



# Musings in Microbiomes

Dr. Michael Schwarz  
Director  
Virginia Seafood AREC

**Florida Shrimp Aquaculture Summit**

**May 16 – 17, 2024**

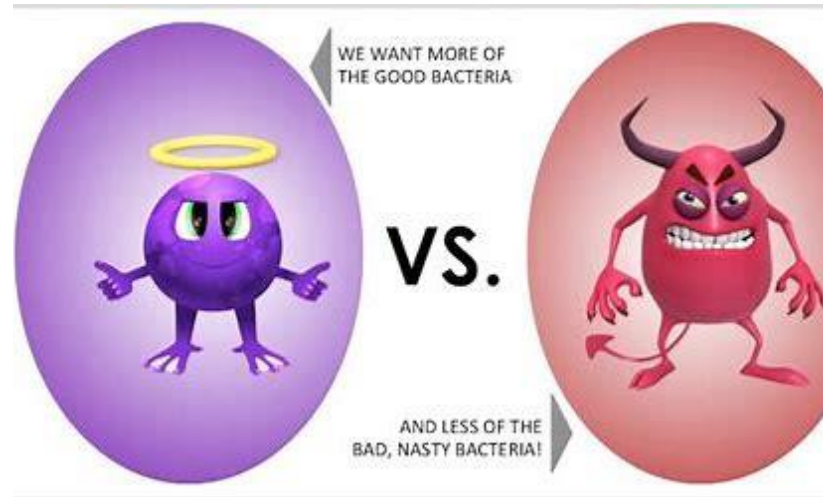
**Fort Pierce, FL**



## **Mi·cro·bi·ome**

**Noun - the microorganisms in a particular environment  
(including the body or a part of the body)**

# Musing on Microbiomes: r versus K strategist communities



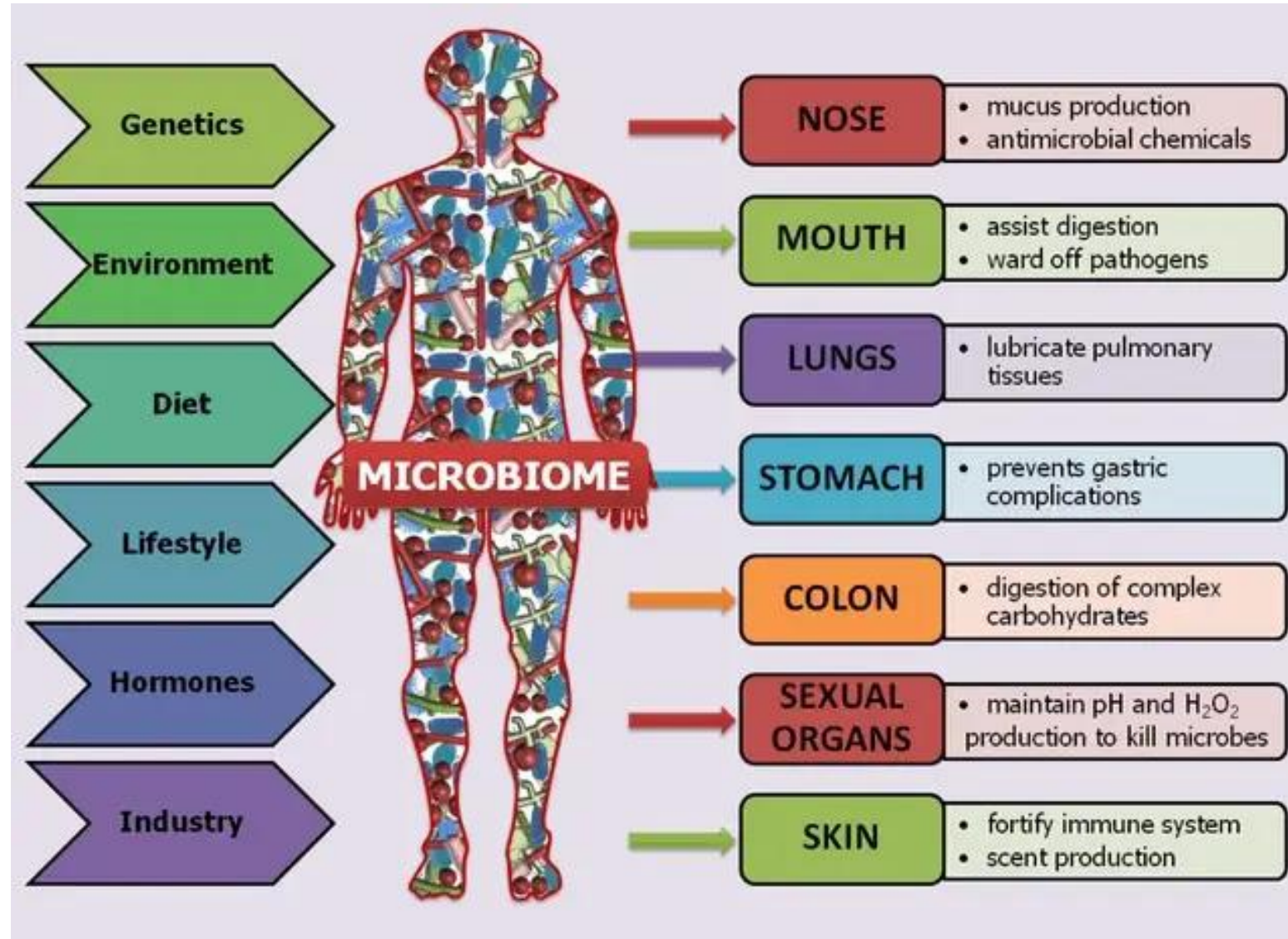
Vadstein O, Attramadal KJK, Bakke I, Olsen Y. K-Selection as Microbial Community Management Strategy: A Method for Improved Viability of Larvae in Aquaculture. *Front Microbiol.* 2018 Nov 14;9:2730. doi: 10.3389/fmicb.2018.02730. PMID: 30487782; PMCID: PMC6246659.

