Diet & Microbial Interactions In Palinurid Lobster Larvae

Presented by:
Mike Hall

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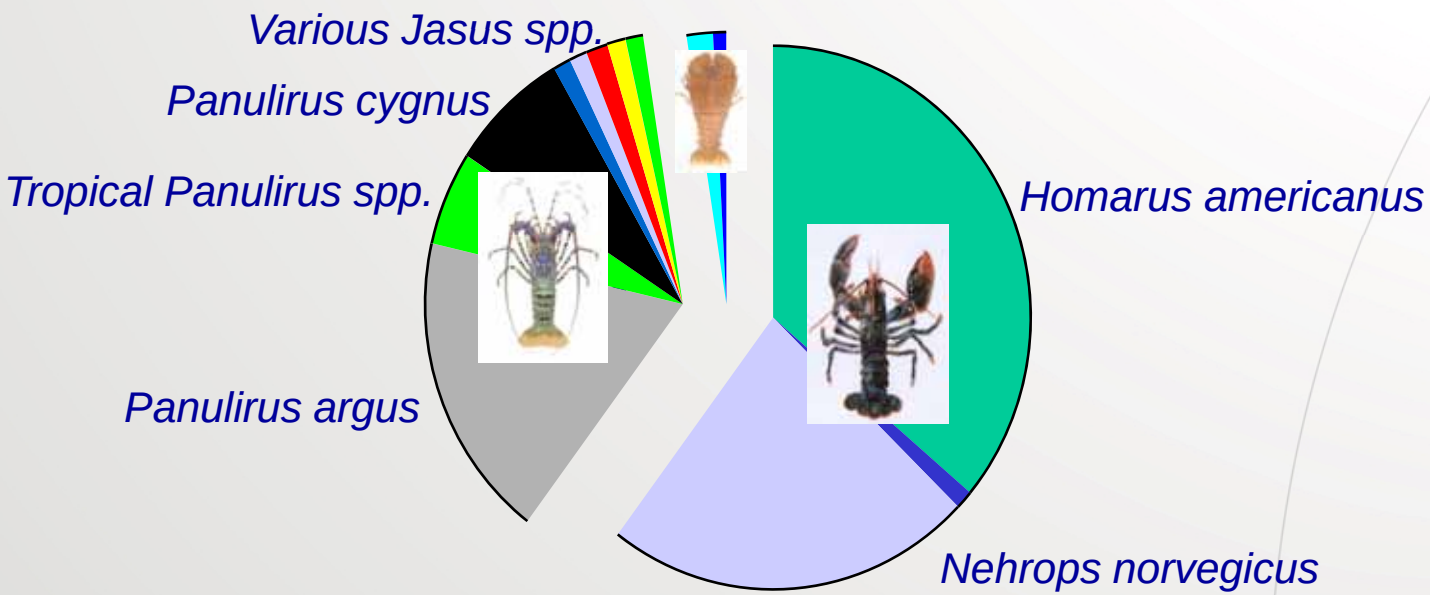
Marine Lobsters

Nephropoidea

Palinuridea

Scyllaridae



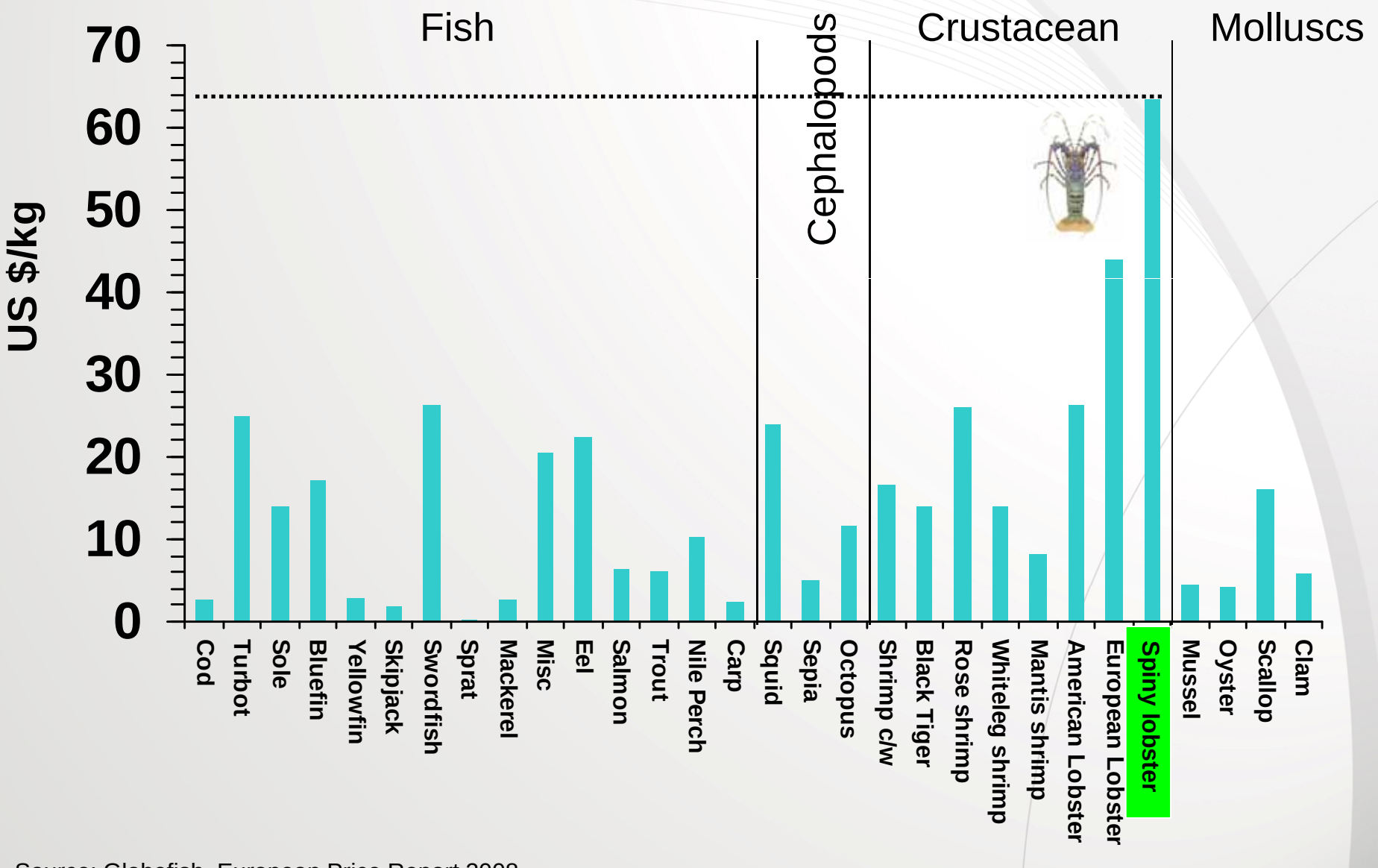
Lobster Biodiversity

Species: Wild Fisheries and Aquaculture Potential

Group	Species	Wild Fishery		Aquaculture Potential	
		Major	Minor/ None	Seafood	Aquarium
Family *Palinuroidea*	47	31	16	+++	++
Family *Scyllaridae*					
Subfamily *Arctidinae*	16	-	Some	++	+
Subfamily *Ibacinae*	13	-	Some	+	+
Subfamily *Scyllarinae*	+40	-	-	-	++
Subfamily *Theninae*	5	-	5	+++	+
Family *Synaxidae*	3	-	-	-	+++
Family *Nephropoidea*					
Subfamily *Neophoberinae*	2	-	-	-	-
Subfamily *Thymopinae*	20	-	-	+	-
Subfamily *Nephropinae*	26	3	Some	+(++)	+
Family *Thaumastochelidae*	3	-	-	-	-
Family *Enoplometopoidae*	+11	-	-	-	+++
TOTAL	**+176**	**34**	**Some**	**Several**	**Some**

Seafood Groups – as Production Units

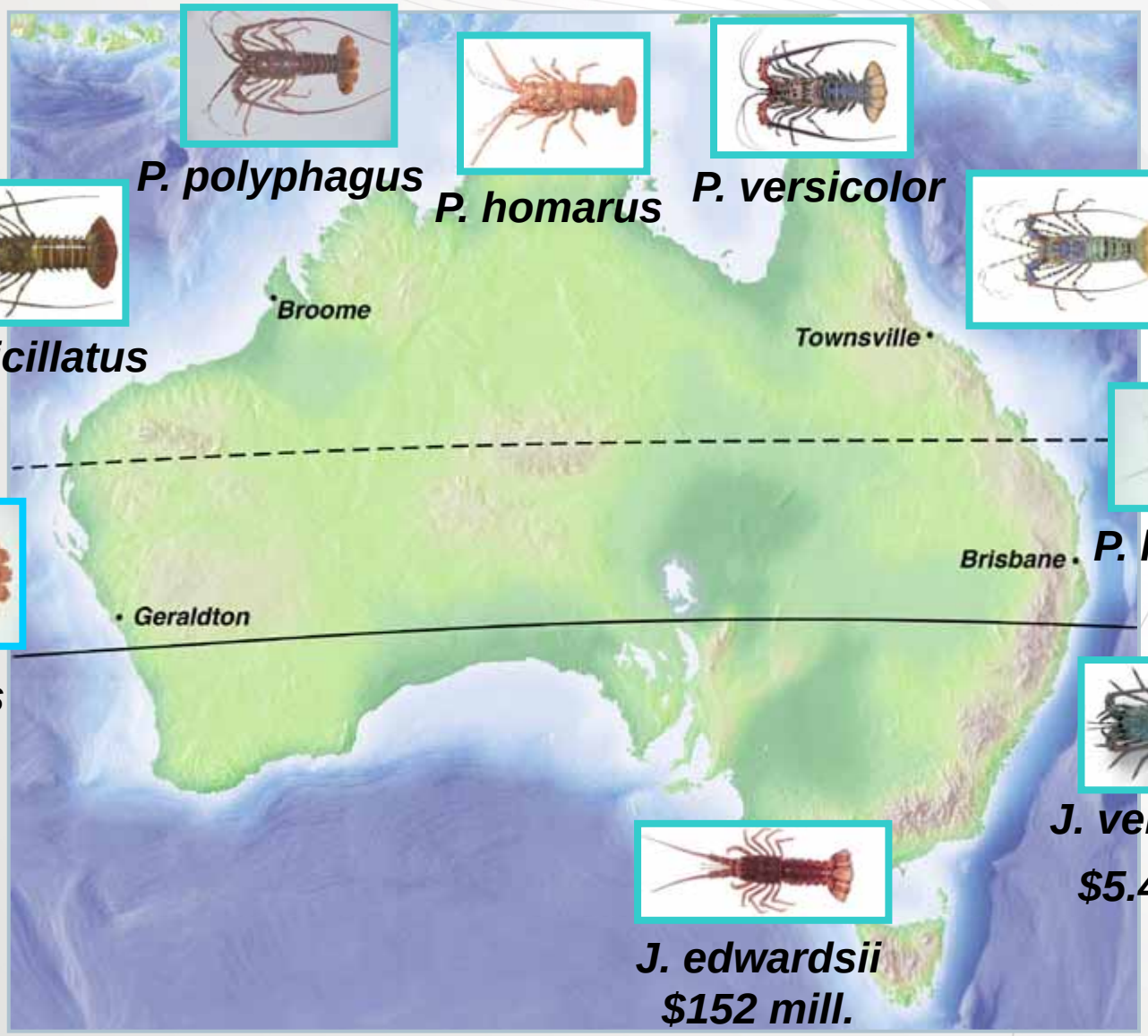
Price per kg per whole animal



Source: Globefish, European Price Report 2008

Australian Rock Lobster Biodiversity

Potential Aquaculture Candidates (9 species)



P. polyphagus

P. homarus

P. versicolor

P. ornatus

$22 mill.

P. penicillatus

P. longipes

P. cygnus

$281 mill.

J. verreauxi

$5.4 mill.

J. edwardsii

$152 mill.

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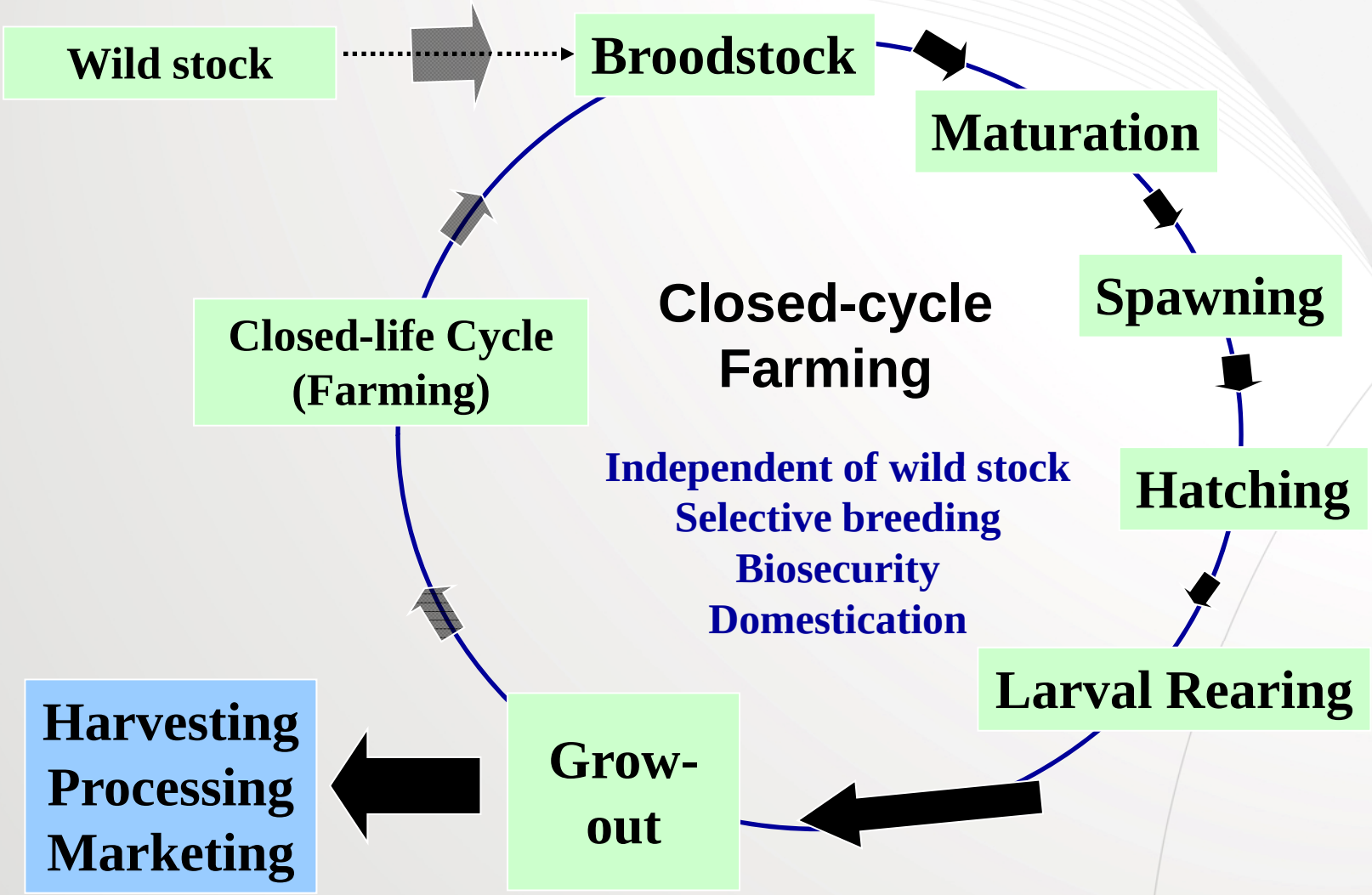
Model of Aquaculture Propagation System

Closed life cycle



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Closed-life cycle Propagation System

Wild stock
(Captured Rearing)

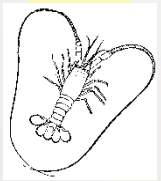
Broodstock

Maturation

Spawning

Larval Rearing

?



