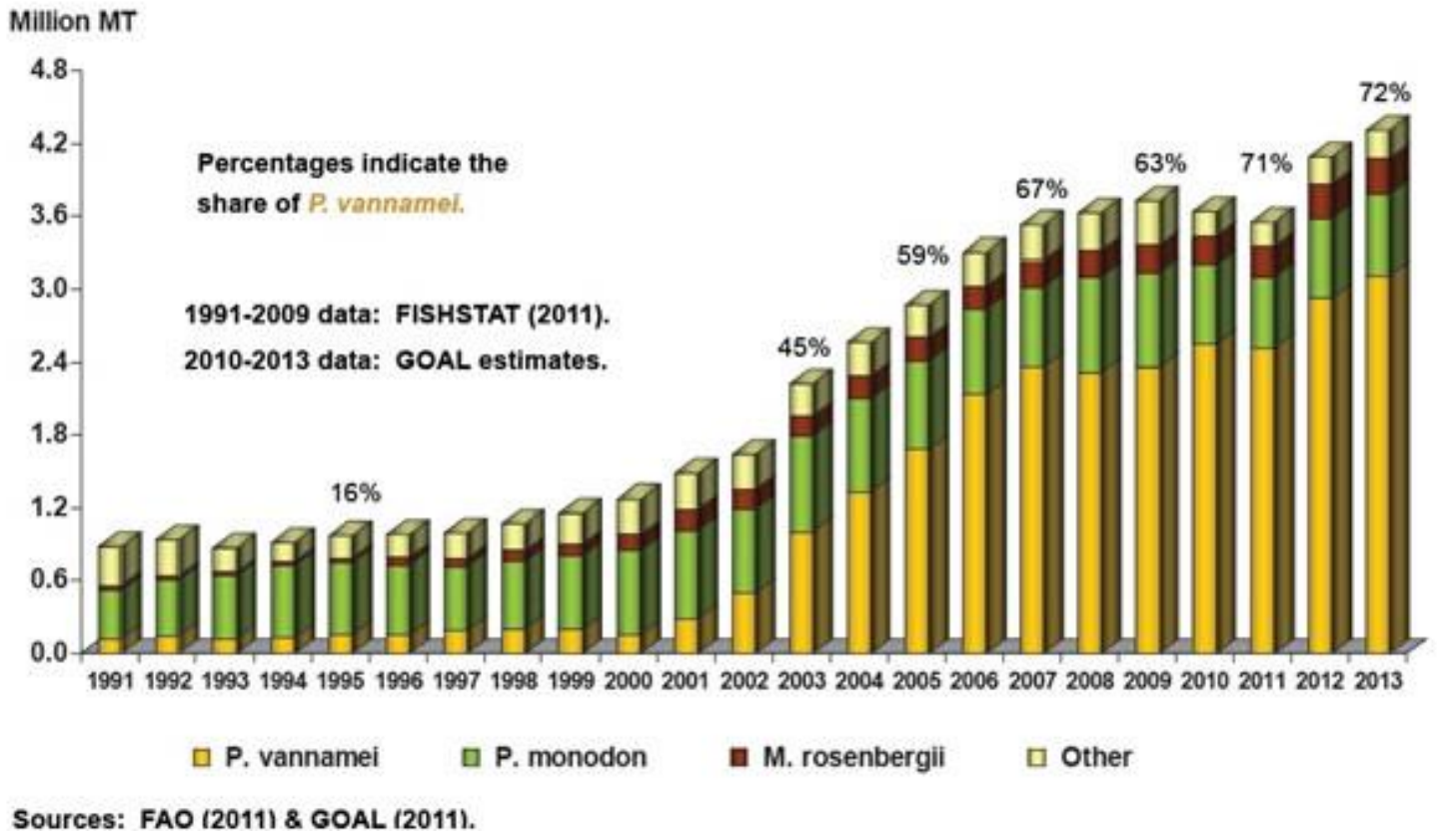
Presentation overview

- Global production and shifts in farming of species
- The black tiger prawn
- Challenges and reasons for shifts in culture
- Opportunities
- Australian farming context

