Pathogen persistence: What is the role of organic aggregates in recreational waters?

An organic aggregate

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What are **organic aggregates**?

- marine snow
- lake snow, river snow
- marine aggregates
- macro-aggregates
- micro-aggregates
- organic detritus
- flakes, flocs, bioflocs

Photo courtesy of Dr. Cindy Pilskaln
600-700 m NW of Andros Island, Bahamas
1984 Alvin Dive Series; A.C. Neumann chief scientist
Organic aggregates

- Pathogens
- Zooplankton
- Phytoplankton
- Protozoans
- Bacteria
- Fungi
- Detritus
- Macrophyte fragments
- Molts, tests, carcasses
- Fecal pellets
- Inorganic particles

Collision Cohesion

Biological “Glues”
DOM, COM, TEP

Disaggregation

Settling Suspension-feeding

Consumption:
Fish meroplankton

Benthic Communities

Issue
Problem
So What?
Solutions
Benefits
Take Home Message
Traineeship
Field studies on organic aggregates in Long Island Sound:

- NY: (A) Mattituck Inlet, (B) Hashamomuck Pond
- CT: (C) Mystic River, (D) Stonington Harbor

*imhoff settling cone*

Lyons et al., 2005
Potentially pathogenic bacteria found in organic aggregates

• *Vibrio cholerae*
• *Vibrio parahaemolyticus*
• *Vibrio vulnificus*
• *Vibrio alginolyticus*
• *Aeromonas hydrophila*
• *Pseudomonas aeruginosa*
• *Shigella sonnei*
• *Stenotrophomonas maltophilia*
• *Photobacterium damsela*
• *Burkholderia cepacia*
• *Escherichia coli*
• *Mycobacteria* sp.

What is the role of organic aggregates in the *persistence* of bacteria (including pathogens and indicators) in recreational waters?

**? Prolong persistence:**
- provides substrate
- more nutrients
- protection from UV

**? Reduce persistence:**
- more predation
- more competition
- potential settling

Sailing Center at Old Dominion University
Importance of understanding pathogen persistence:

Pathogen more likely to find a host

Issue * Problem * So What? * Solutions * Benefits * Take Home Message * Traineeship

- Shellfish $$$
- Waterborne Diseases $$$
- Beach Closures $$$
- Monitoring & Modeling $$$

http://bact.uwosh.edu/
Studies on microbial ecology of organic aggregates

Knitting Mill Creek, Norfolk VA

"Microscopic Islands"
Island Biogeography: Species-Area Relationship
(i.e., larger islands have more species)

Metabolic functional diversity ($S$; number of substrates used), increased with an increase in size (in area; $A$) of aggregates ($n = 79$)
Island Biogeography: Consistency of Species Richness
(i.e., at equilibrium the number of species remains constant)

Functional diversity was relatively constant in aggregates for at least one week compared to “aggregate-free” water which declined.
Island Biogeography: Consistency of Species Richness

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Is the decline due to a die-off or is the microbial community moving from the water fraction to aggregates?
Sucrose-fermenting Vibrio (i.e., yellow colonies on TCBS agar plate)

Sucrose (+) vibrios include several potential pathogens:
- *V. cholerae*
- *V. alginolyticus*
- *V. harveyi*
- *V. cincinnatiensis*
- *V. fluvialis*
- *V. furnissi*
- *V. metschnikovii*
**Vibrio** spp. thrive in aggregates (i.e., higher and longer exposures)

Concentrations of Sucrose-positive *Vibrio* in aggregates vs. water
*E. coli* (indicator of fecal pollution) in aggregates

Colilert-18 and IDEXX Quanti-Trays
*E. coli* thrives in aggregates (i.e., higher and longer exposures)

Concentrations of *E. coli* in aggregates vs. water

Concentration (MPN/100 ml)

Time (days)
Theory of Island Biogeography on a Microscopic Scale: Organic Aggregates as “Islands” for Aquatic Pathogens

M. Maille Lyons, J. Evan Ward, Holly Gaff, Randall Hicks, John Drake, Fred C. Dobbs
2010 Aquatic Microbial Ecology Feature Article
The microbial ecology of organic aggregates is linked to human health because of potentially higher and longer exposures of humans to aquatic pathogens via both

- **direct**: ingestion of natural waters & consumption of shellfish
- **indirect**: closure of beaches & quality of life

Organic aggregates require further investigations in order to improve the:
1. monitoring of recreational waters
2. modeling of waterborne disease transmission
3. understanding of infectious diseases
THANK YOU!

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