Grow-out

Harvesting
Processing
Marketing

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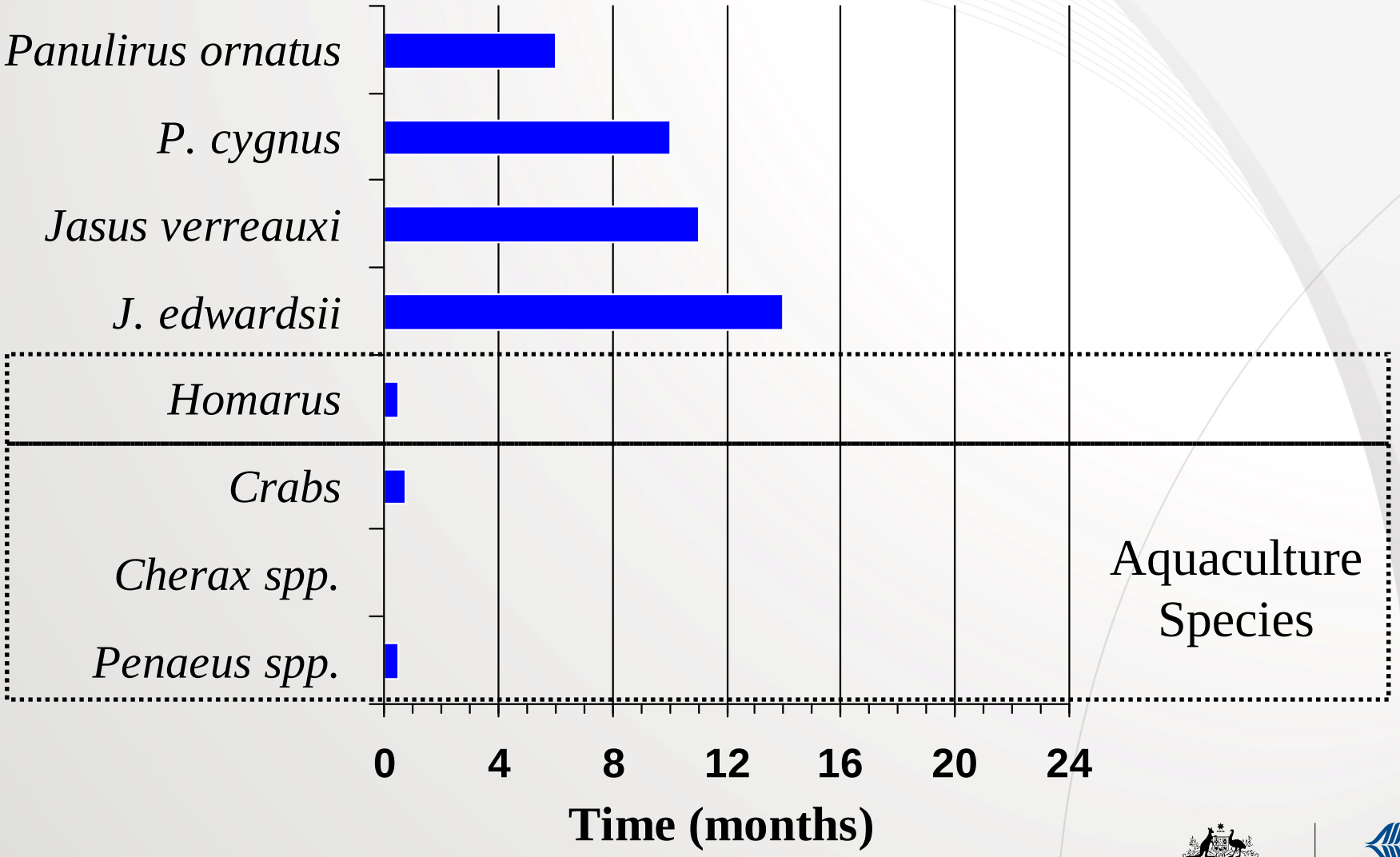
Larval Periods of Selected Crustacea



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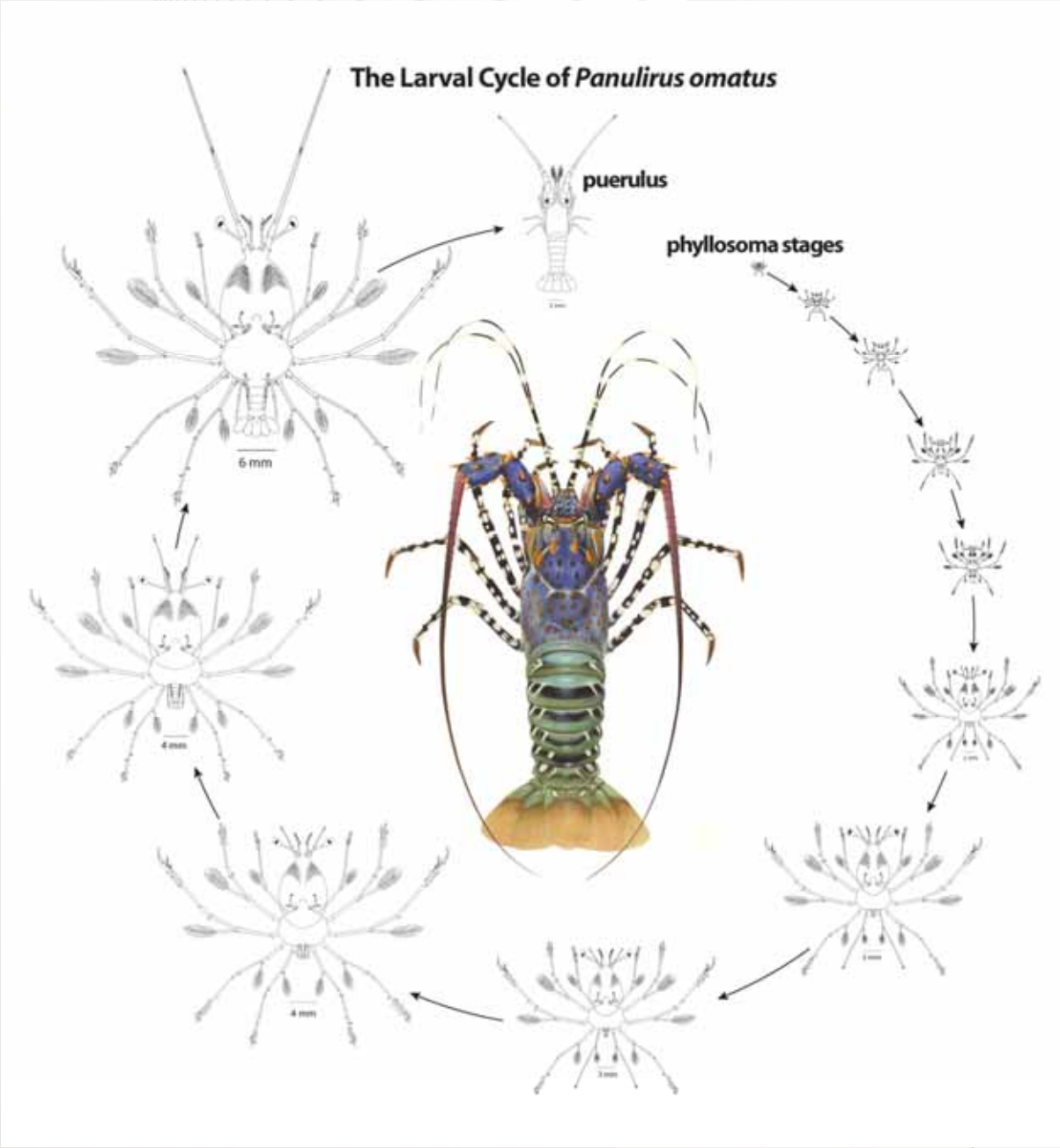
Palinuridae Phyllosoma Larval Rearing

Larval Cycle Completed in > 9 species

Species	Reference
Panulirus species	
Panulirus argus	Moe (1991), **Goldstein et al. (2008)**
Panulirus elephas	Mercer et al. (1997), **Kittaka et al. (1988), Kittaka et al. (2000)**
Panulirus homarus	Radhakrishnan and Vijayakumaran (1993)
Panulirus japonicus	Oshima (1936), **Kittaka and Kimura (1989), Yamakawa et al. (1989), Sekine et al. (2000)**
Panulirus interruptus	Johnson (1956), Dexter (1972)
Panulirus lalandii	**Kittaka (1988)**
Panulirus longipes	**Matsuda and Yamakawa (2000)**
Panulirus ornatus	**MGKailis (2006), AIMS (2007)**
Panulirus pencillatus	**Matsuda et al. (2006)**
Panulirus polyphagus	Saisho (1966), Sin (1967)
Jasus species	
Jasus edwardsii	**Kittaka et al. (1988), Booth (1996),** Illingworth et al. (1997), Tong (1997), **Moss (2000), TAFI (2005)**
Jasus verreauxi	**Kiattaka et al. (1997), TAFI (2006)**
Scyllarid species	
Thenus orientalis	**Mikami and Greenwood (1997)**



Smith, G., Salmon, M., Kenway, M. and Hall, M. (2009) Description of the larval morphology of captive reared *Panulirus ornatus* spiny lobsters, benchmarked against wild caught specimens. Aquaculture 295:76-88.

Change in Larval Size through Development

11 Stages

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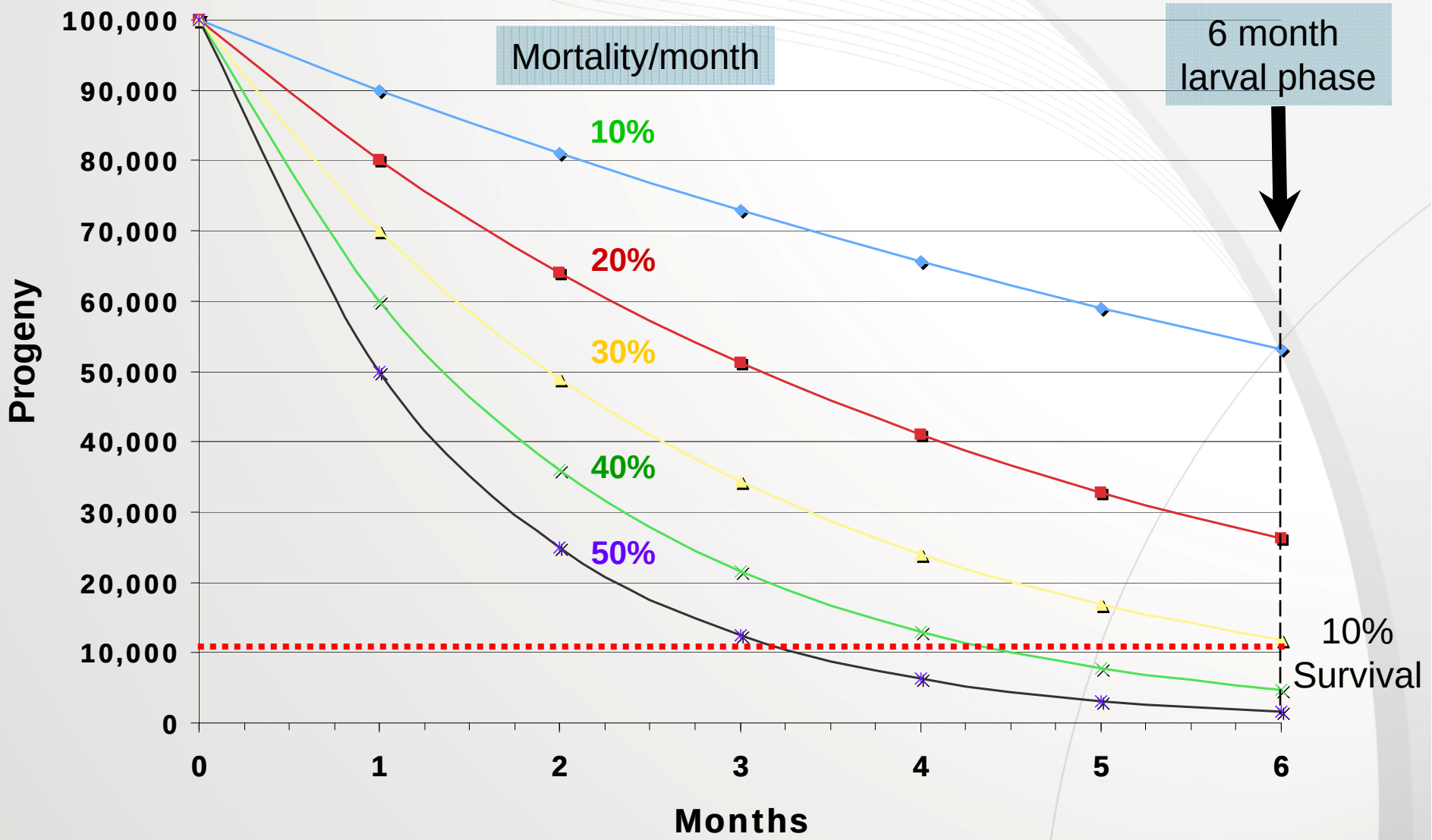
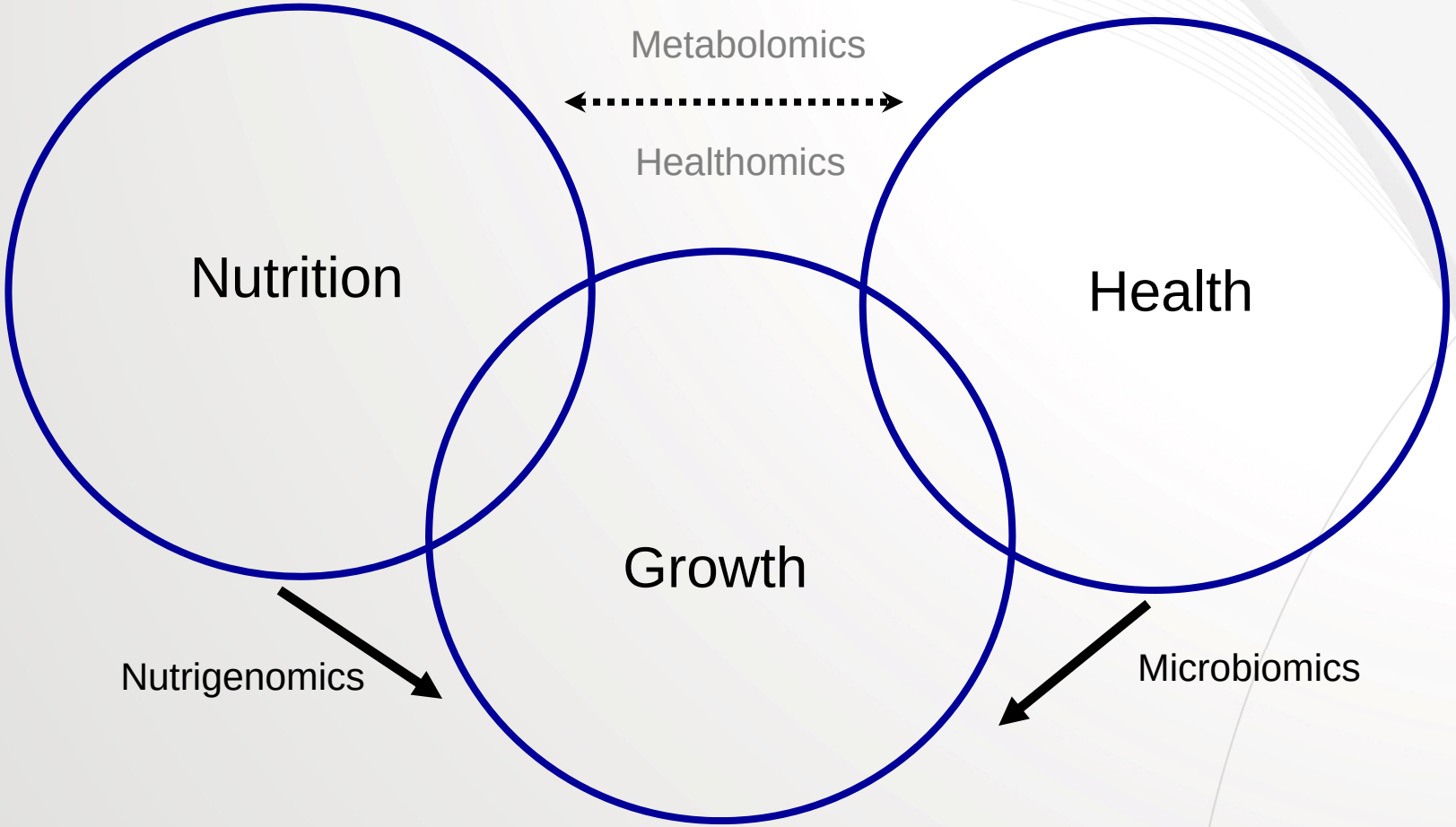
Model of Larval Survival