Shrimp farming production data



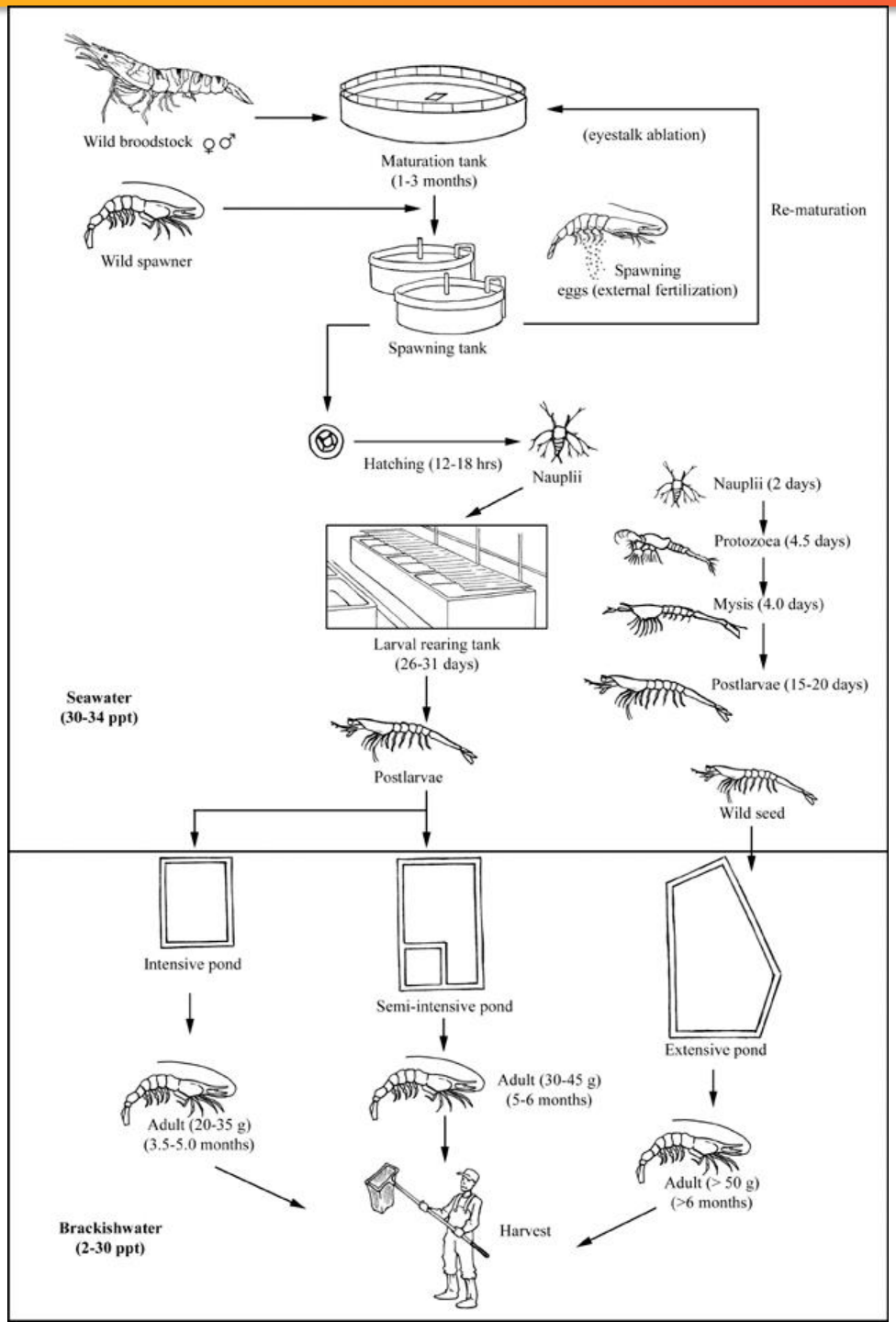
Changes in species farmed

The black tiger prawn

- Nocturnal
- Predator rather than omnivorous scavenger
- Tolerance to salinity (1- 32 ppt)
- Closed thelycum
- Large shrimp

History of farming

- By-product in milkfish ponds
- 1970-1975 breeding (Taiwan & Thailand)
- 1973 extensive farming methods developed (Thailand)
- Spread through SE Asia, Australia, India etc



Source:
http://www.fao.org/fishery/culturedspecies/Penaeus_monodon/en

Challenges

- Species amenability
  - Breeding biology
  - Reliance on wild stocks
  - Solitary
  - Disease
- Incentive to farm
  - Harder biology
  - High protein feeds
  - High price

Challenges – breeding biology

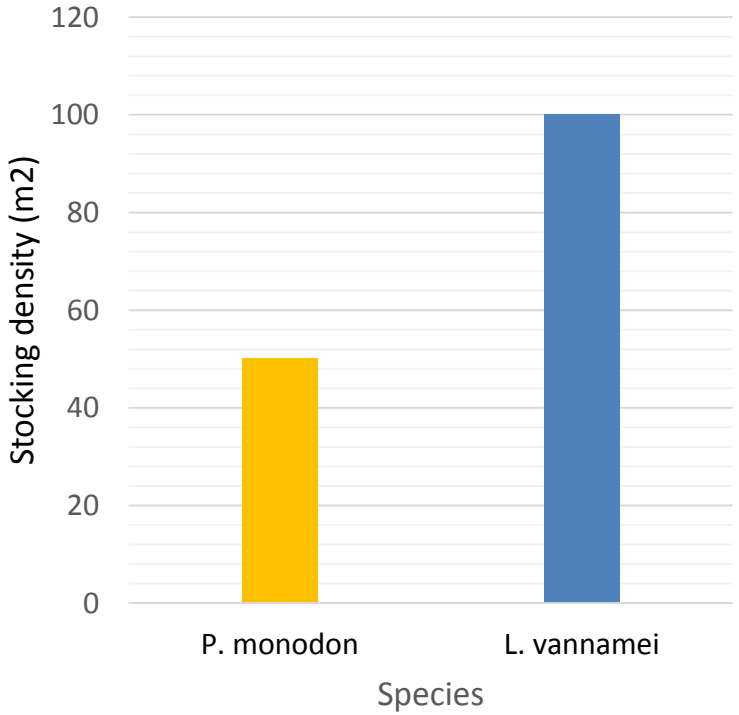
- Closed theylcum
- Moult – mate – mature – spawn
- Mate at night
- Late maturation (males 30g, females 70 g)
- Highly fecund (500,000 eggs)