“Substantial evidence indicates that the poor performance and viability of larvae is largely due to detrimental larvae-microbiota interactions. This emphasizes the need for microbial management strategies in the cultivation of marine fish larvae”.

Pettersen, J.P., Gundersen, M.S. & Almaas, E. Robust bacterial co-occurrence community structures are independent of r- and K-selection history. *Sci Rep* 11, 23497 (2021). <https://doi.org/10.1038/s41598-021-03018-z>

“Selection for bacteria which are *K*-strategists instead of *r*-strategists has been shown to improve fish health and survival in aquaculture”

# Musing on Microbiomes: Personal health



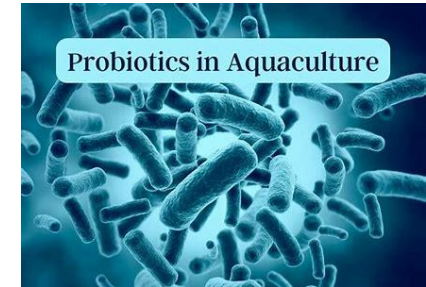
# Musing on Microbiomes: Global Travels



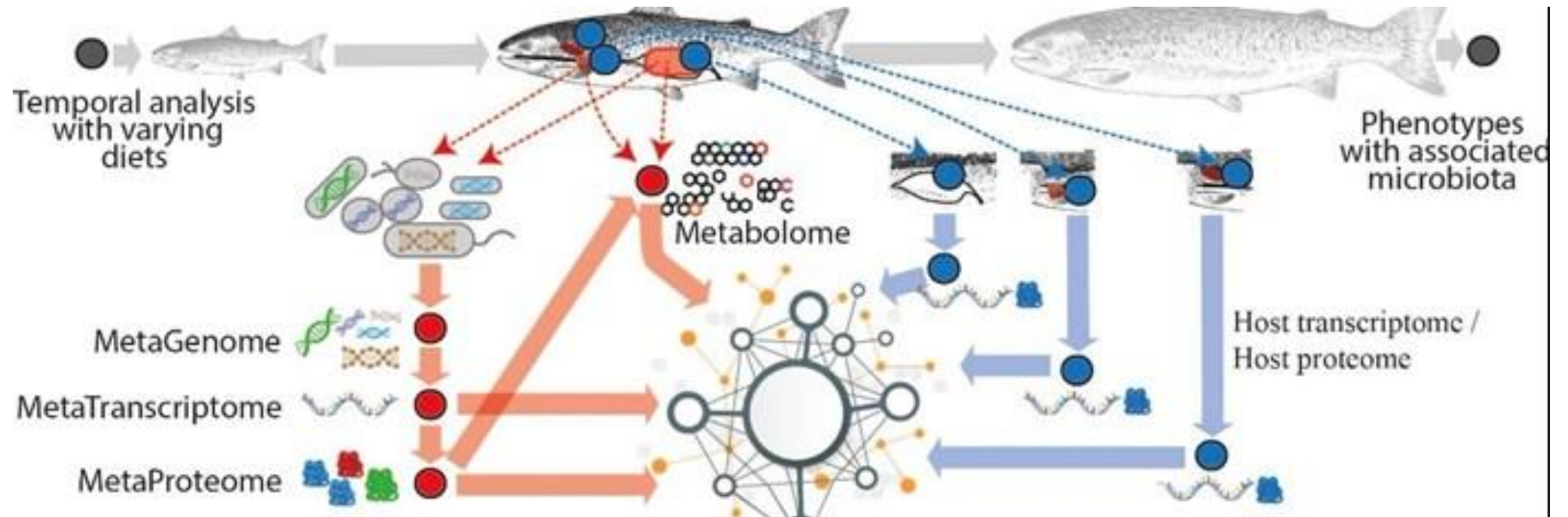
Boolchandani, M., Blake, K.S., Tilley, D.H. et al. Impact of international travel and diarrhea on gut microbiome and resistome dynamics. Nat Commun 13, 7485 (2022).

<https://doi.org/10.1038/s41467-022-34862-w>

# Musing on Microbiomes: Aquaculture, accelerating interest/information



# Musing on Microbiomes: Aquaculture, accelerating interest/information



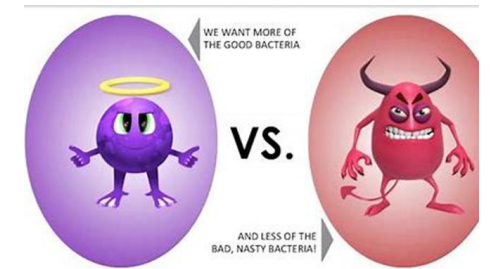
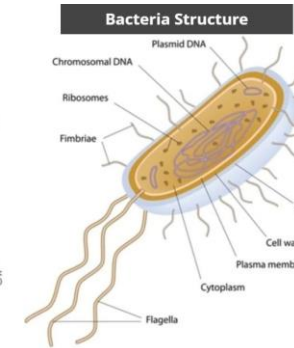
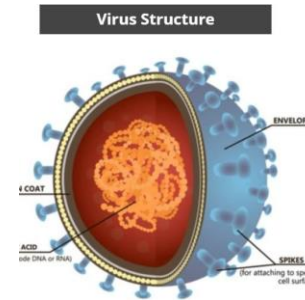