Continuous larval attrition and mass mortality events

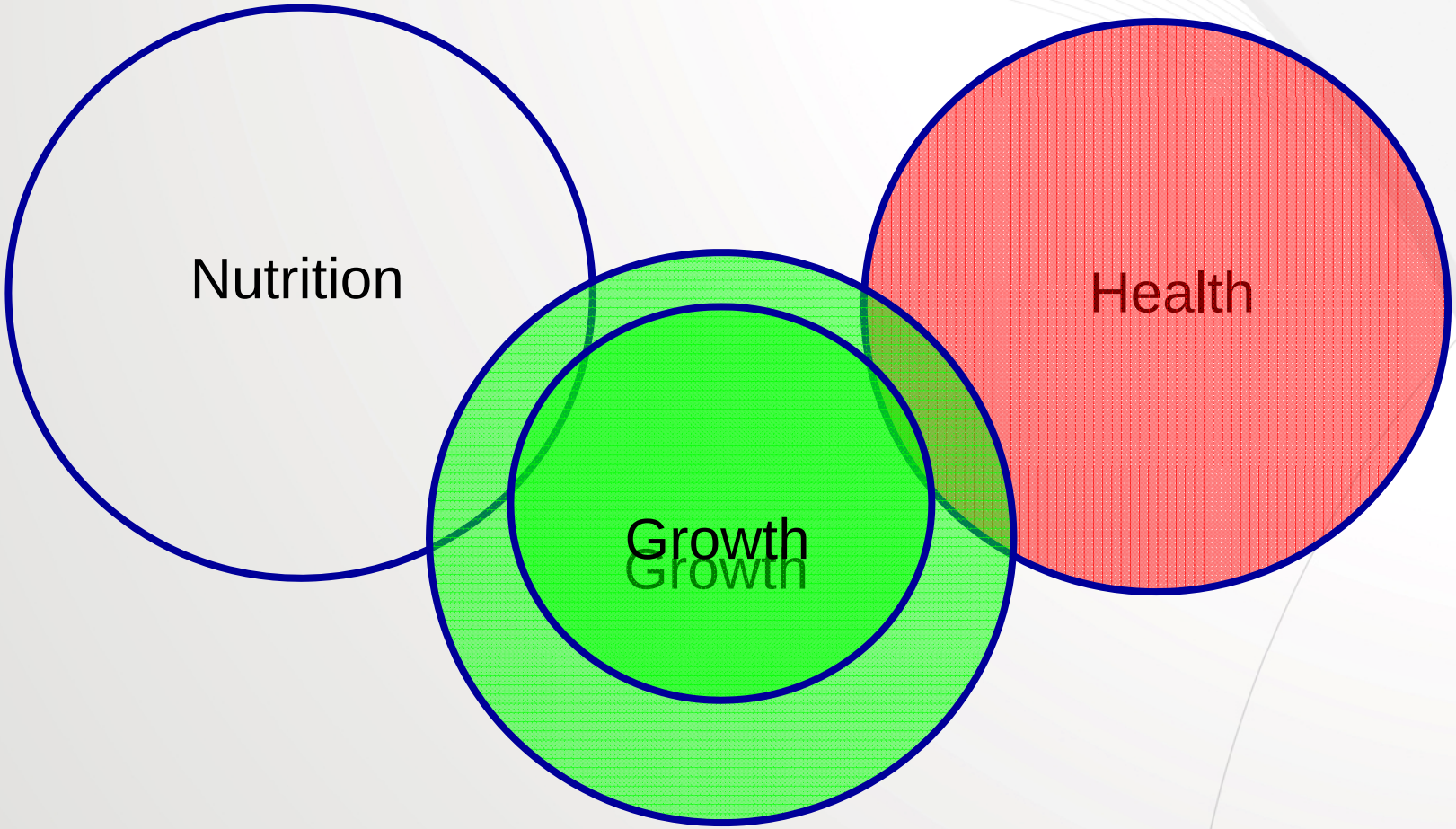


Conceptual Model

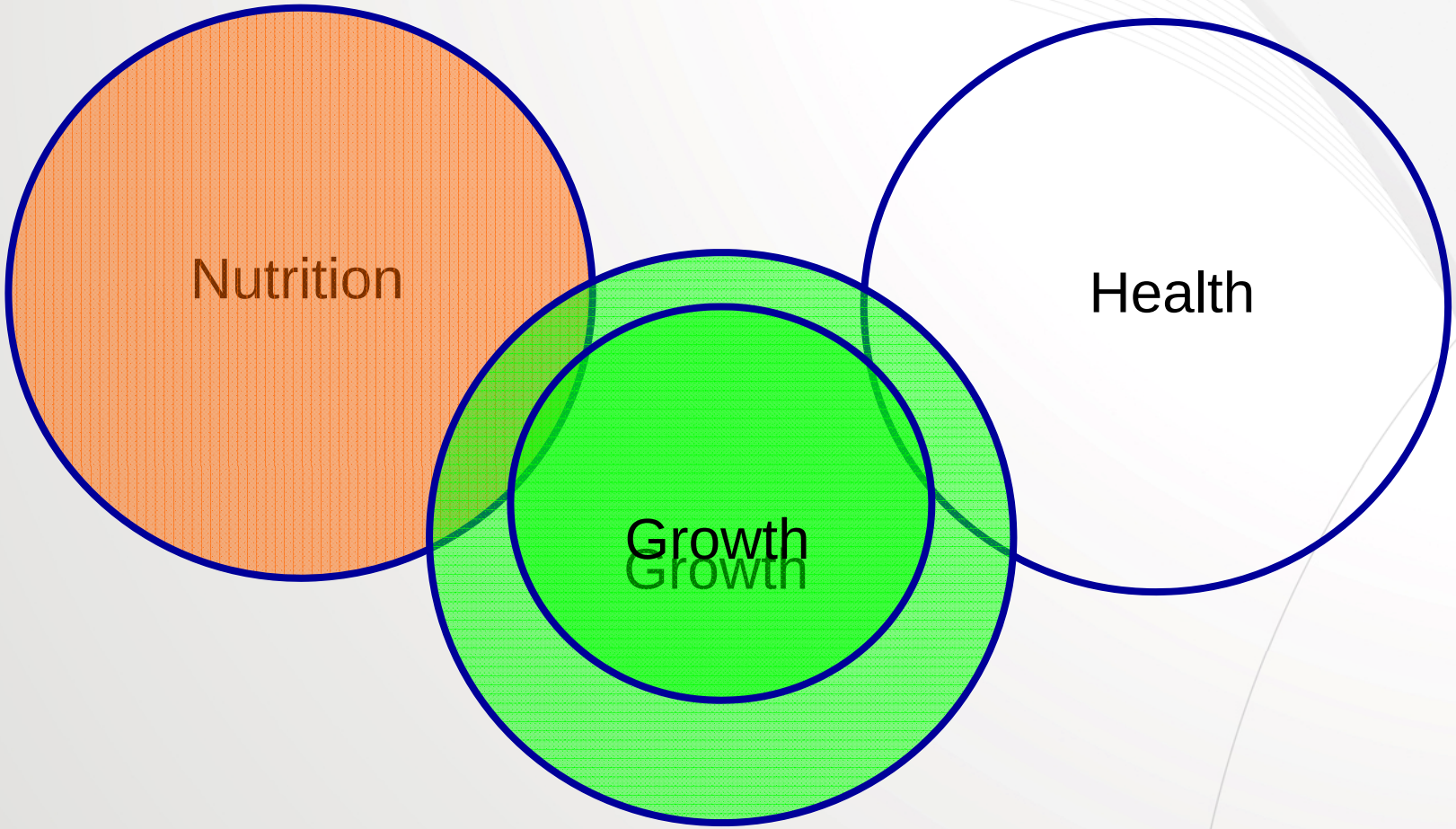
Interactions between Nutrition – Health - Growth



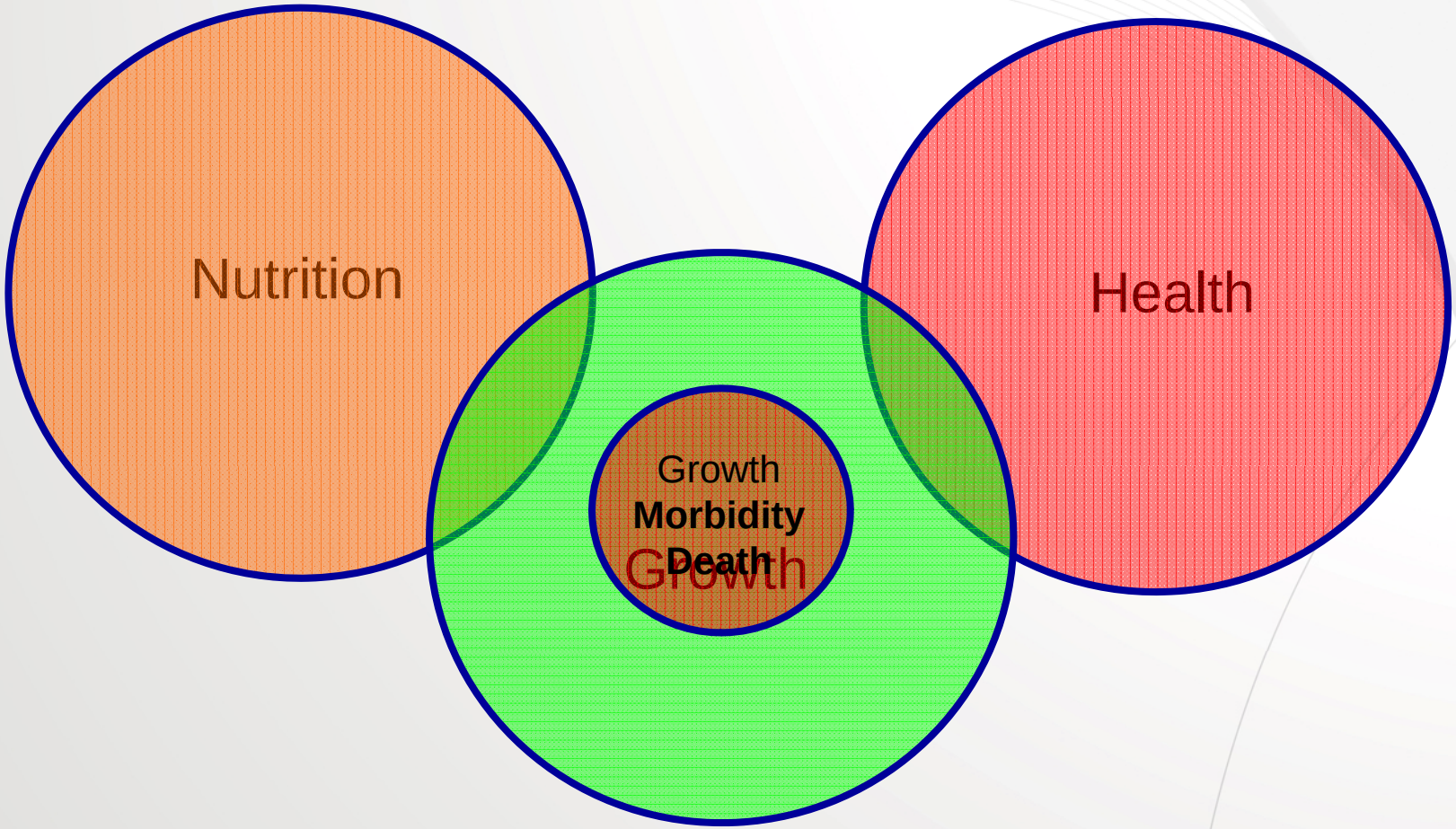
Nutrition – Disease - Growth



Poor Nutrition – Health - Growth

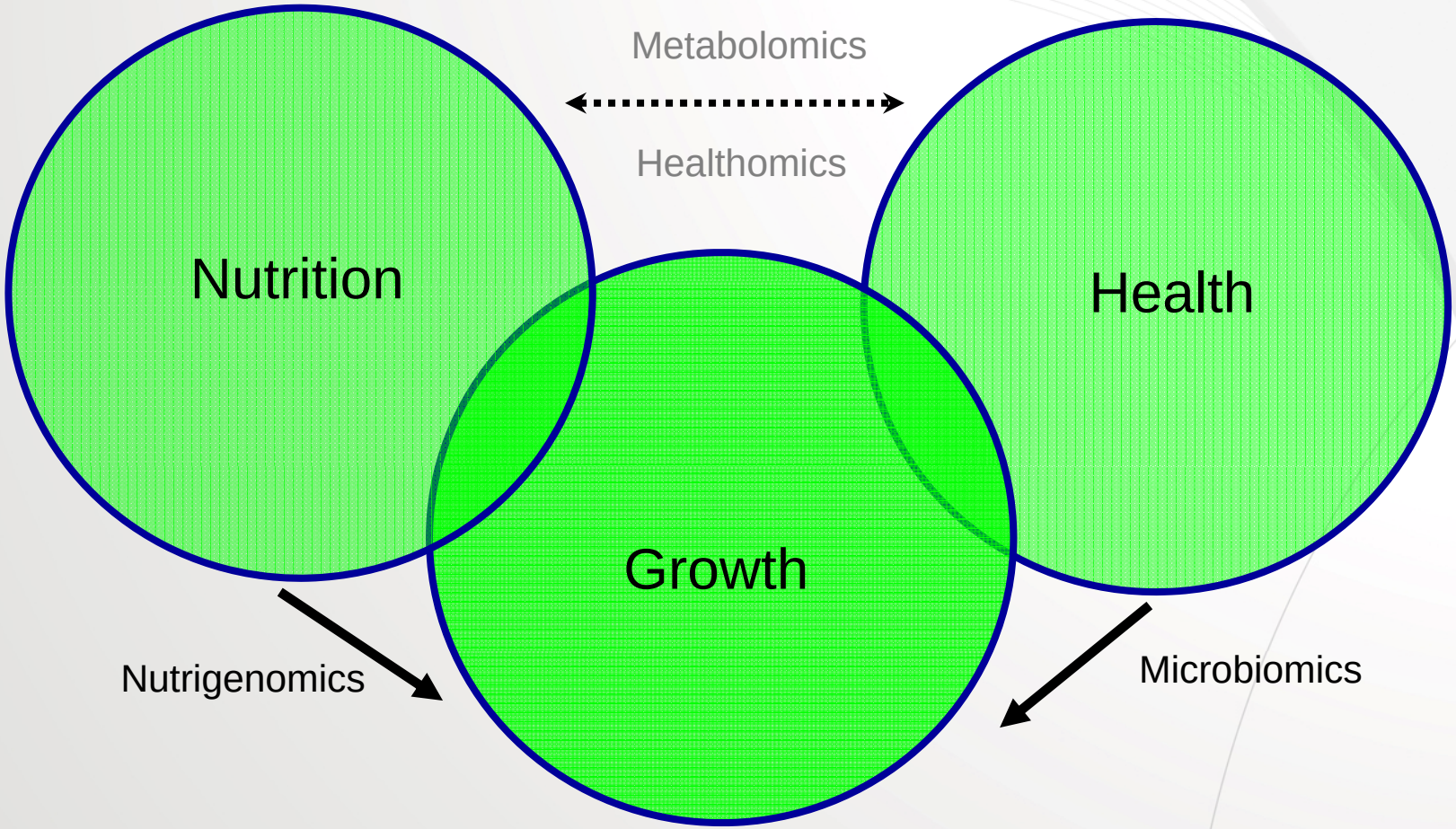


Poor Nutrition – Disease - Growth



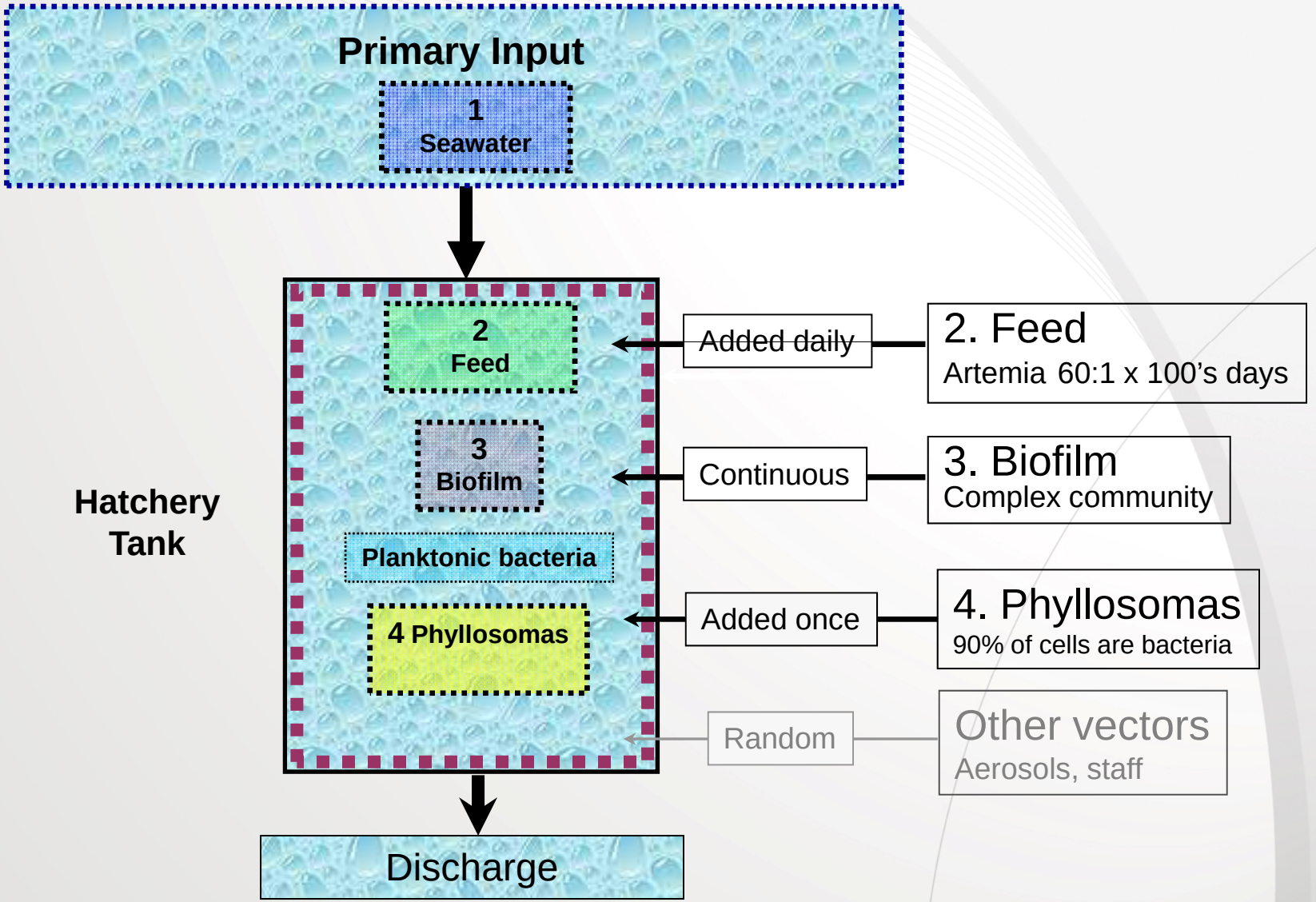
Optimising the Triad

Interactions between Nutrition – Disease - Growth



Microbial Inputs

Microbial Biosecurity



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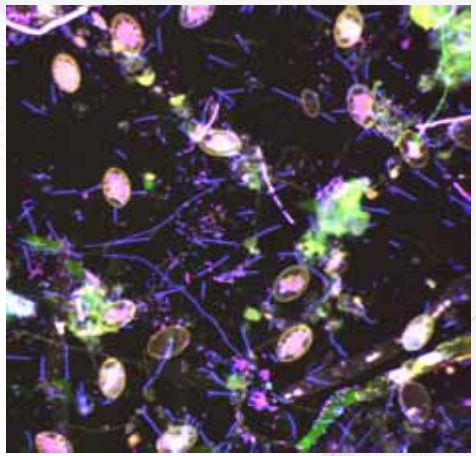
Microbial Sources and Sinks in Hatchery