Challenges - reliance on wild brood stock

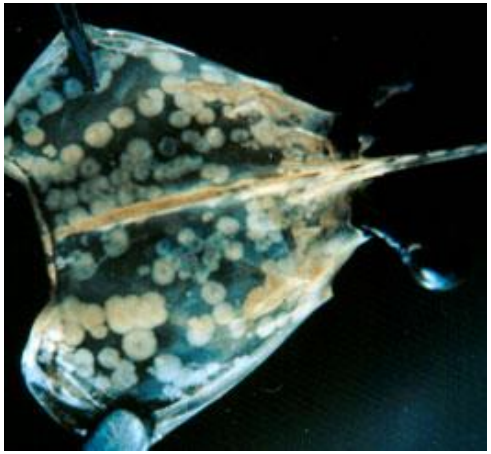
- Females already mated 200-250 g (30 cm) males 100-170 g (20cm).
- Supply and quality issues – particularly in Sth-East Asia
- Introduction of disease

Challenges – it's a loner

- A solitary shrimp
- Not as comfortable under high density (40-50/m^2 vs 60-150 m^2)



Challenges - disease



White spot disease in giant black tiger prawn (*Penaeus monodon*). Prawns at top and right of main photo show pink body colour typical of acute phase of infection. Those at bottom and to left show classic white spots following acute phase (http://library.enaca.org/Health/FieldGuide/html/cv020wsd.htm)

Yellowhead disease in giant black tiger prawn. Note yellow heads of infected prawns on left. Prawns on right are normal . Source DV Lightner

White shrimp with necrotising hepatopancreatitis. Source: (DV Lightner)

Black tiger prawn with severe spherical baculovirosis. Note white streak in midgut line, seen through the shell (DV Lightner)

Gill-associated virus (GAV)

Challenges – incentive to farm

- Harder biology
- High protein requirements (36-40%), high FCR (1.5)
- Government restrictions
- Higher market price (hard to sell into domestic markets, unstable export markets

Challenges – incentive to farm

Comparison of *P. monodon* and *P. vannamei* Production in Thailand		
	P. monodon	***P. vannamei***
Density in Postlarvae Stocked Per Square Meter	**40 to 50**	**120 to 200**
Crop Duration in Days	**110 to 140**	**105 to 120**
Harvest Size in Grams	**22 to 28**	**21 to 25**
Yield in Metric Tons Per Hectare	**8**	**24**
Crop Value in USA Dollars Per Hectare	**$45,000**	**$96,000**
Crop Costs in USA Dollars Per Hectare	**$32,000**	**$60,000**
Production Profit	**$13,000**	**$36,000**

Source: Jim Wyban Global Aquaculture Advocate

Opportunities

- Fast growth
- Domestication
- Better diets
- Selective breeding

Larger, fast growing animal

- *L. vannamei* growth slows after 20 g
- Black tiger prawn (1.5-3g/week) 25 – 35 g – unimproved
- Australia – 17-20 t/ha

Domestication

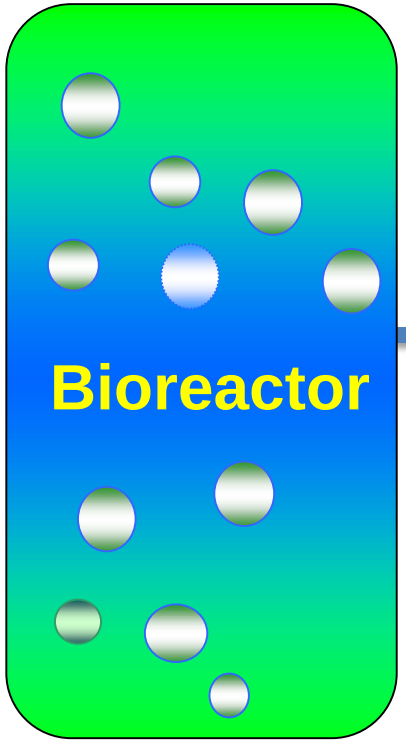
- Life-cycle closure possible
- CSIRO breeding line 8 generations
- Opportunity for SB and SPF
- AI technologies