# Musing on Microbiomes: Typical aquaculture

- Larviculture
  - Disinfect systems, seed, live feeds
  - Short production runs
  - Rapid biological loading



- Phase/growout
  - Densities maximized
  - Dynamic water quality/chemistry
  - Additives

- Healthy microbiomes need stability



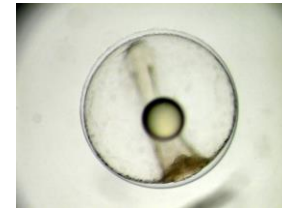


# Musing on Microbiomes: Observations

- HarvestFresh Seafoods LLC.
  - 1987 – 1997
  - Vertically integrated redfish farm
  - 450 MT redfish, 150 MT HSB



- Larviculture
  - Traditional pond production (> 50% survival)
  - Closed system (~ 25% survival)
  - Closed system shifted to “mature” system/water (> 70% survival)



# Musing on Microbiomes: Observations

- VT – Summer flounder R&D
  - 2000 - 2005
- Larviculture
  - Traditional closed system/RAS (~ 25% survival)
  - Closed system shifted to “mature” system/water (> 90% survival)
    - Larger tanks





**National Centre for  
Aquatic Animal Health**  
Cochin University of Science and Technology

**Project Director:** Indo-US initiatives on innovative reforms in marine biotechnology education and research, and development of sustainable aquaculture production systems for inclusive economic growth and sustainable development. Indo-US 21st Century Knowledge Initiative (OSI). 2015 – 2018.