Four Compartments

1.
Seawater Column

2.
Larval Feeds



3.
Biofilm

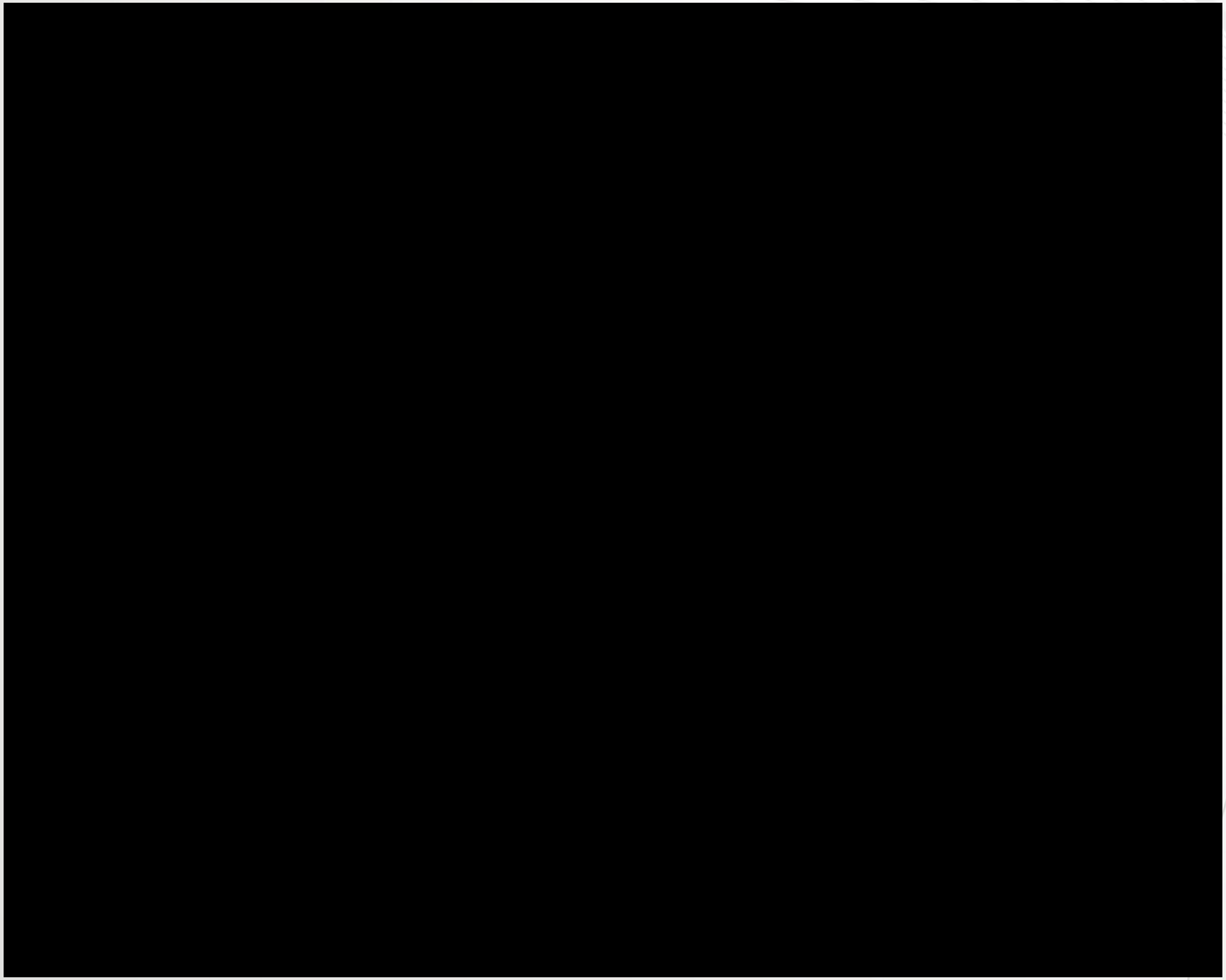
4.
Phyllosoma

External

Internal

Biofilm – Complex Bacterial Ecosystem

Diving through the biofilm – Surface to Tank (2 µm steps)



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Interactions between Nutrition – Disease - Growth

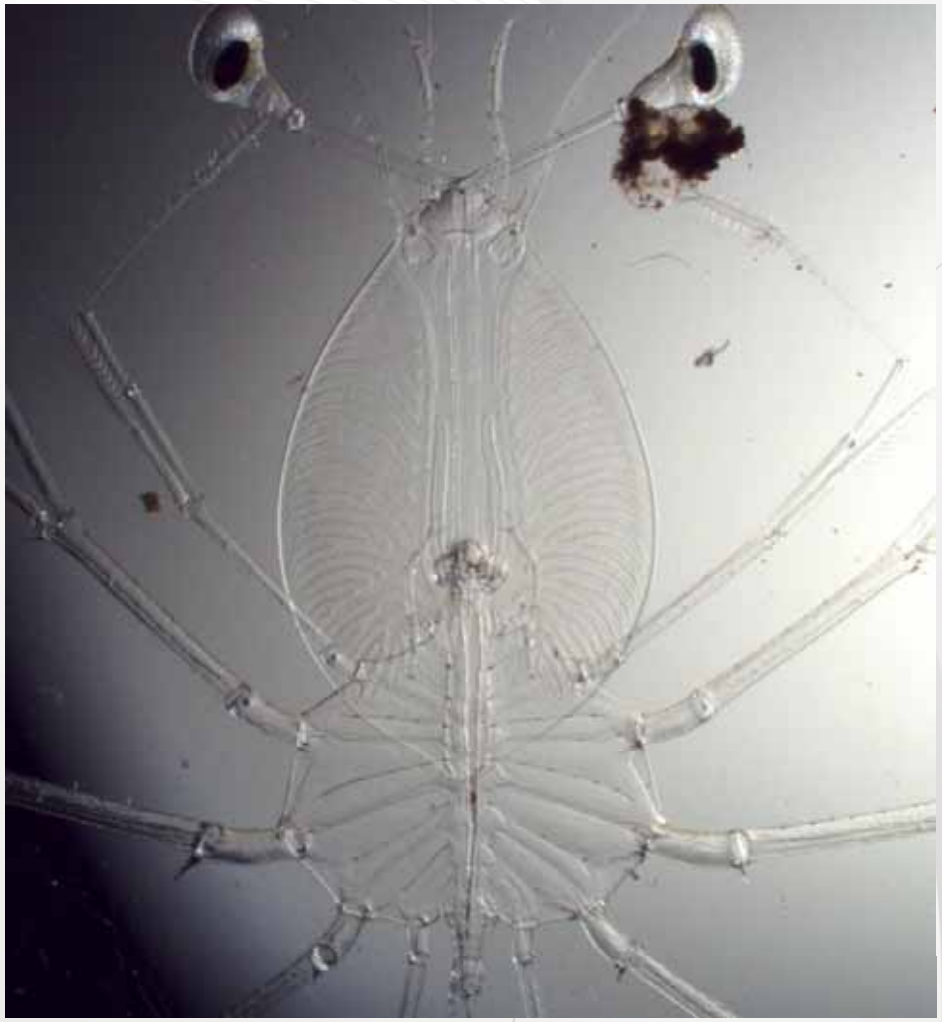
Larval finfish consume feed whole - Feed size related to mouth gape