Better diets -Novacq™ Bioactive

Patent : AU2008201886

Raw materials

Solid or liquid wastes

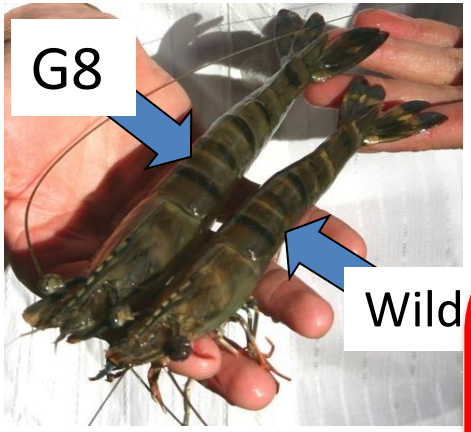


Bioconversion to Novacq

Novacq +  **Prawn feed**

Prawn feed + Novacq

More efficient diets and genetic improvement



DIET A
High specification

322%

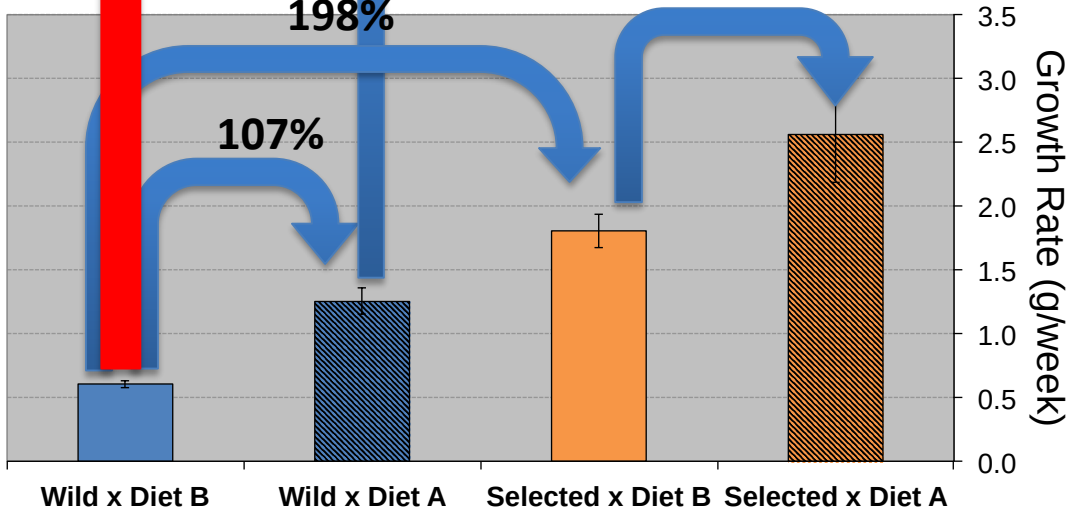
DIET B
Low specification

104%

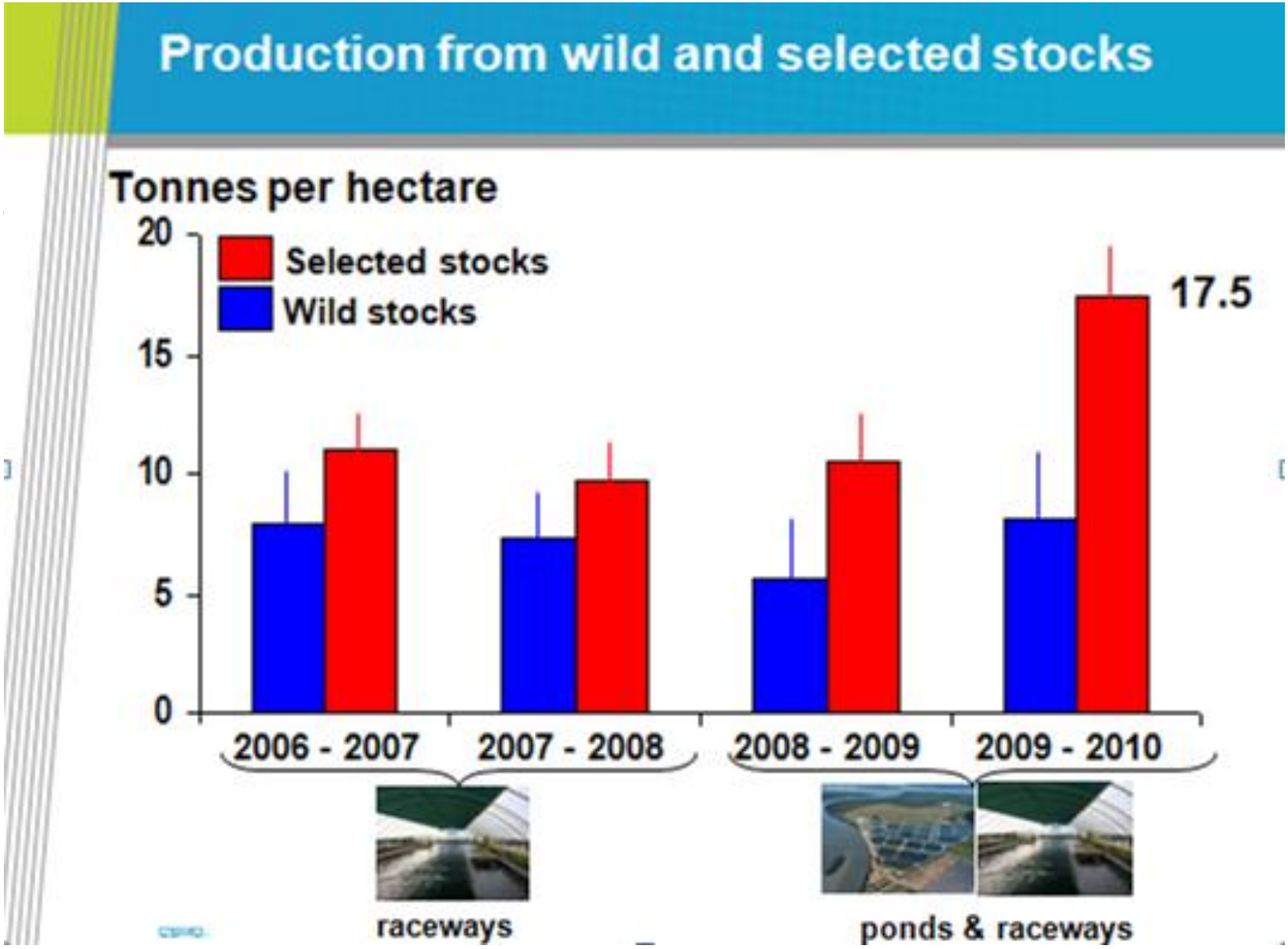
198%

42%

107%



Production from wild and selected stocks



Courtesy Nigel Preston - CSIRO

Unleashing the Tiger – ARC ITRH for Advanced Prawn Breeding

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Partners

Australian Government
Australian Research Council

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CSIRO

THE UNIVERSITY OF SYDNEY

agrf Australian Genome Research Facility Ltd