Marine biotechnology R&D focused on microbiome research/manipulation.

- Quantified healthy pond microbiome
- Extracted/manufactured beneficial stock cultures
- Created weekly pond “inoculations”
- Repeated seasonally

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2019 - 2024

## Commercial Enhancement of Bivalve Hatchery Sustainability Through Applied Technology Application

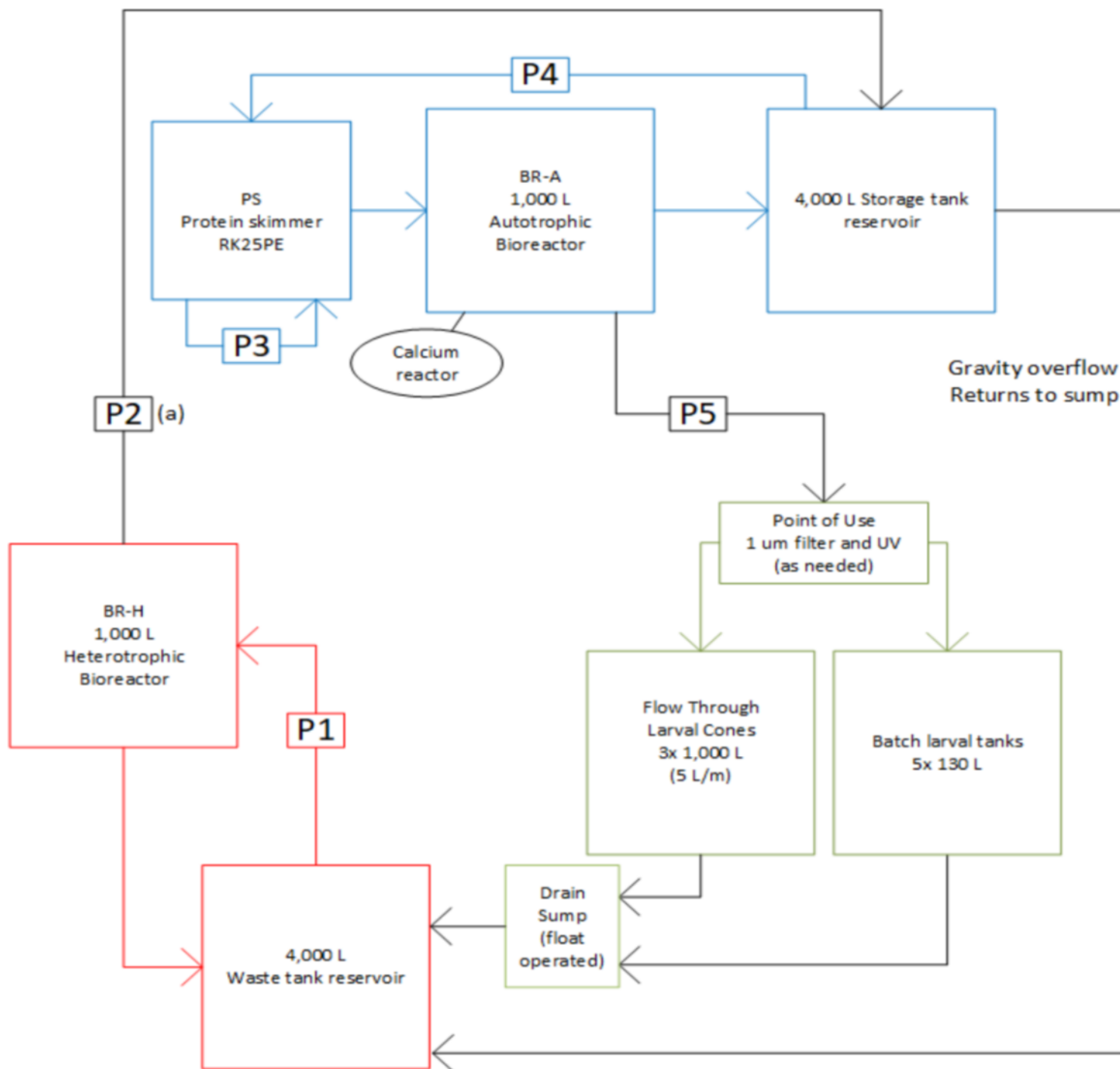


- Oyster Seed Holdings, LLC
- Recirculating Aquaculture system:
- 1) K1 carrier elements to provide high surface area to support biofilm growth by bacteria and protists
- 2) Tank with heterotrophic filter
- 3) Tank with autotrophic filter