Source: © Artemia World

Interactions between Nutrition – Disease - Growth

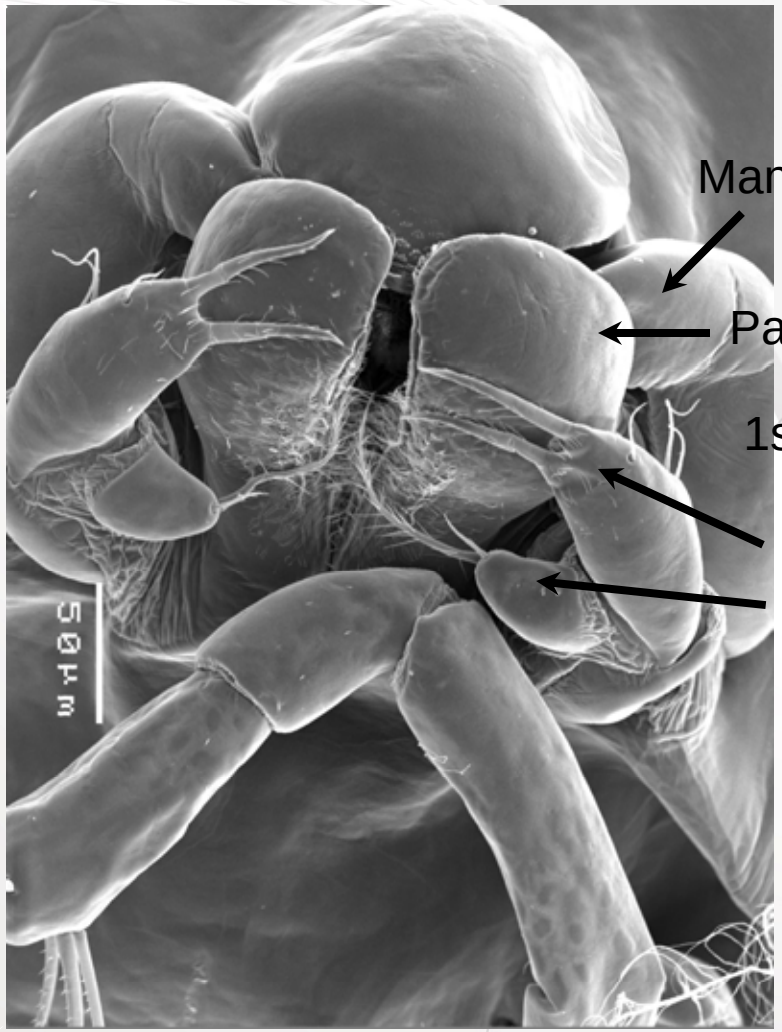
Phyllosomas consume feed piecemeal

Stage 1



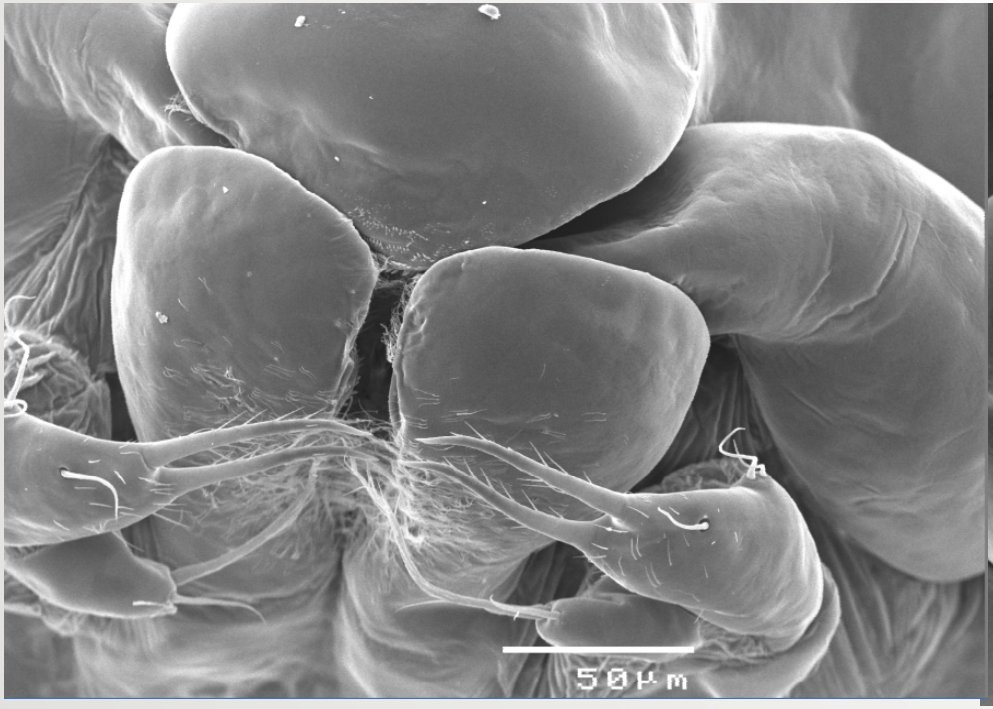
Stage 7

Health - External Fouling

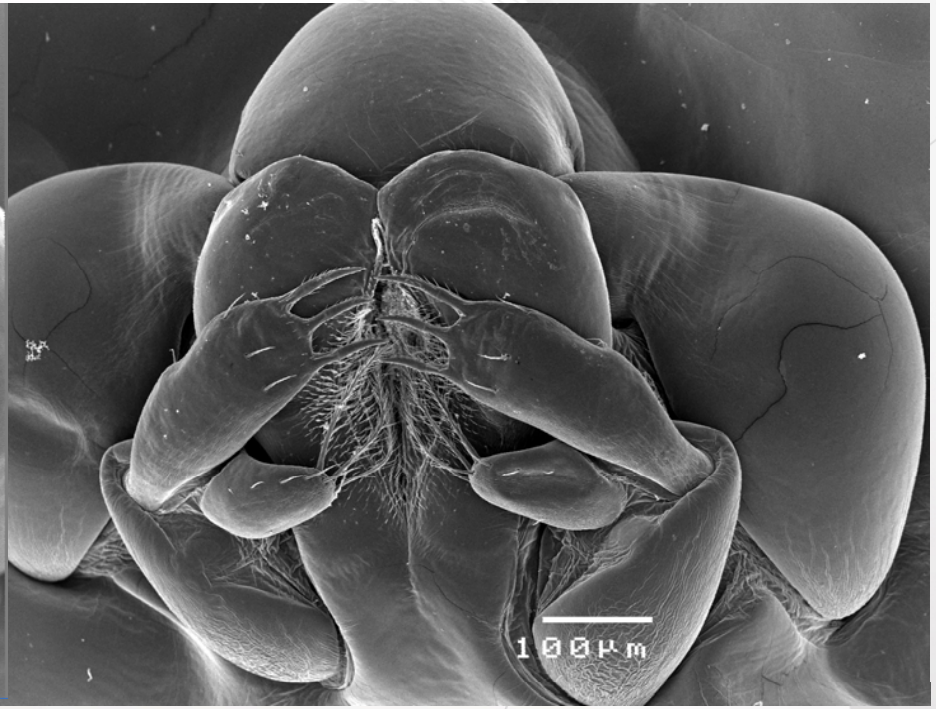


Changes in Mouthpart through Development

Stages 1 to 11



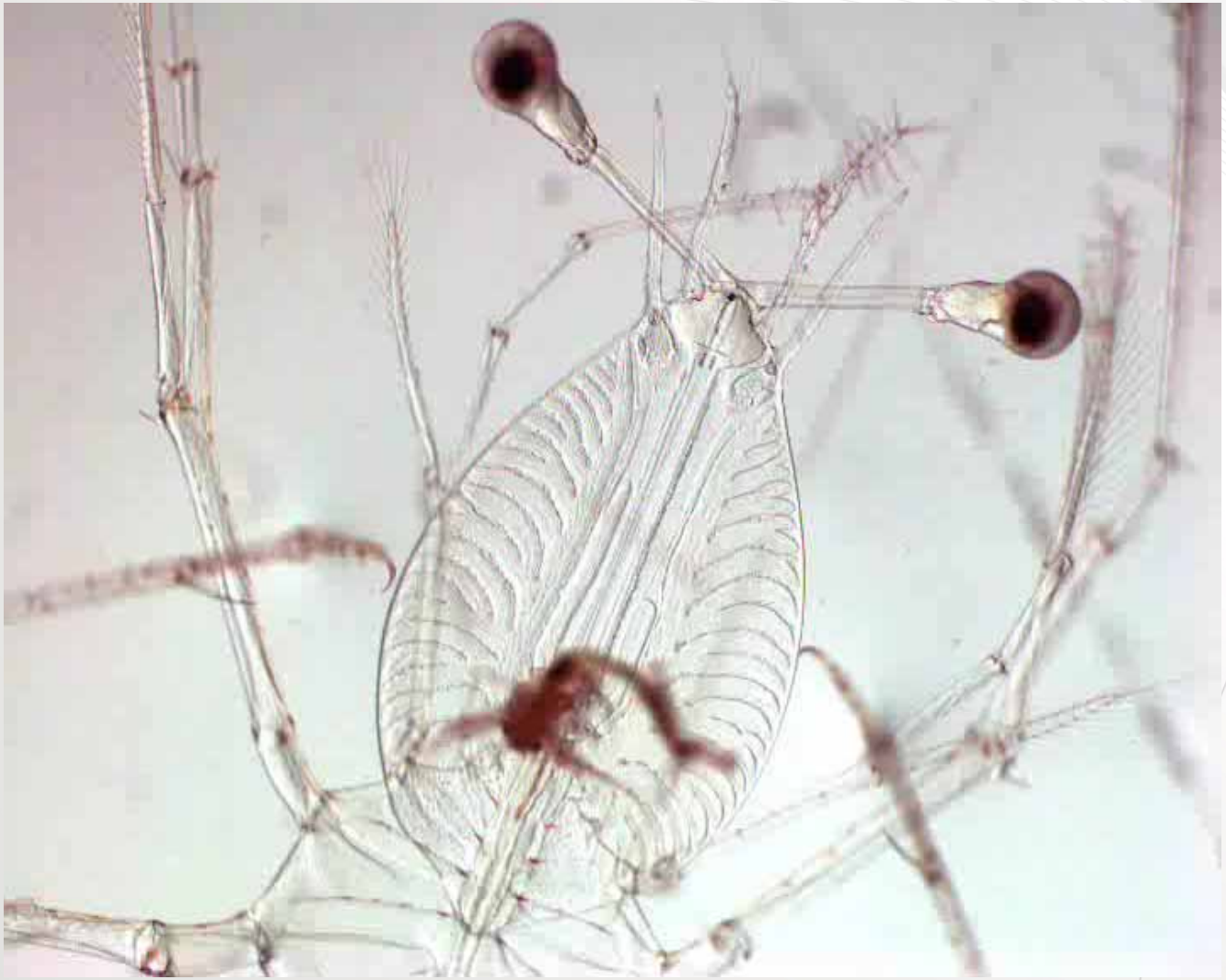
Stage 1



Stage 11

Larval phyllosomas consume feed piecemeal

Feeding video artemia



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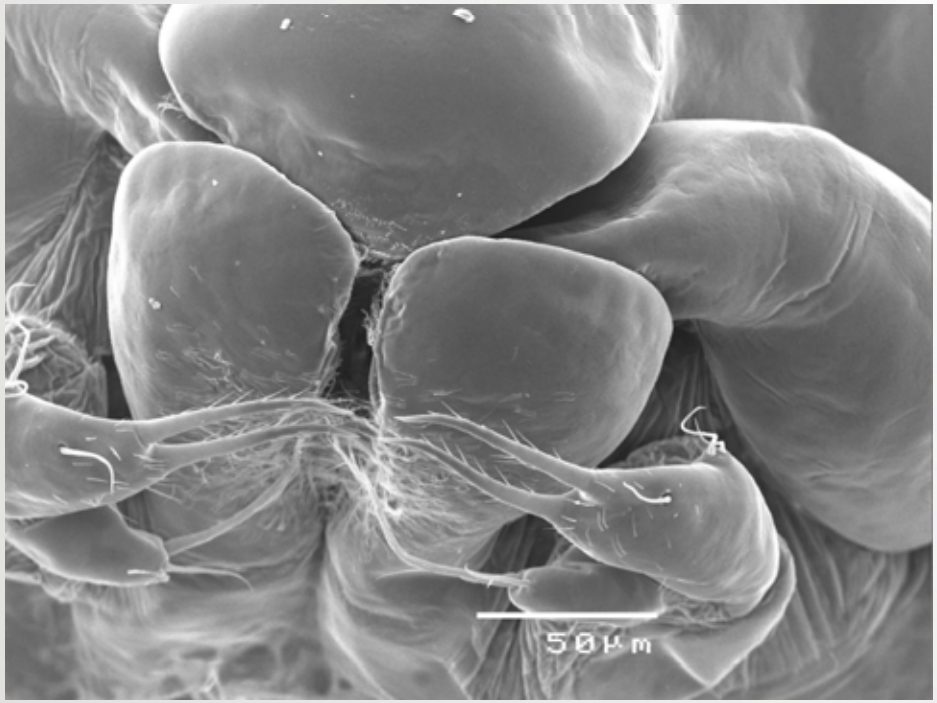
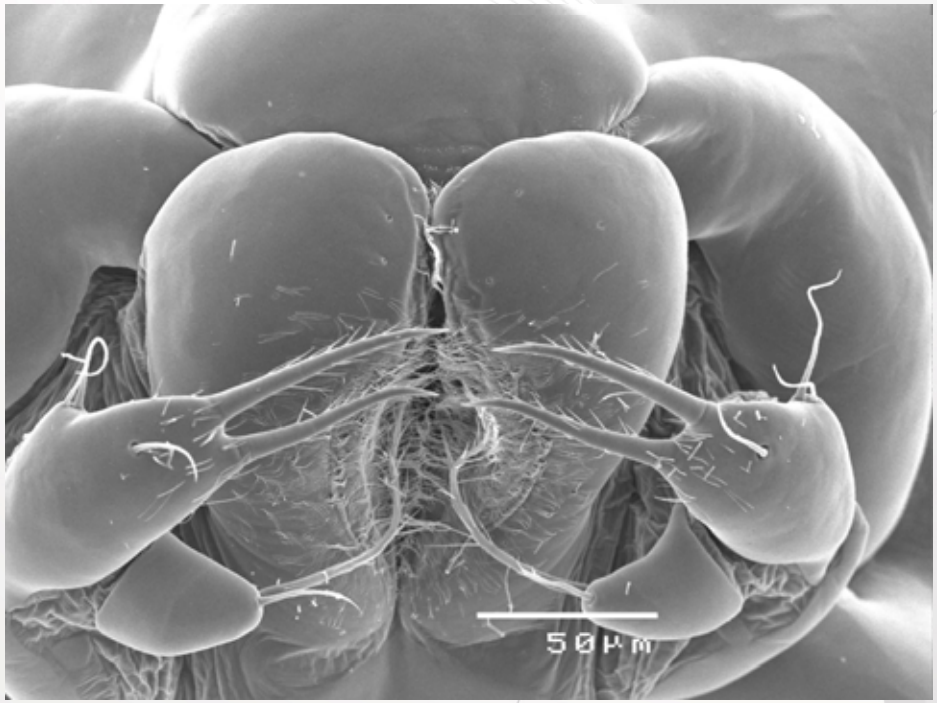
External Bacterial Fouling of Phyllosoma Mouthparts

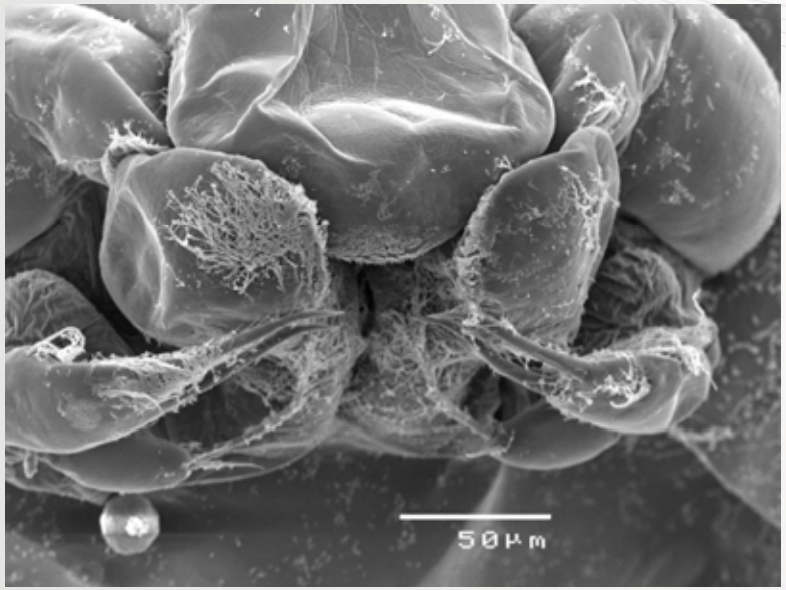


Day 1
Post-molt

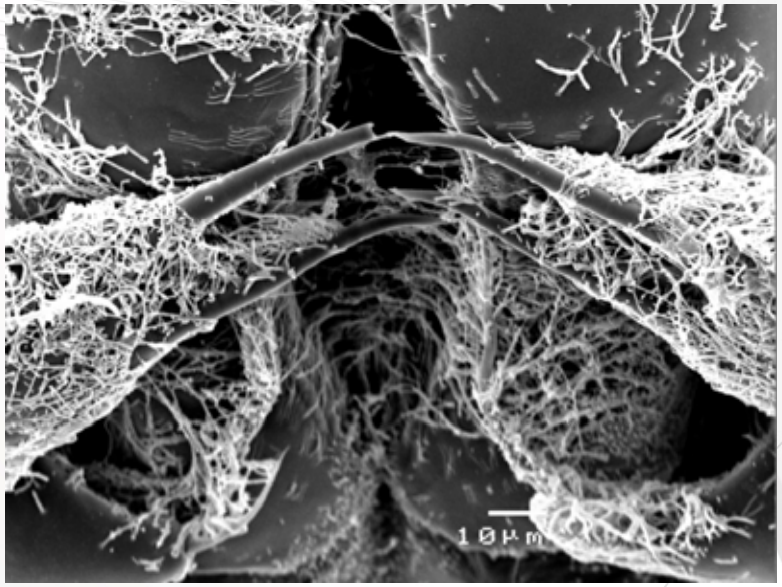


Day 3
Post-molt

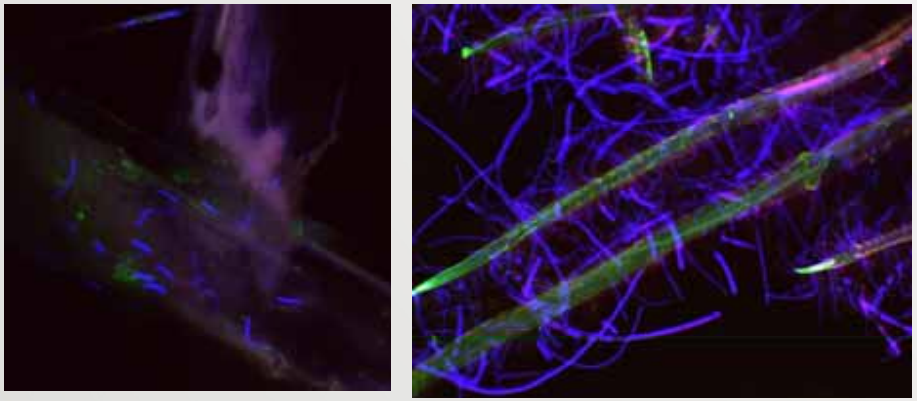
External Bacterial Fouling of Phyllosoma Mouthparts



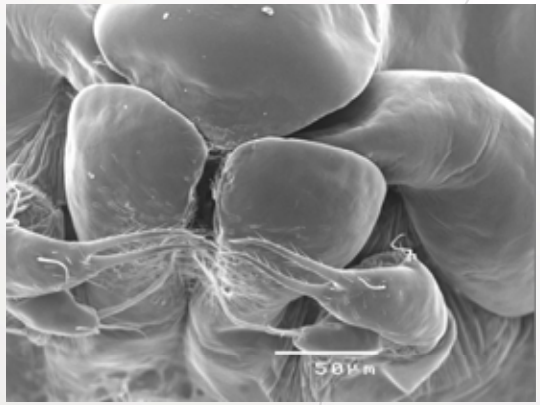
Day 11 Post-molt



Day 13 Post-molt



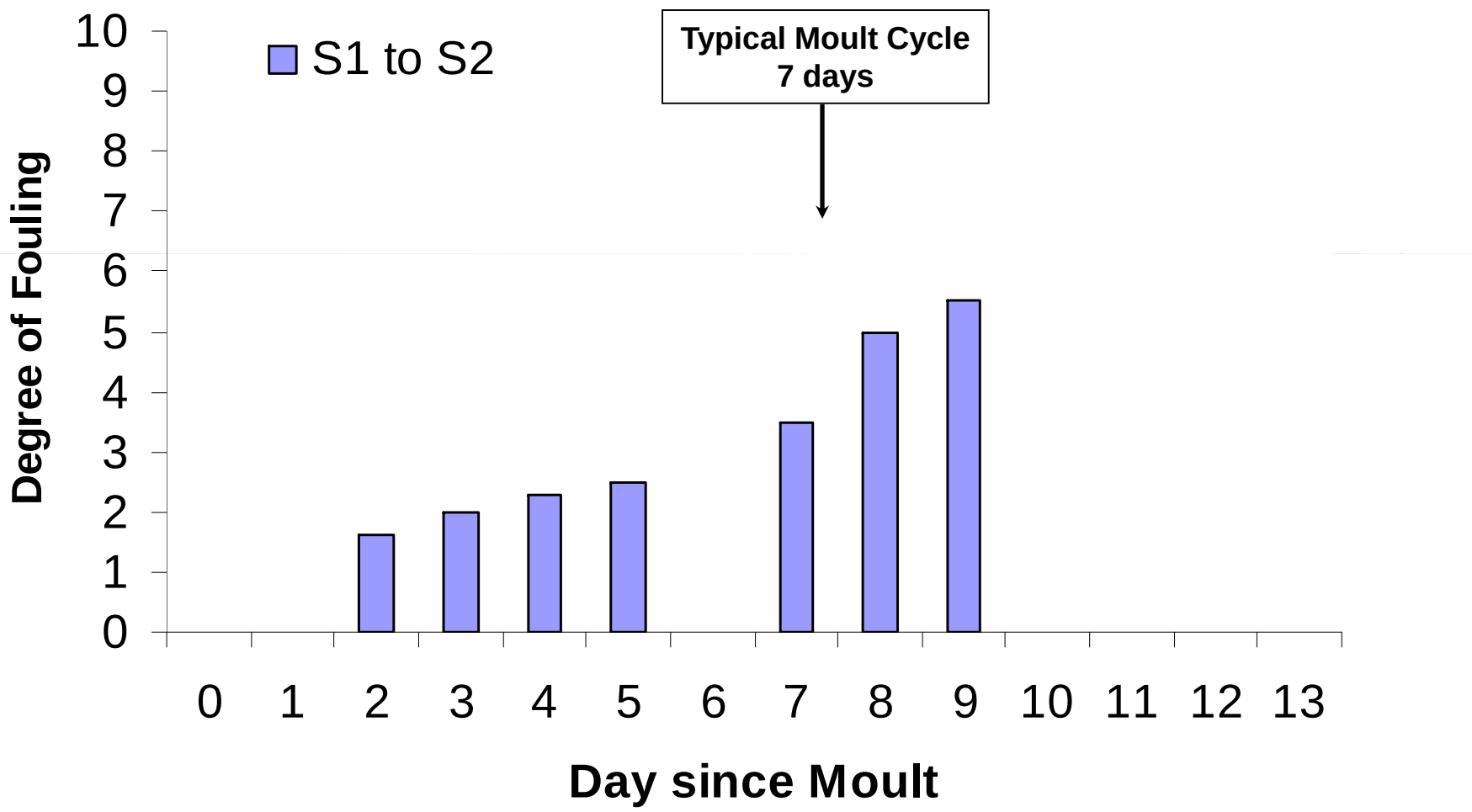
FISH probe - *Thiothrix*



Immediate Post-molt

Fouling (*Thiothrix*) of Phyllosoma Mouthparts

Stage 1 to 2



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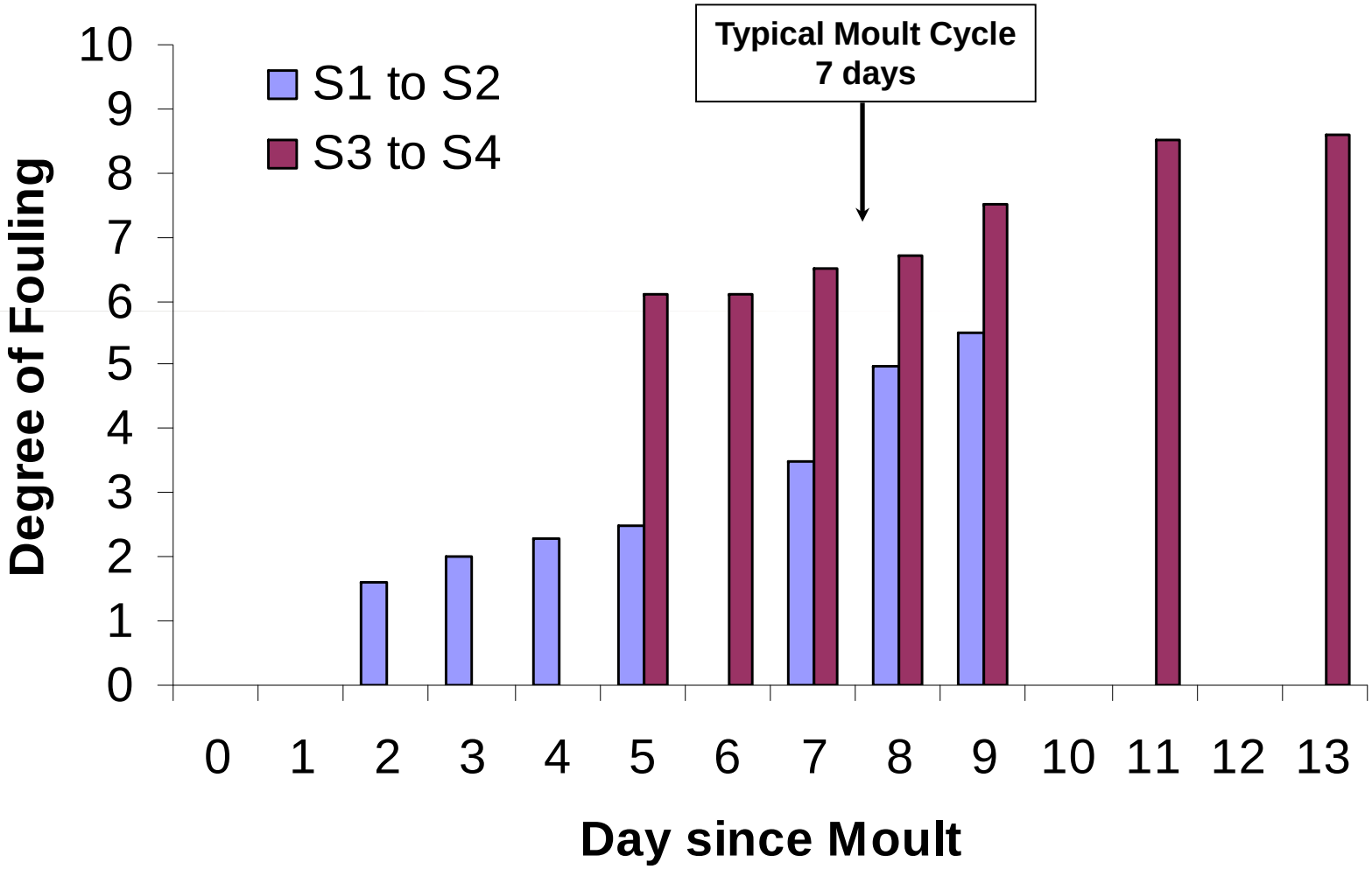
Fouling (*Thiothrix*) of Phyllosoma Mouthparts

Stage 3 to 4 compared to Stage 1 to 2



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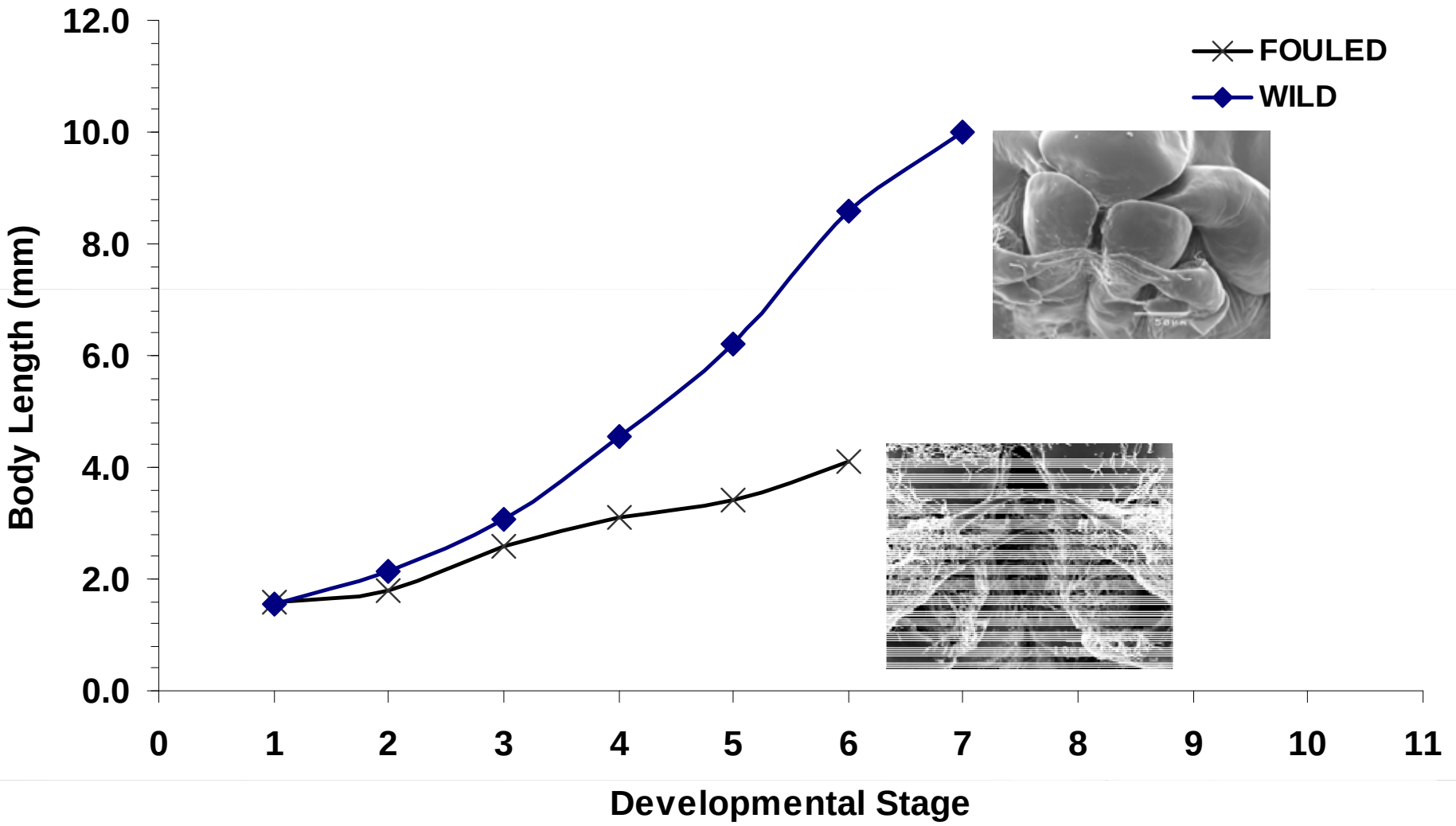
Interactions between Nutrition – Health - Growth