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seafarms

- Aquaculture geneticists
- Terrestrial livestock breeders
- Australia's largest genome sequencing provider
- World leaders in genome assembly
- Bioinformatics leaders
- Quantitative statisticians
- Prawn disease specialists
- Large commercial partner

Philosophy

- Efficient advanced breeding programs need

Phenotypes

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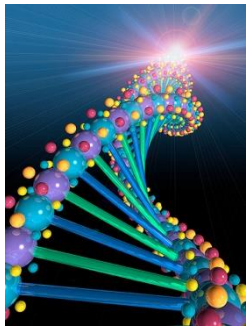

Robust molecular data

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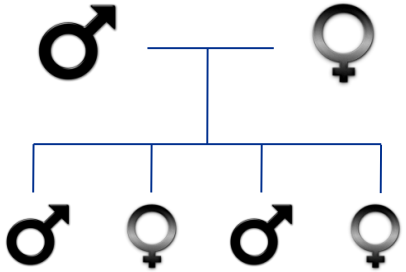


Pedigrees

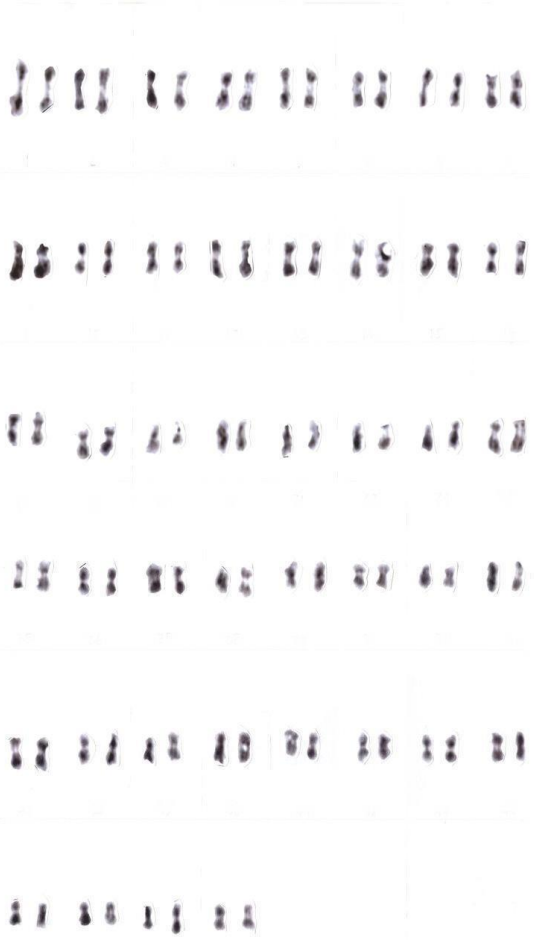
ARC for Advanced Prawn Breeding

Four pillars

- Fully domesticate *P. monodon*
- -Sequence *P. monodon* genome
- -Develop genomic, quantitative and phenotypic recording resources
- -Evaluate genomic selection