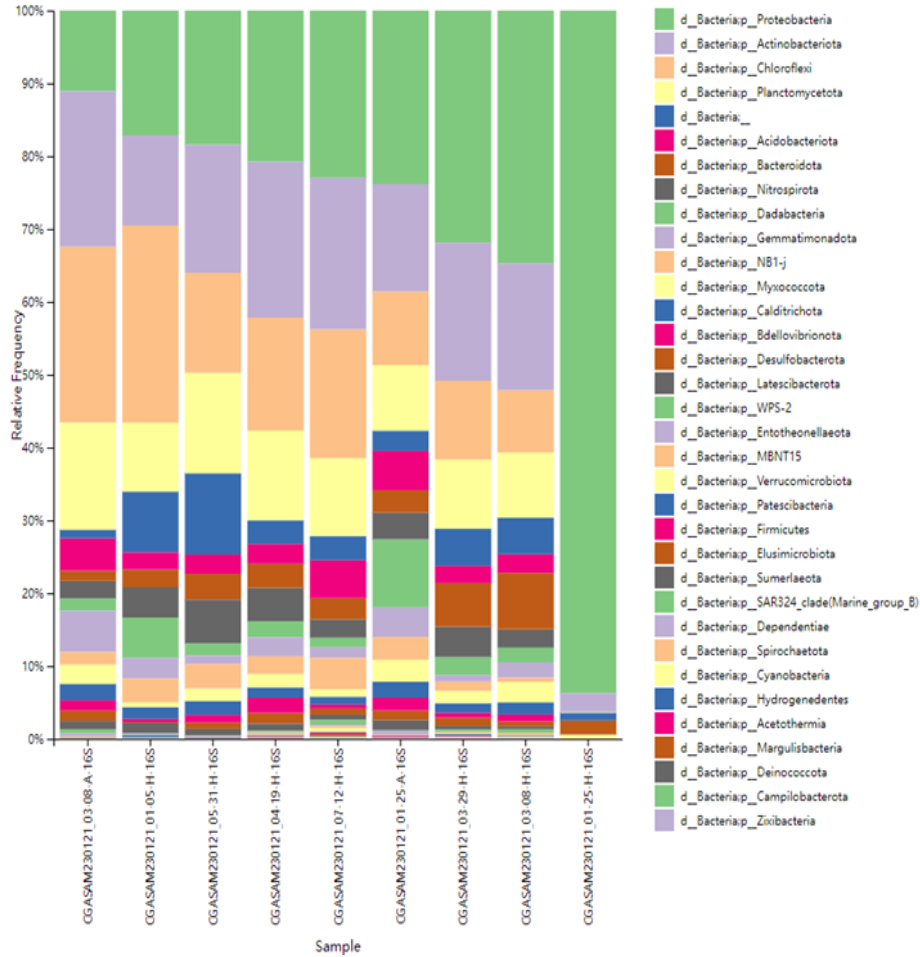
- Weekly microbial analysis of both tanks
- Sequencing analysis