Fouled Hatchery compared to Unfouled



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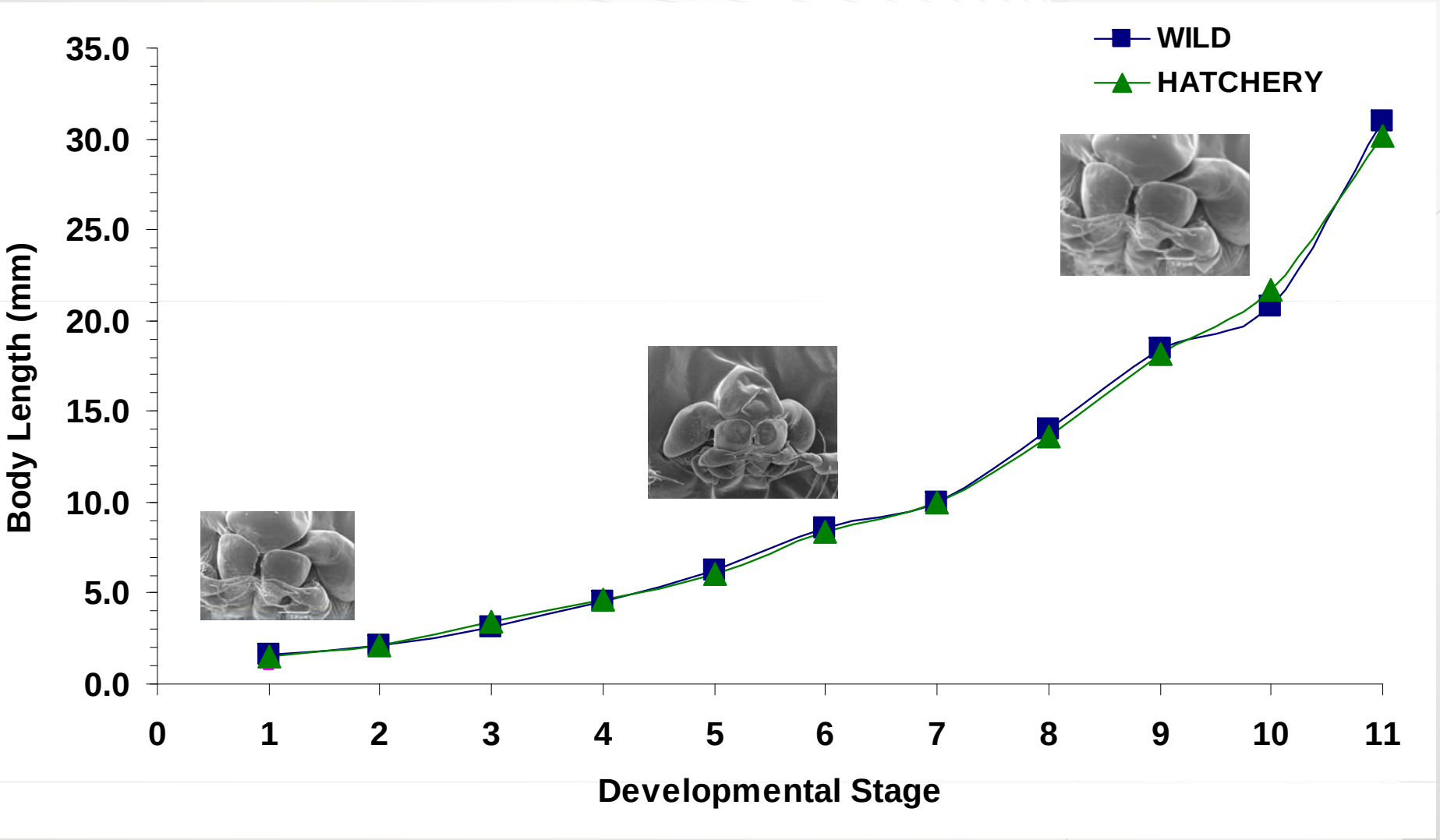
Interactions between Nutrition – Health - Growth

Unfouled Hatchery compared to Wild



Interactions between Nutrition – Health – Growth

Internal Infection

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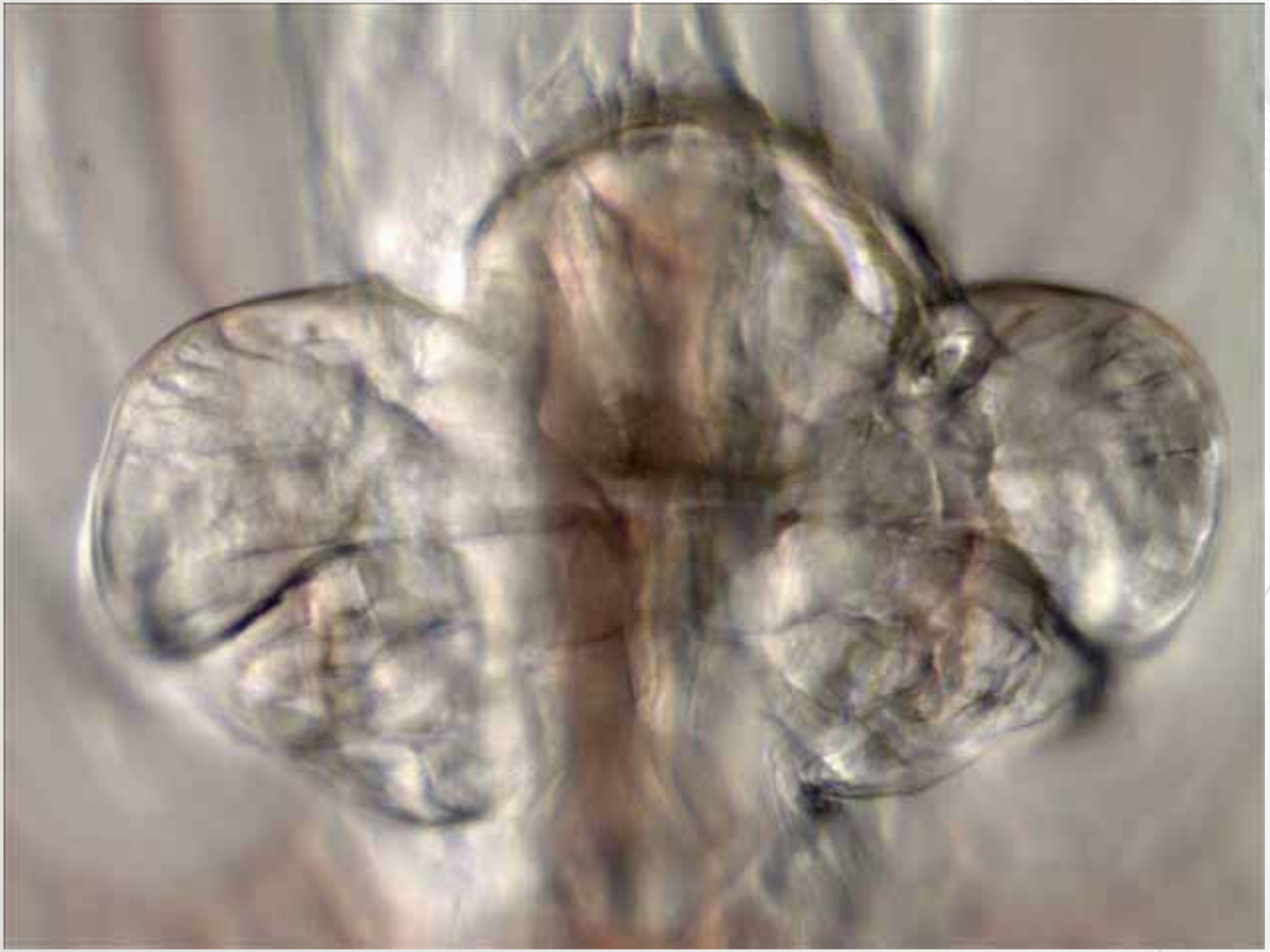
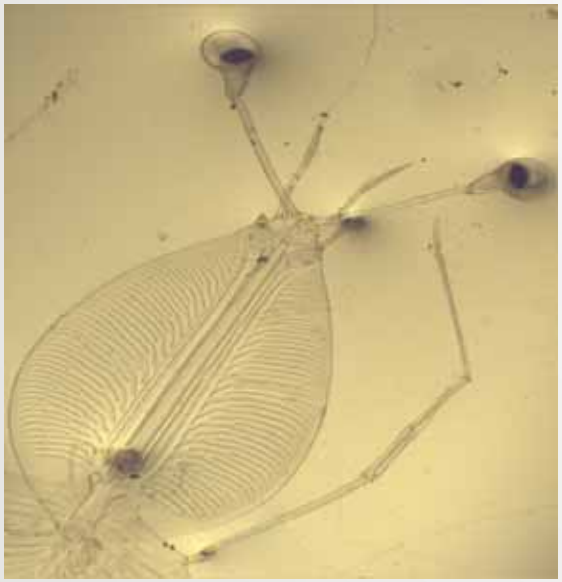
Interactions between Nutrition – Health – Growth

Ingestion and Digestion



Interactions between Nutrition – Health – Growth

Internal Infection

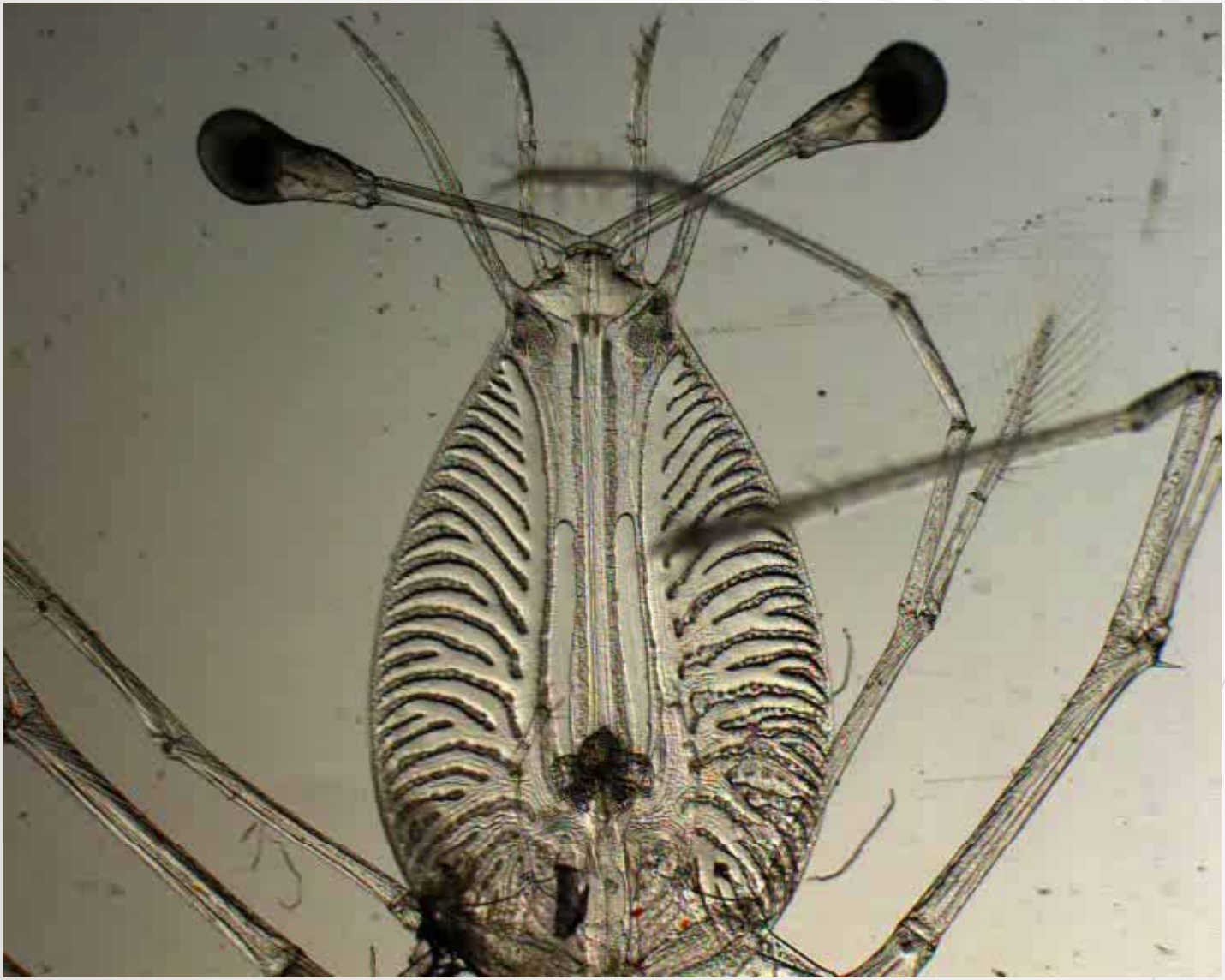


Wild-caught larva with intact hepatopancreas

Hatchery larva with **'white-gut syndrome'**, infected by *Vibrio spp.*

Phyllosoma gut infection

Real-time video



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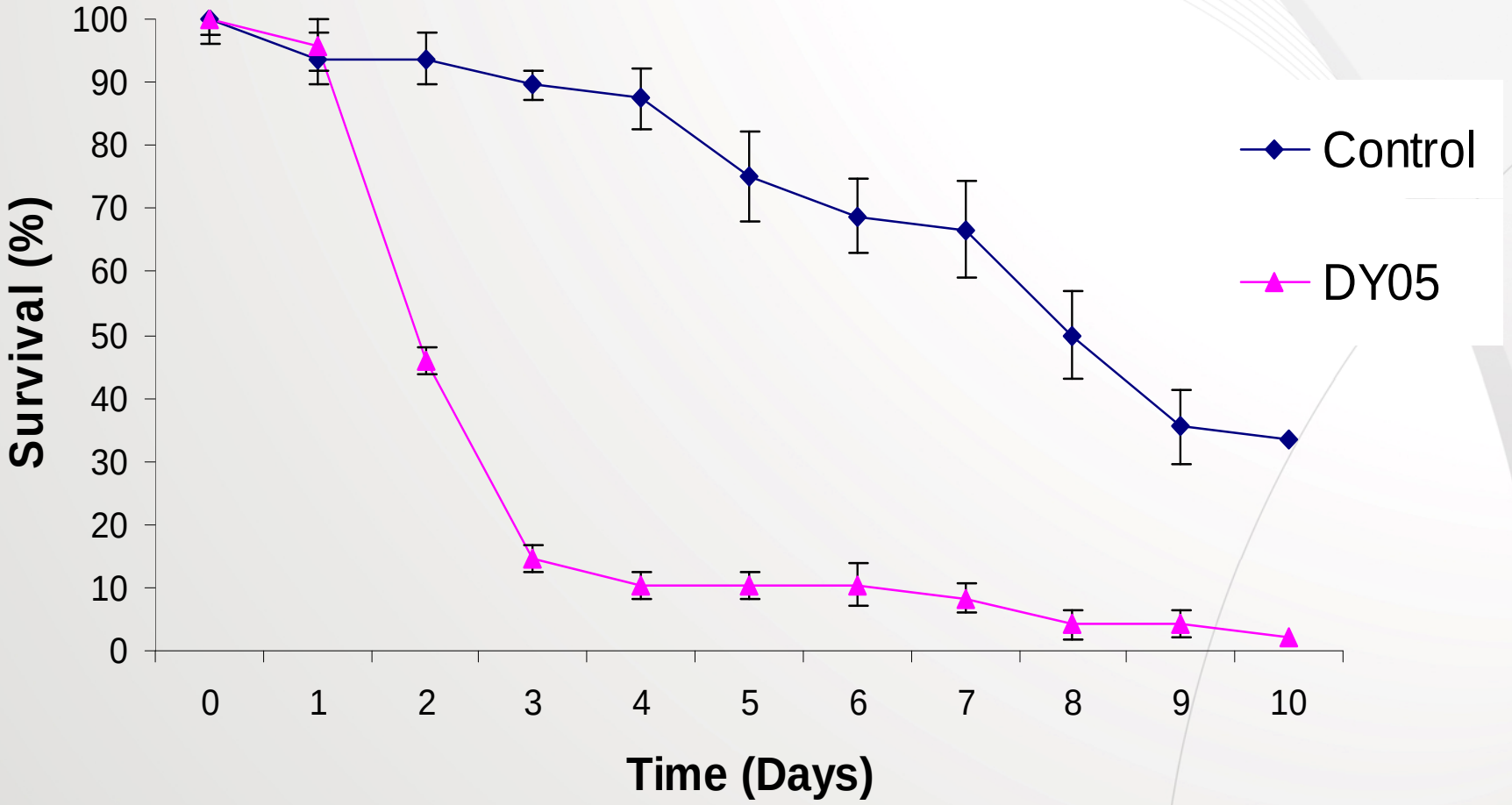
Health – Internal Infections