1. Genome sequence and resources

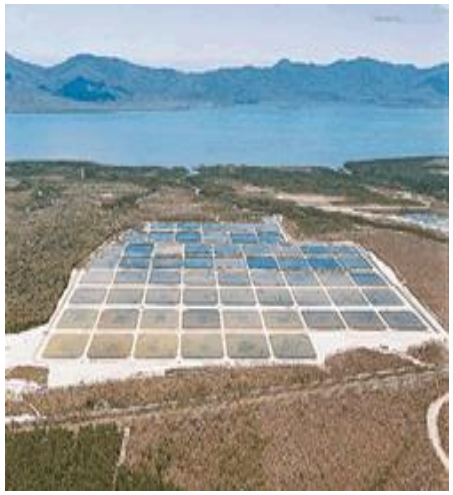
- Genome size = 2.2 billion bp
- Limited knowledge on genome, almost non-existent for Australian popns
- Draft genome sequence for *P.monodon (*AGRF, Uni Ghent)
- Genetic linkage maps
- Isolate 50,000 SNPs
- Useful resource for gene mining and linking to phenotypic traits



The chromosome image of *Penaeus monodon* in mid-mitotic stage.

2. Industrial-scale phenotype collection and establishment heritable basis

- Growth is easy
- Genetic basis of most commercial traits unknown
  - Growth $h^2 = 0.13 – 0.54$
  - Egg number $h^2 = 0.41 \pm 0.18$
  - Nauplii no $h^2 = 0.27 \pm 0.16$
  - Tank-based trials



- Performance on-farm? GAV tolerance? Physiological tolerance? Robustness? Fecundity? Carcass traits? Cooked colouration?.....

- Limited capacity within sector to collect industrial-scale multi-trait phenotypic data, either on-farm or through challenge testing