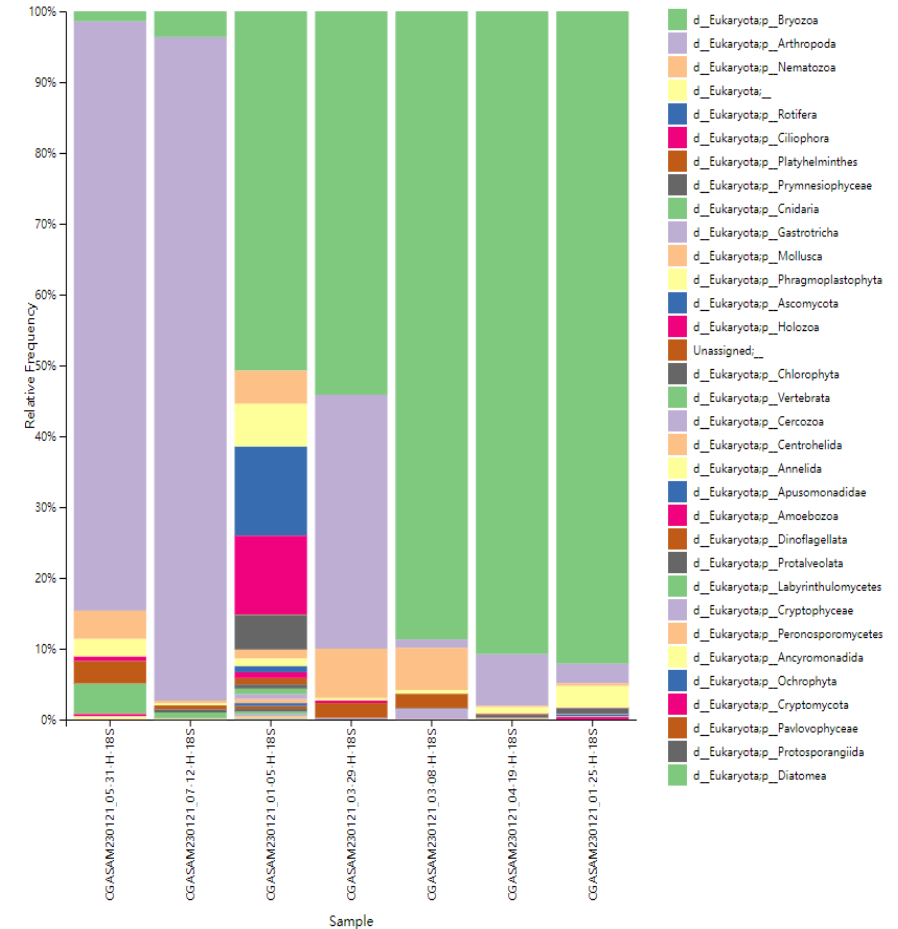


- Stabilizing system with survival rates comparable to optimal SOP.
- Promoted phages consuming vibrios etc..
- Allowing hatchery to operate when SOPs 100% mortality (late summer/fall)
- “Industrial” nature of study = ‘noisy results.