Survival of *P. ornatus* phyllosomas (S5) challenged with *Vibrio sp.* (DY05)



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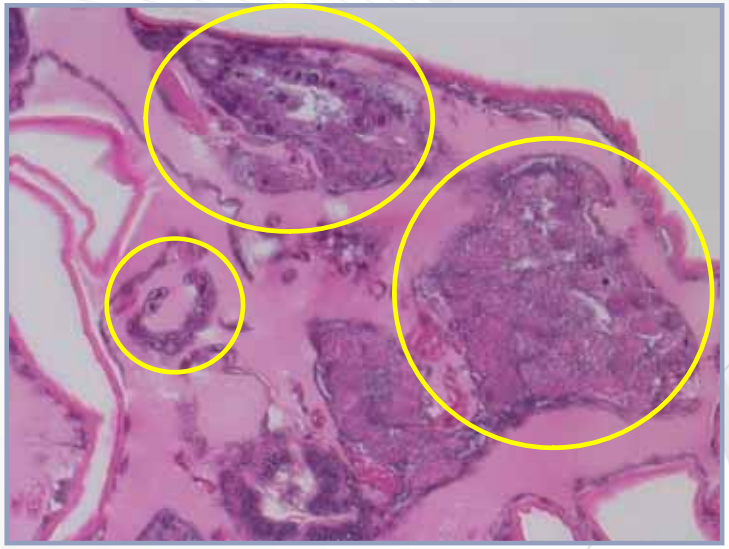
Phyllosoma gut

Internal bacterial colonization

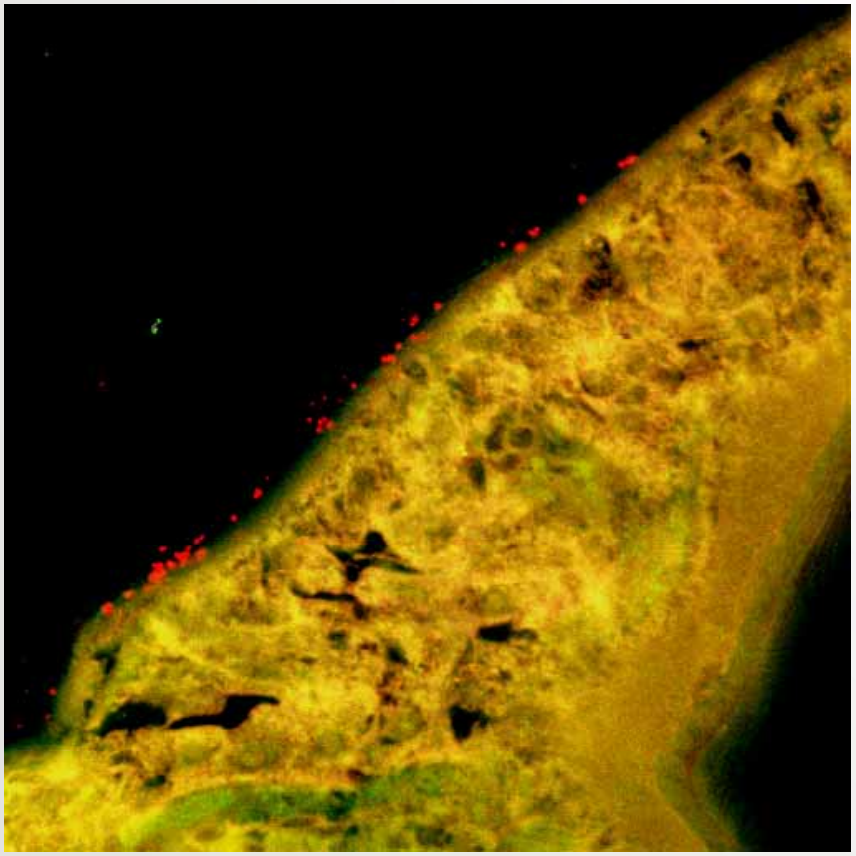
Healthy



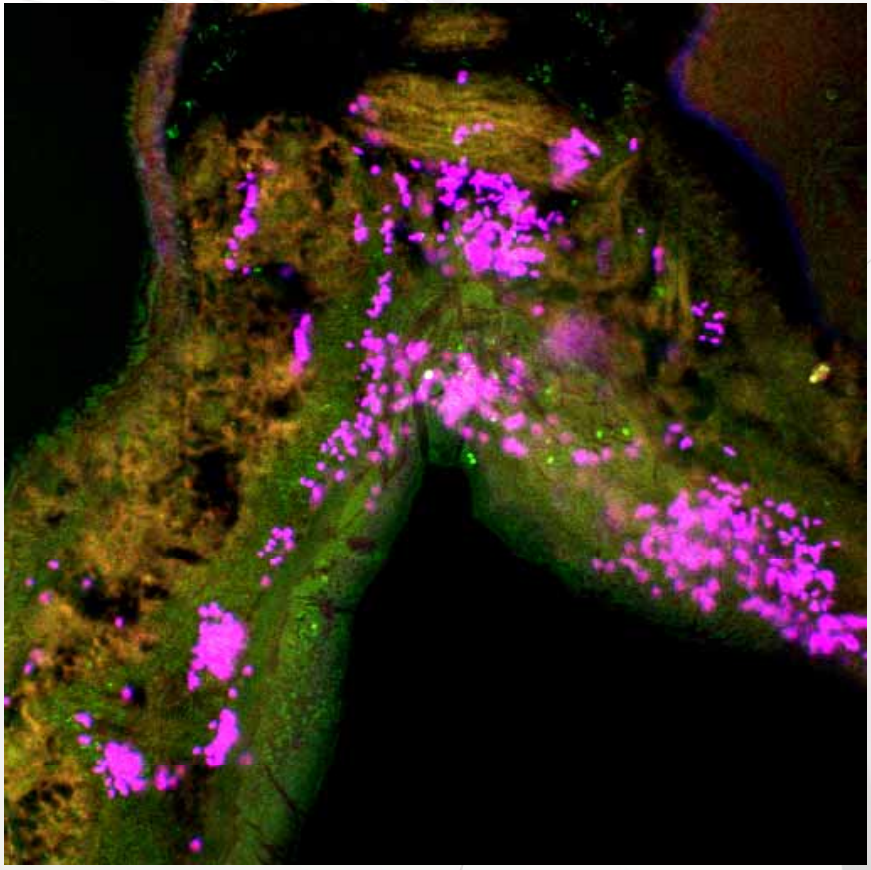
Moribund

- Histopathology of hepatopancreas (H&E)
  - Healthy: caeca open and clear
  - Moribound: caeca are blocked and disrupted

Fluorescent *in situ* hybridisation (FISH) Bacterial localisation



Healthy

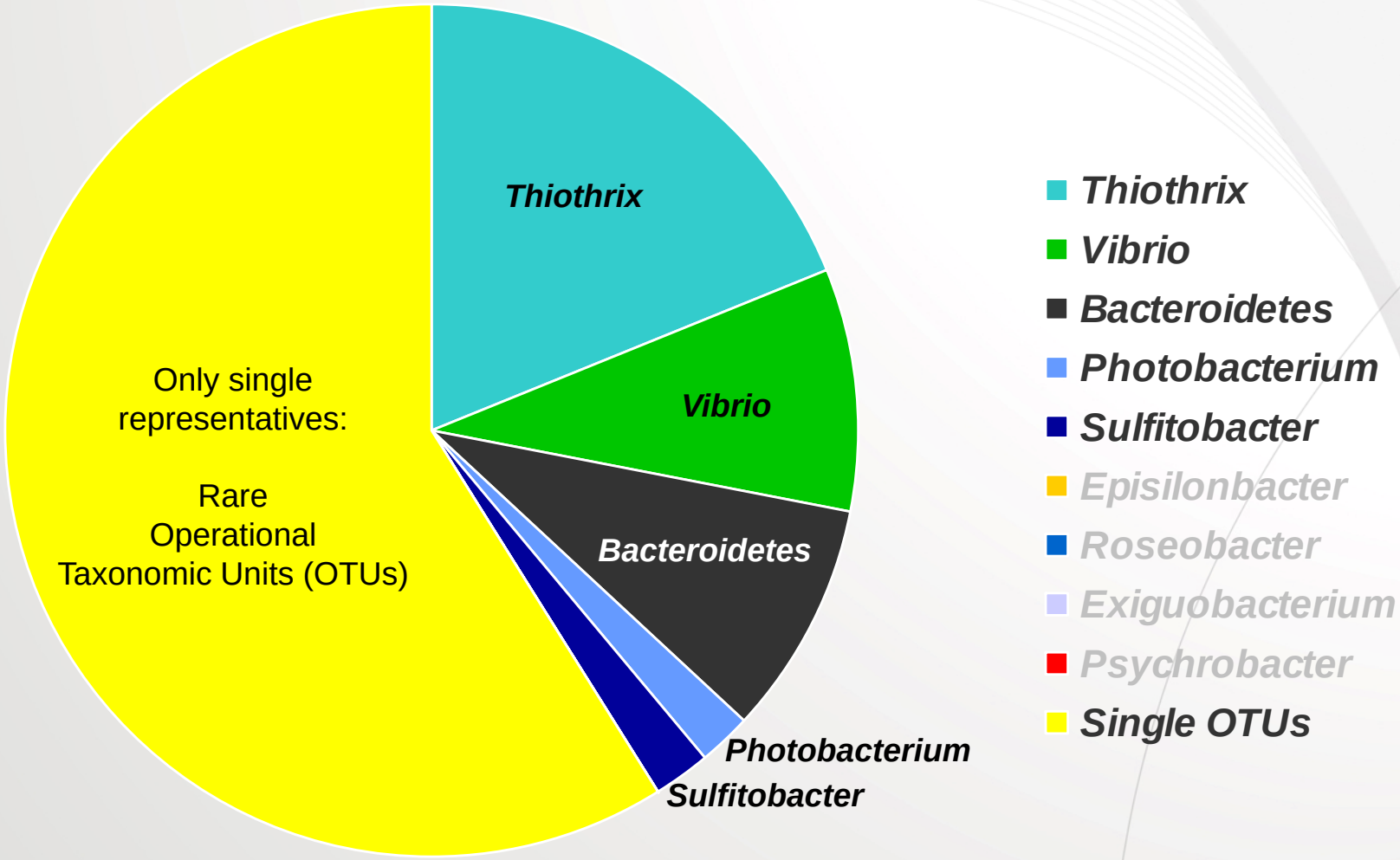


Moribund

Probes: Red = general bacteria, Purple = Vibrio

Bacterial Diversity in Hatchery Phyllosoma

Clone Library Analysis



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Interactions between Nutrition – Health - Growth

Hunting Probiotics

Oceanic

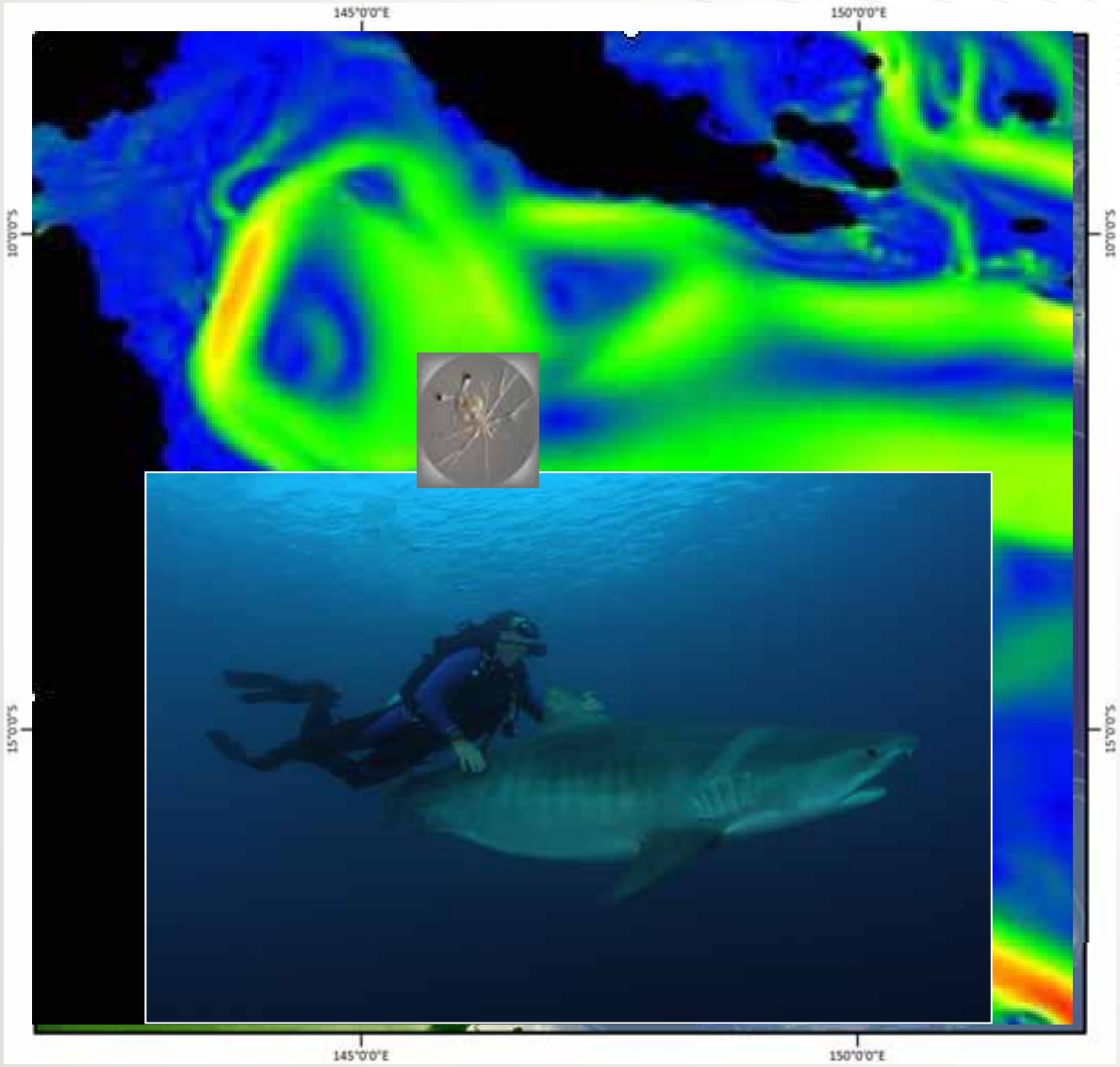
Health –
Natural Microbial community

Tank

Health –
Probiotic Microbial community

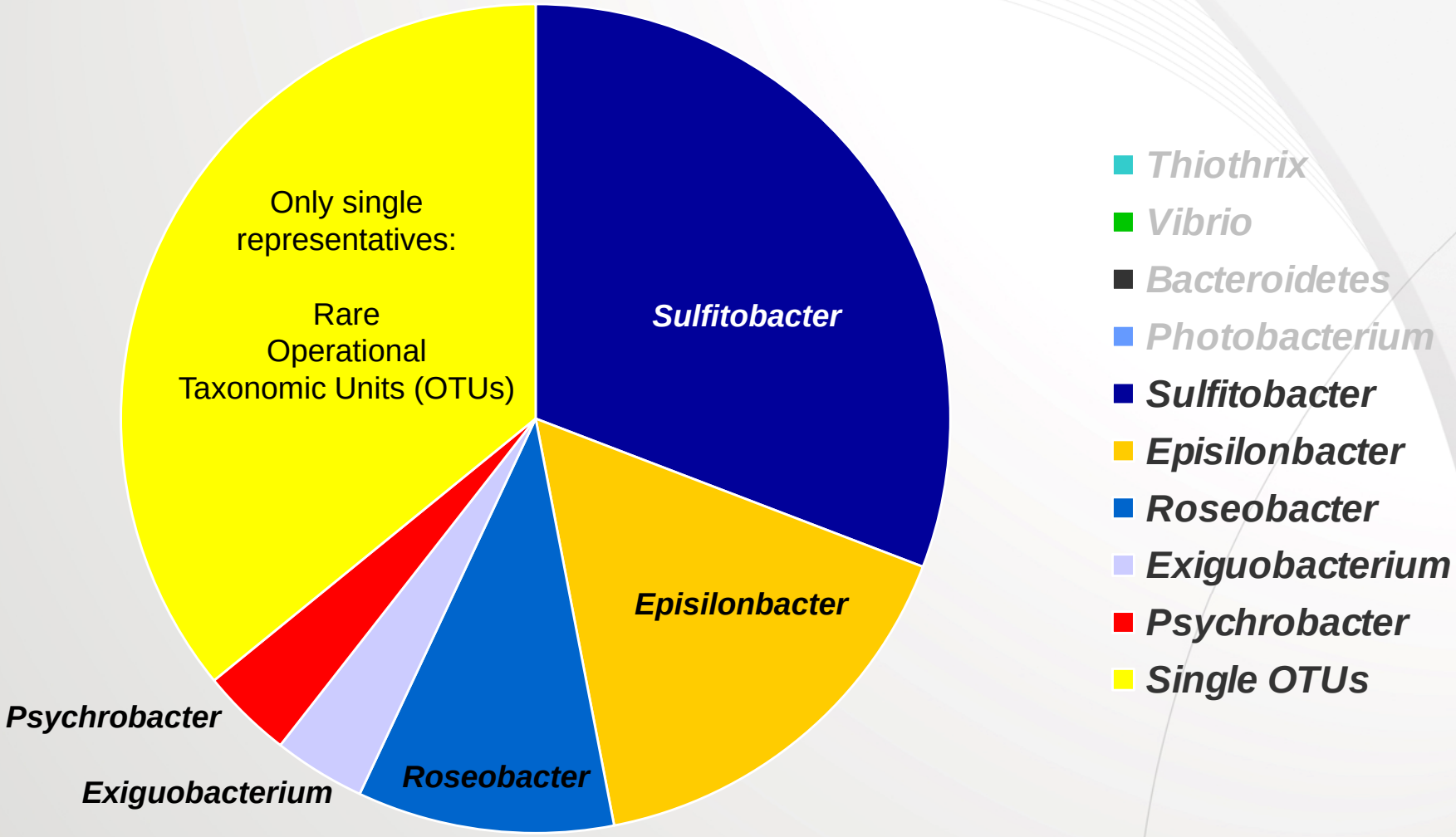
Larval Ecology of *P.ornatus* in NE Australia