Growout Facility

Hold up to 36 families

Family 1

PL9-15 from farm
Grow to 3-4g
8-12 weeks

Family 2

Family 3

Family 4

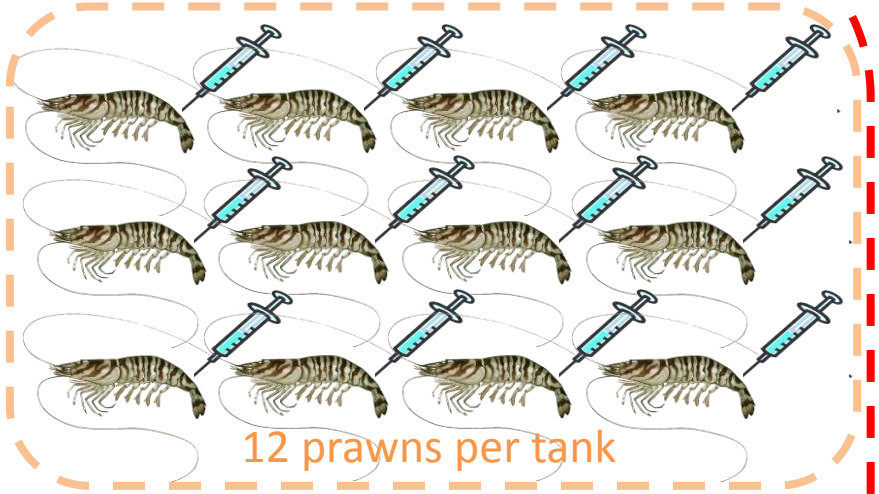
Family 5

Family 6

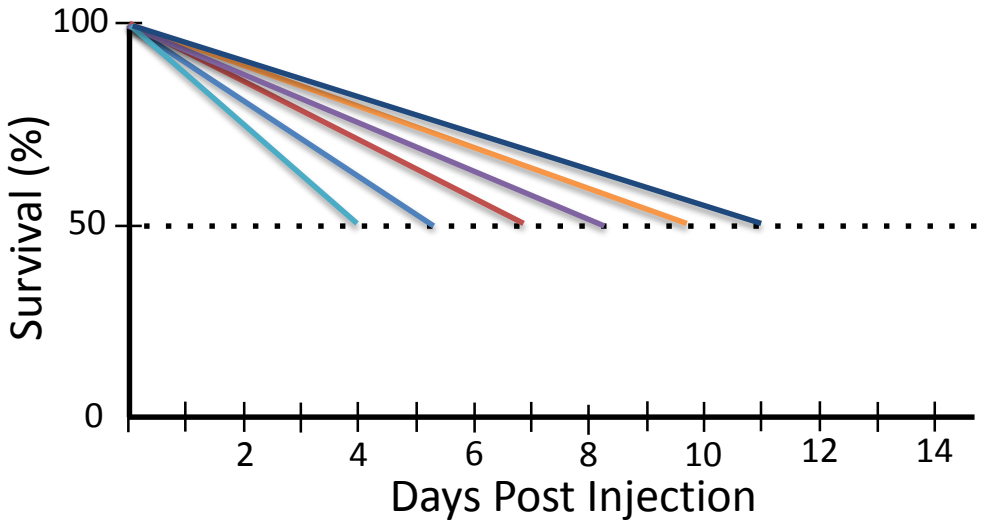
BIOSECURE AREA

Challenge Facility

1
2
3
4
5



12 prawns per tank

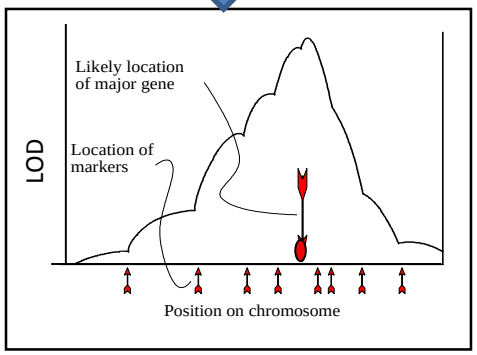


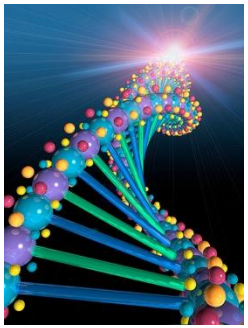
Median Survival – time till 50% mortality

Viral Load – Average viral load in survivors

3. Linking phenotype with genome

Phenotype

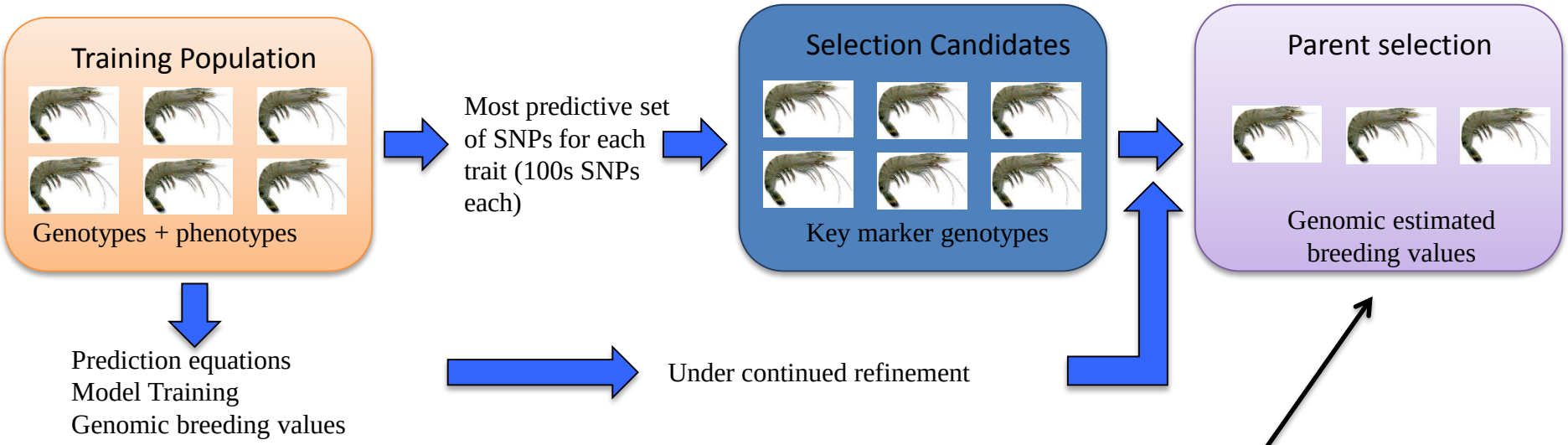




Molecular

Marker
assisted
selection

Genomic selection – basic framework



ID #	SNP1	SNP2	SNP3	SNP4	SNPn	GEBV
1M	8	3	4	8	6	29
2M	6	1	3	0	1	11
3M	0	1	0	1	-3	-1
4F	6	3	2	5	1	17
5F	1	2	--1	2	-4	2

Livestock breeding programs

- Genomic selection advanced dairy selection by up to 40% for many traits

Table 1: Traits evaluated by ADHIS, their units of measurement, phenotypic standard deviations (σ_p), genetic standard deviations (σ_A) and standard deviations of ABVs (σ_{ABV}) at 100% reliability for proven bulls born in 2000 (*) and all proven Holstein bulls (#).