## 16S rRNA Gene Sequencing Results: Exploring Bacterial and Archaeal Diversity

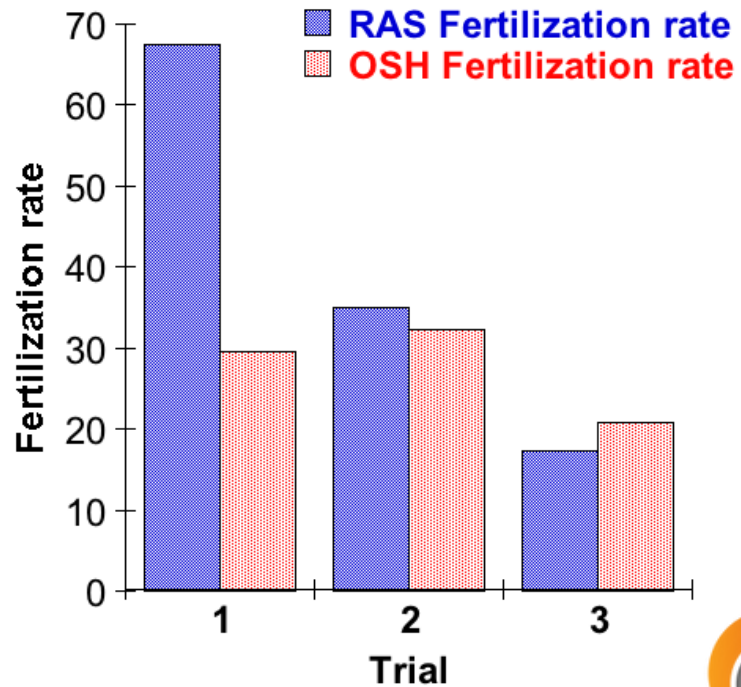


## 18S rRNA Gene Sequencing Results: Investigating Eukaryotic Diversity (Fungi, Algae, Protozoa)

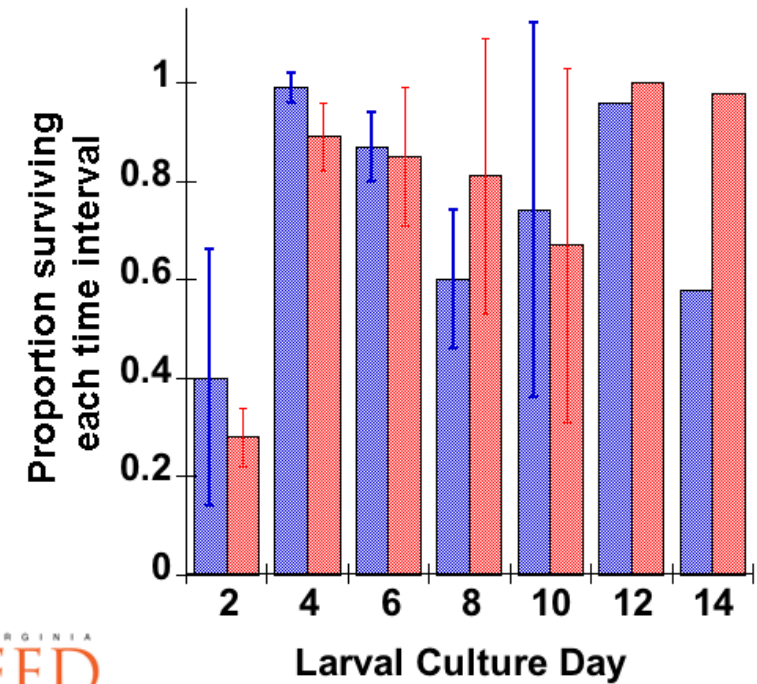


- DNA samples extracted from K1 filters collected from a **RAS system** at *Oyster Seed Holdings, LLC* on various dates.
- The **taxonomy distribution** at the Phylum classification level illustrates the **microbiome diversity** in the system.

# Pilot scale tests in commercial hatchery



Legend: RAS Production (blue), OSH Production (red)



## Average of three sequential trials

Michael Schwarz<sup>1</sup>, Richard Snyder<sup>2</sup>, Reza Ovissi<sup>1</sup>, Steve urick<sup>1</sup>, Jonathan van Senten<sup>1</sup>, Michael Congrove<sup>3</sup>, Kasey Bond<sup>3</sup>, Chris Bentley<sup>3</sup>. WAS AA 2022. UPDATES ON DEVELOPMENT OF A RECIRCULATING AQUACULTURE SYSTEM FOR BIVALVE LARVAL CULTURE

<sup>1</sup>Virginia Institute of Marine Science Eastern Shore Laboratory, Wachapreague, VA

<sup>2</sup>Virginia Tech, Virginia Seafood AREC, 102 South King St., Hampton, VA

<sup>3</sup>Oyster Seed Holdings LLC, 425 Callis Wharf Rd, Hudgins, VA



# Musing on Microbiomes: Recent BFT trials at VT

- VT – Shrimp BFT trials
  - 2019 - 2024



Variables	Treatments	
	BFT	RAS
Initial weight (g)	0.102±0.04	0.102±0.04
Final weight (g)	13.55±2.31	8.14±2.18
WG (g week <sup>-1</sup> )	1.35±0.12	0.80±0.15
FCR	1.91±0.12	2.81±0.49
Survival (%)	83.33±9.24	88.0±0.00
Yield (Kg m <sup>-3</sup> )	5.62±0.33	3.58±0.65
Yield (Kg ha)	56,200	35,800

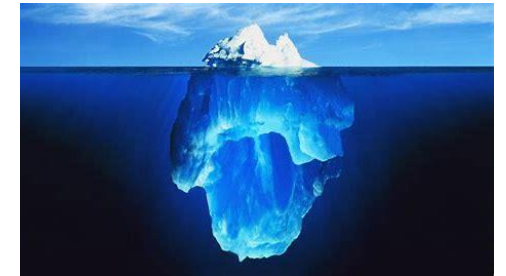
Data are mean ± standard deviation. WG: weekly growth; FCR: feed conversion ratio.