Phyllosoma entrained in the Coral Sea Gyre



Bacterial Diversity in Wild Phyllosoma

Clone Library Analysis



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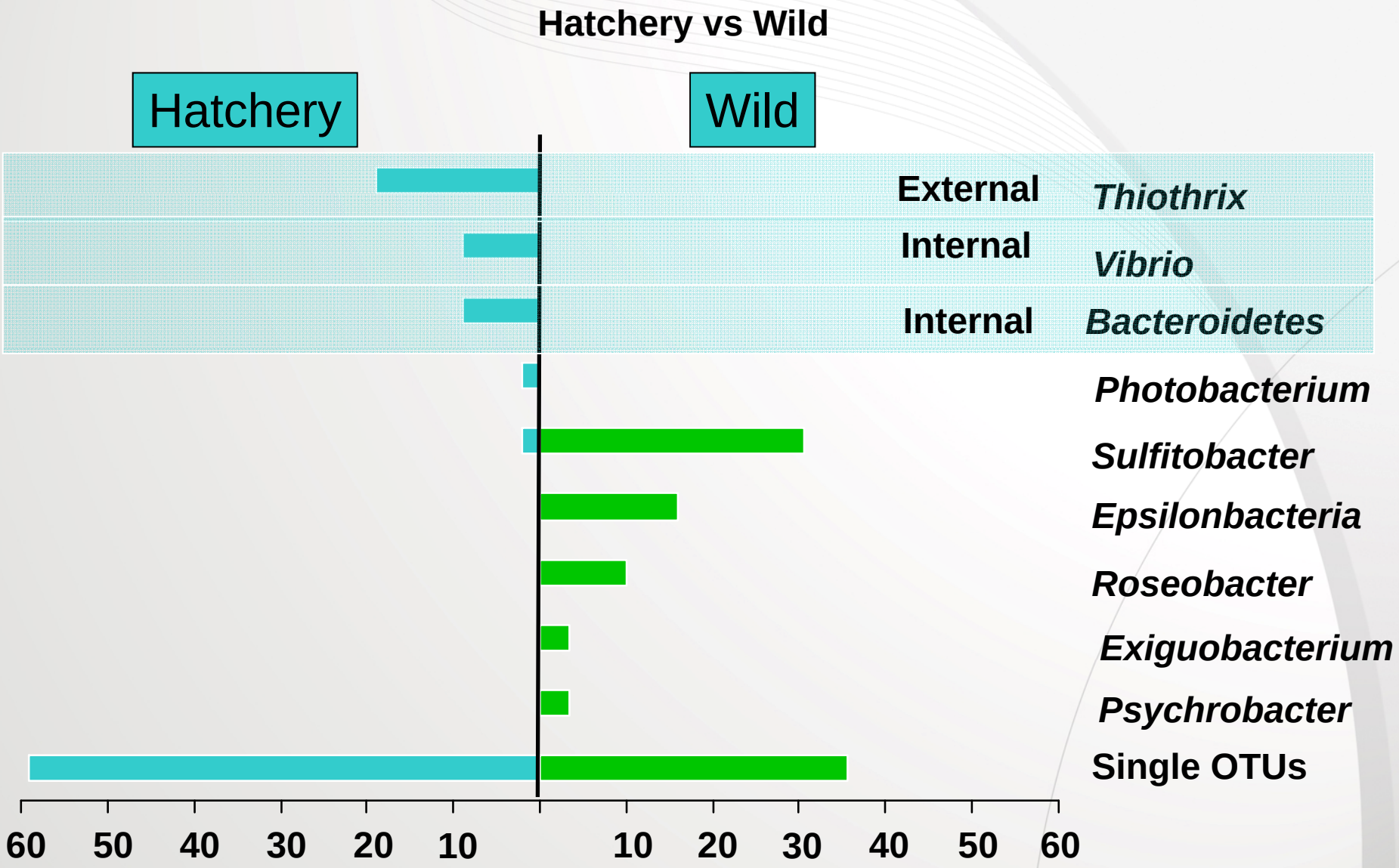
Bacterial Community Composition



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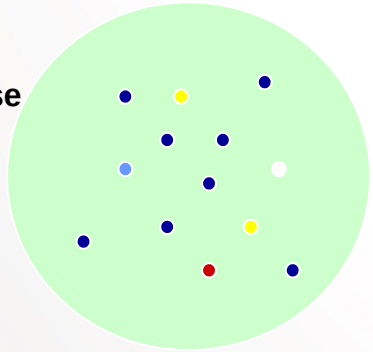
The search for Probiotics

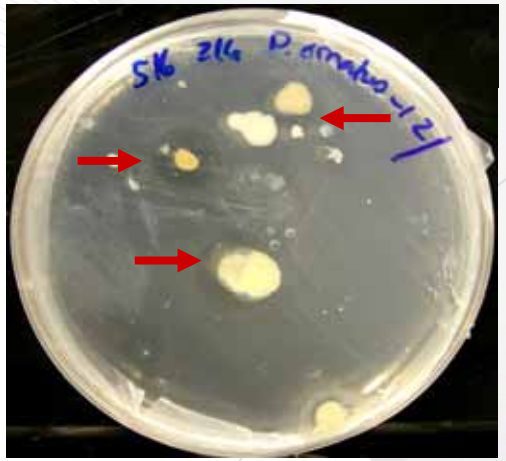
Well diffusion assay – agar infused with strain DY05

Sample natural environment

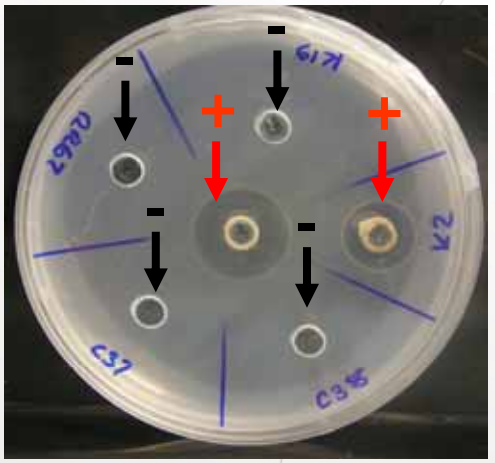
Homogenise



Replica plating



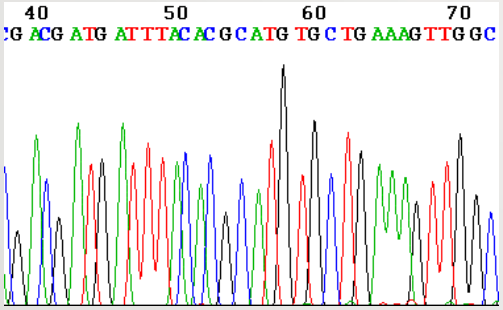
Well Diffusion Assay



Target organism: *Vibrio* sp. DY05

\+
AIMS culture collection

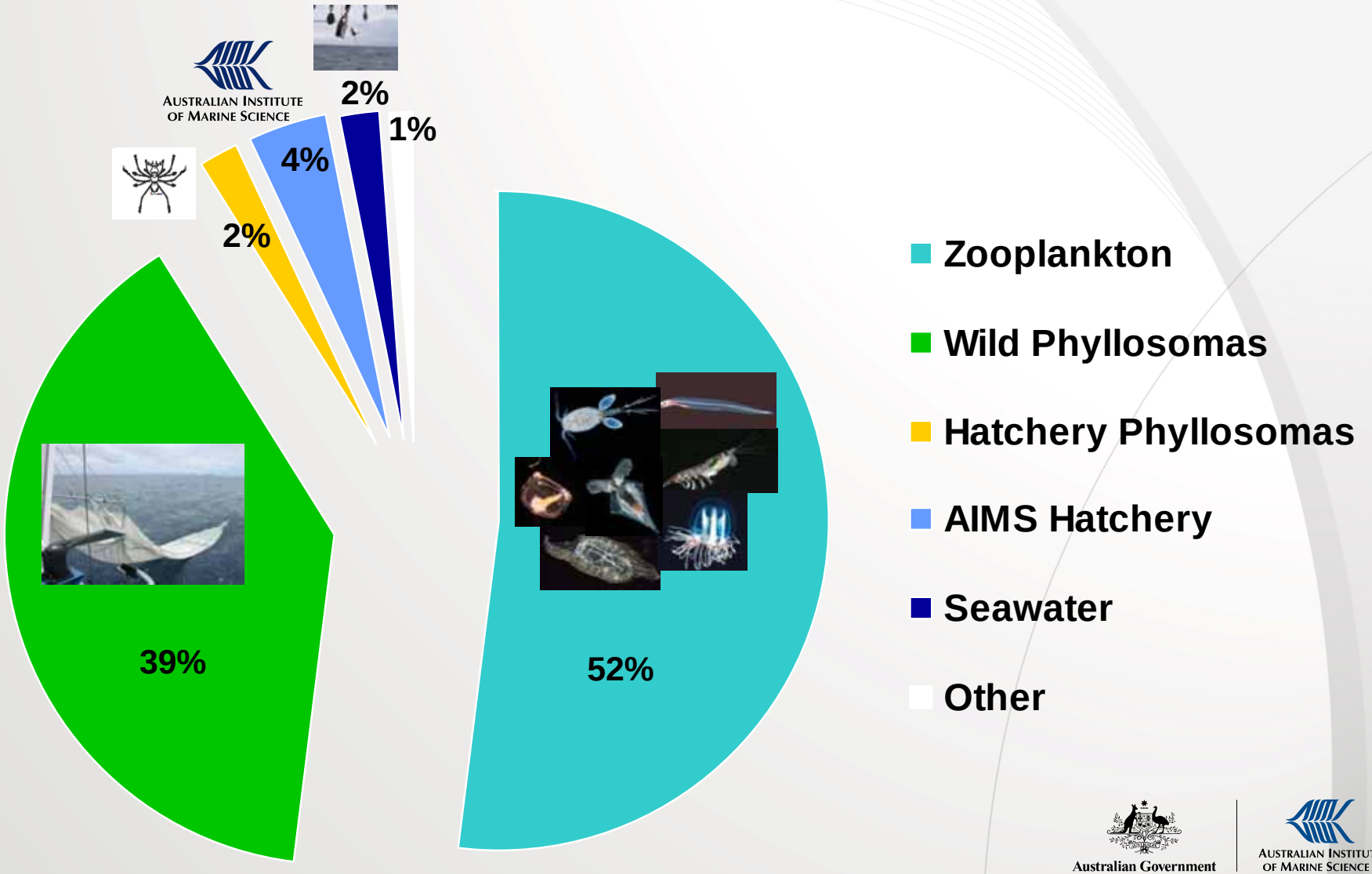
Identification



16S rDNA sequencing

Sourcing Probiotic Strains

18% (92/508) of isolates inhibited growth of known *P. ornatus* pathogens (*Vibrio* strains DY05 & D40) in well-diffusion assays



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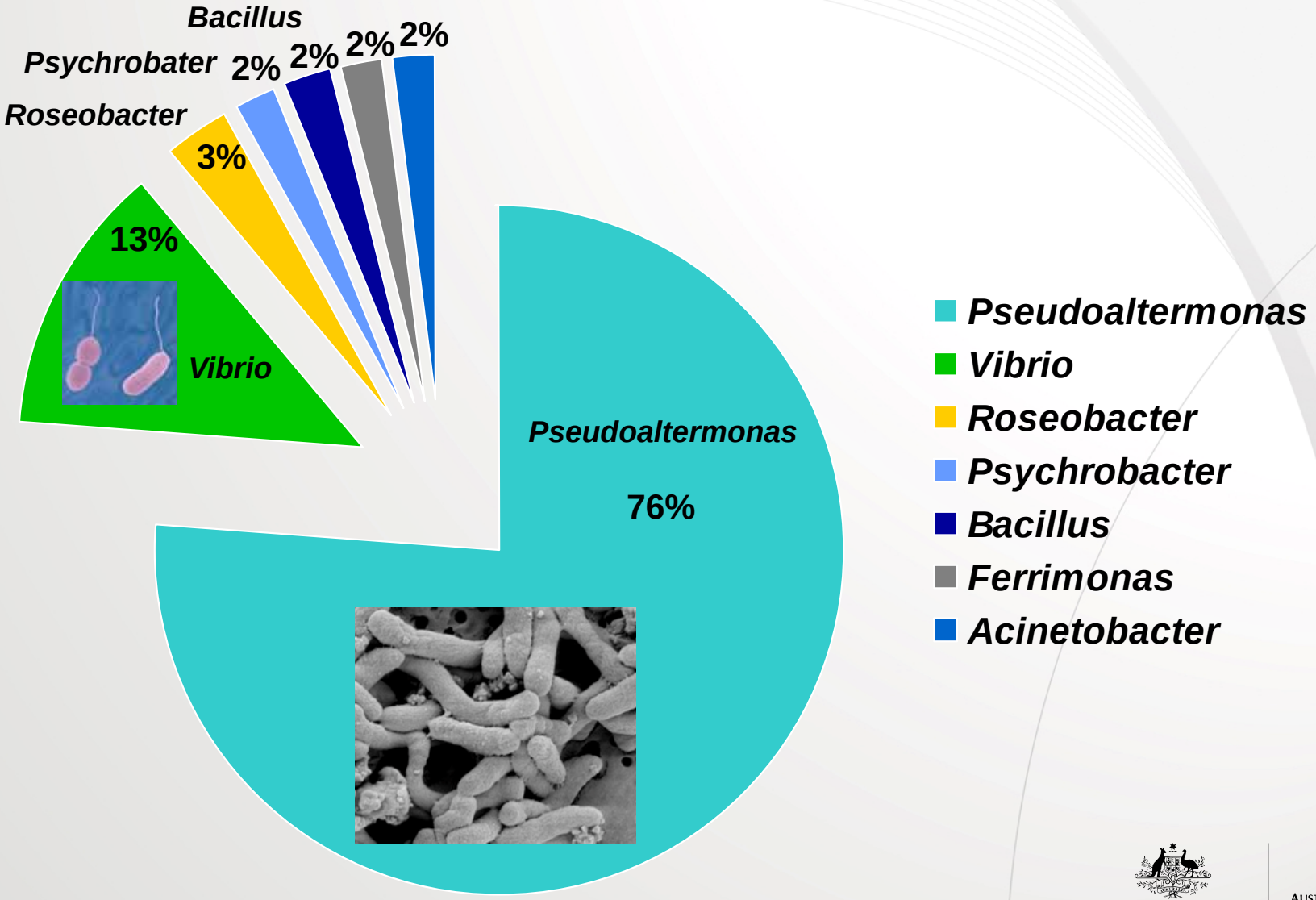
Identifying the Probiotic Candidates

16S rDNA sequencing of 60 candidate probionts



Australian Government

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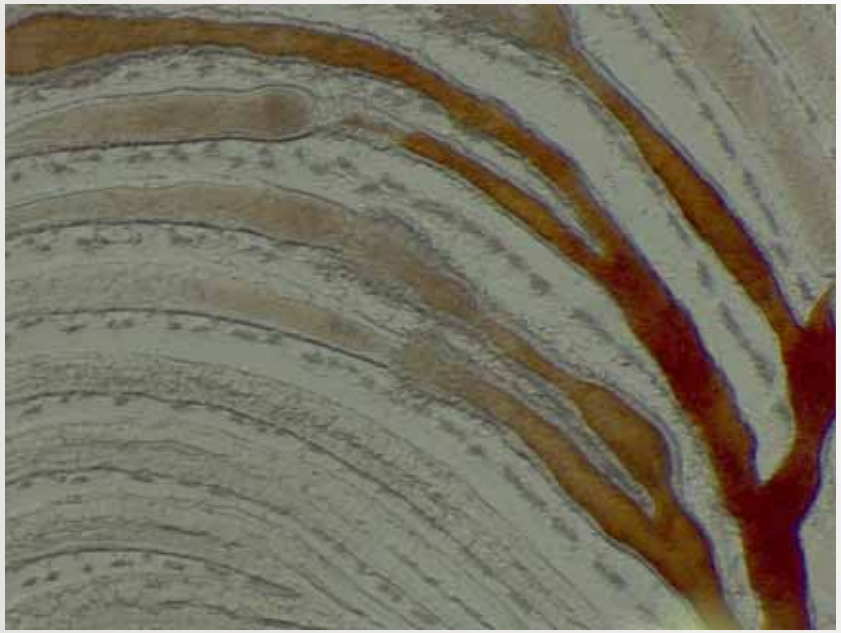
Current and future direction

Interactions between Nutrition – Health - Growth

Elucidation of pathogen-probiont interactions *in vivo*



Vibrio (DY05) Infection

GFP labelled *Vibrio* (DY05)
Artemia gut

Closed life cycle Aquaculture

Panulirus ornatus

Wild stock

Broodstock

Maturation

Spawning

Hatching

Larval Rearing

Grow-out

Harvesting Processing Marketing

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Closed life cycle Aquaculture

Panulirus ornatus

Wild stock (Captured Rearing)

Broodstock

Maturation

Spawning

Larval Rearing

Grow-out

Harvesting Processing Marketing

Closed-life Cycle (Farming)

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Staff Investment

Area	Staff
Water Quality	**Matt Kenway** **Jane Gioffre** **Michael Clarkson** **Katie Holroyd** **Matt Salmon** **Grant Milton** **Justin Hochen** **Greg Smith**
Broodstock Facility	
Larval Rearing Facility **Live Feed Facility**	
Health (Microbiology) Research	**Lone Høj** **Mike Hall**
Diet (Larval Feeds) Research	**Greg Smith** **Mike Hall**
Cruises – Natural History, Prey, Probiotics, Diet	**Above staff plus volunteers**
Associated Larval Research	**6 PhDs, 1 MSc** **Evan Goulden** **Ana Cano Gomez**

Australian Government

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