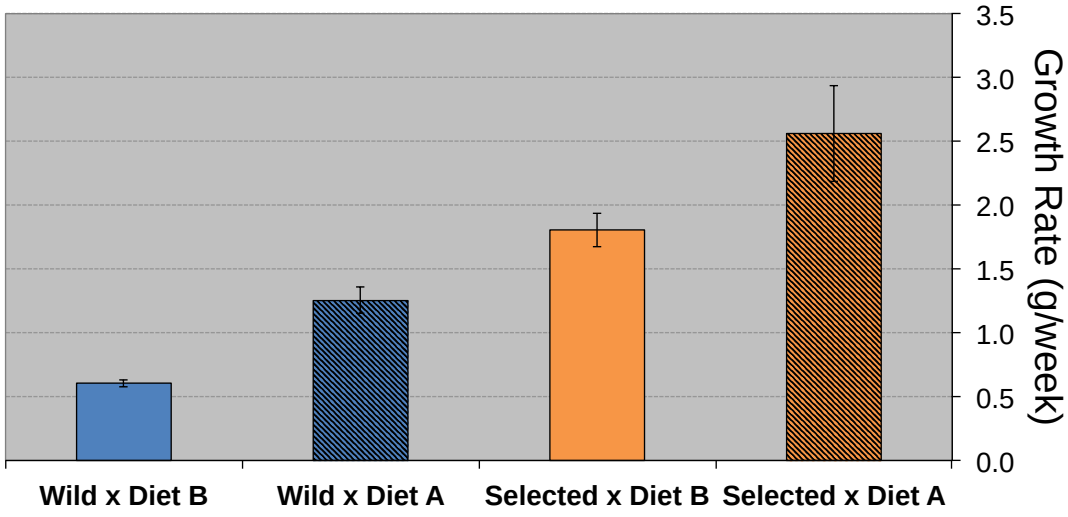
Trait	Units	σ_p	ABV trait	Units	σ_A	σ_{ABV1}*	σ_{ABV2}#
APR	-	-	APR	Index	-	38.0	47.3
ASI	-	-	ASI	index	-	37.8	40.1
Protein yield	kg	24	Protein yield	kg	12.5	12.0	11.5
Fat yield	kg	32	Fat	kg	16.3	18.8	17.0
Protein	%	-	Protein	%	-	0.15	
Fat	%	-	Fat	%	-	0.36	
Milk volume	Litre	800	Milk	Litres	445	536	444
Survival	%	33.9	Survival Index	%	-	2.9	3.6
Calving interval	days	33.5	Daughter Fertility	%	-	3.6	4.4
Cell count	log	1	Cell count	%	28	25.9	24.4
Liveweight	kg	40	Liveweight	kg	-	4.3	4.0
Milk speed	A-E	0.72	Milk speed	%	2.8	2.0	3.6
Temperament	A-E	0.75	Temperament	%	3.3	2.0	2.8
Mammary system	1-15	1.54	Mamm system	%	6.9	4.9	6.6
Likability	A-E	0.76	Likability	%	3.3	1.6	2.6
Overall type	1-15	1.52	Overall type	%	6.5	6.5	7.0
Udder depth	1-9	1.02	Udder depth	%	5.9	10.2	9.9
Udder texture	1-9	1.07	Udder texture	%	4.3	5.9	6.8
Central ligament	1-9	1.0	Central ligament	%	4.1	6.6	7.3
Fore attachment	1-9	1.0	Fore attachment	%	4.1	6.4	7.0
Rear attach height	1-9	0.94	Rear attach height	%	4.3	6.6	7.6
Rear attach width	1-9	0.93	Rear attach width	%	4.0	6.7	6.4
Teat placement	1-9	1.13	Teat Placement	%	6.1	10.2	10.7
Teat length	1-9	1.35	Teat length	%	8.0	9.7	14.1
Foot angle	1-9	0.98	Foot angle	%	3.4	6.6	6.6
Bone quality	1-9	1.14	Bone quality	%	5.4	6.4	7.4
Rear leg rear	1-9	1.15	Rear leg rear	%	3.5	5.7	6.3
Rear leg side	1-9	0.96	Rear leg side	%	3.8	4.5	5.4
Stature	1-9	1.41	Stature	%	6.7	11.8	10.7
Chest width	1-9	0.97	Chest width	%	4.1	6.4	6.3
Body length	1-9	0.87	Body length	%	3.9		
Body depth	1-9	0.99	Body depth	%	5.5	7.4	8.1
Angularity	1-9	1.04	Angularity	%	4.6	7.3	6.6
Loin strength	1-9	0.96	Loin strength	%	3.3	7.2	4.7
Muzzle width	1-9	0.95	Muzzle width	%	3.9	7.2	6.7
Pin set	1-9	1.25	Pin set	%	6.9	8.3	11.0
Pin width	1-9	1.08	Pin width	%	5.9	8.3	8.8
Calving ease*	1-3	0.36	Calving ease	%	0.08	3.4	2.2

Most estimates obtained from Haile-Mariam (2008; unpublished)

** Obtained from McClintock (2004). This trait is expressed as an Expected progeny difference*

Wrap-up

- Re-interest in farming black tiger shrimp
- Domestication is happening
- Advanced selection underway



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