*Dr. Dariano Kruppenauer R&D Program (LEAD - Dr. Wasielesky)  
 Institute of Oceanography, Laboratory of Microorganism in Aquaculture  
 - Federal University of Rio Grande - FURG - Rio grande - Brazil*



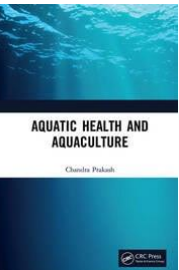
# Musing on Microbiomes: Opportunities

- Microbiomes basic drivers of biological systems
  - Affect system/animal health, performance, carrying capacity
  - Emerging technologies lowering the bar for application in shrimp aquaculture
    - Ponds, RAS, ZWAS.....
    - Pre/pro/post... biotics only tip of the iceberg



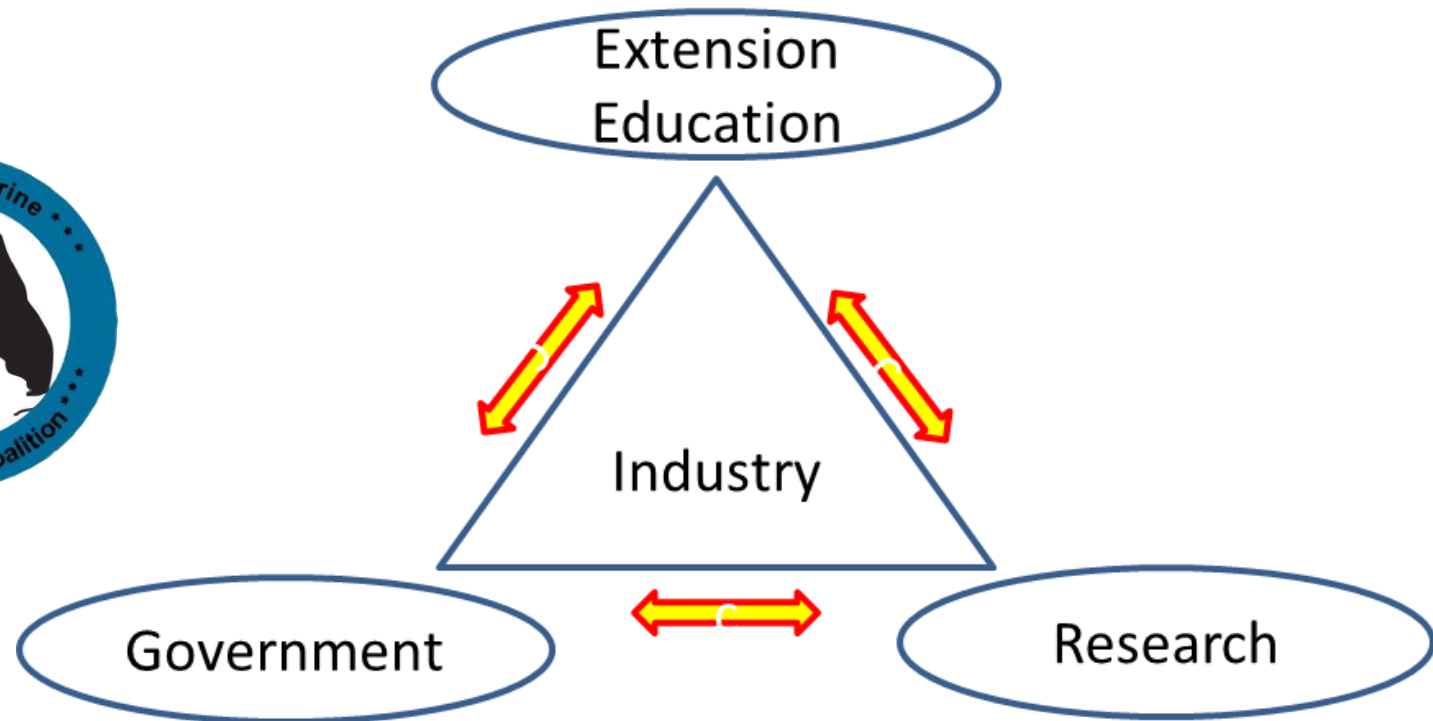
- Good potential to advance ZEWAS/ZWD
  - The use of zero-exchange systems has become a viable alternative to traditional ponds methods of intensive aquaculture production. ZWD system is an improved batch system with an emphasis on microbial manipulation in rearing tank2.

<https://doi.org/10.1201/9781003111528>



# Musing on Microbiomes: Opportunities

- Microbiomes basic drivers of biological systems
  - Supports closing systems (biosecurity, climate resilience....)
  - Advance Florida's marine aquaculture/shrimp sectors





Thank you