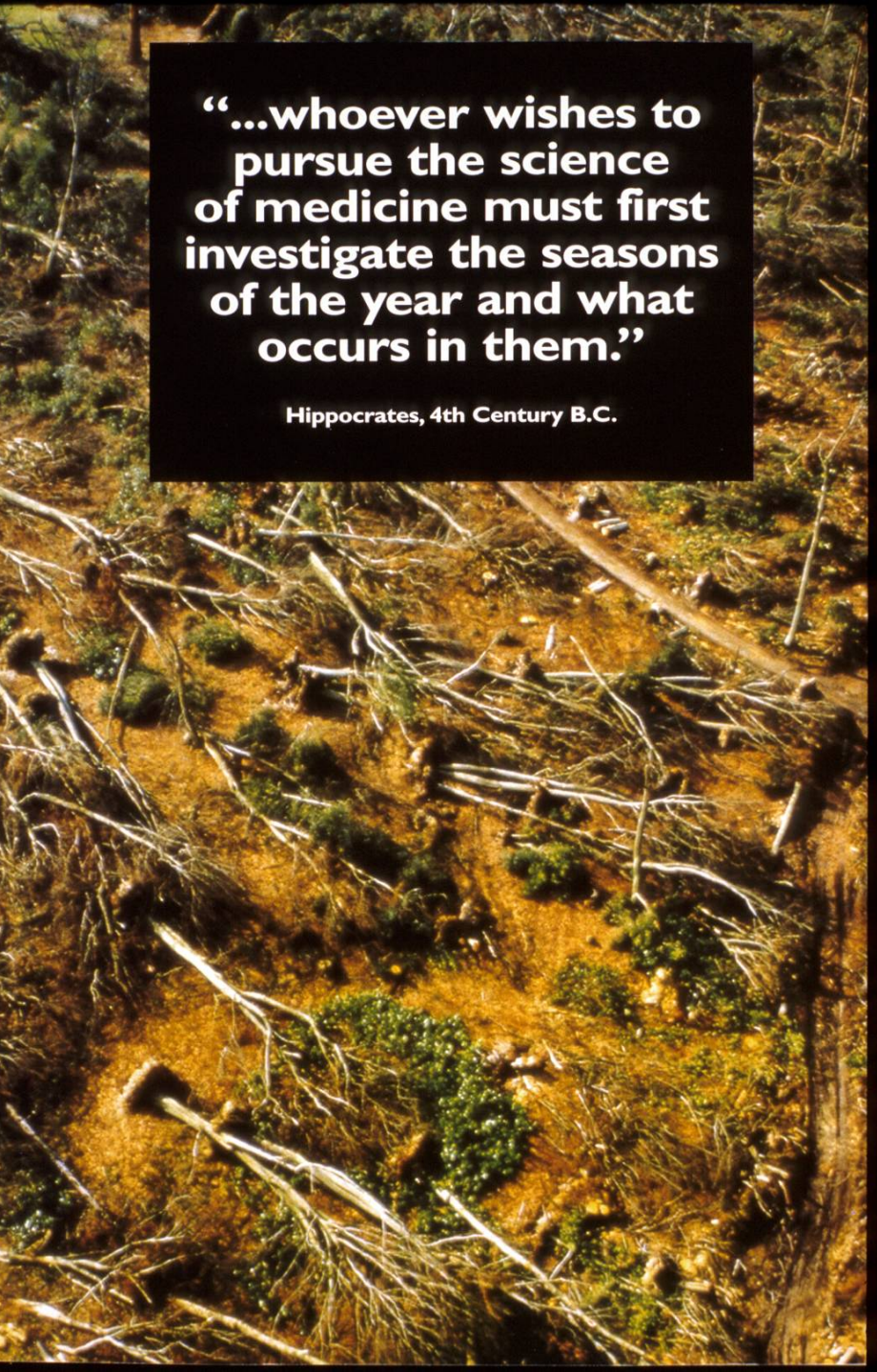
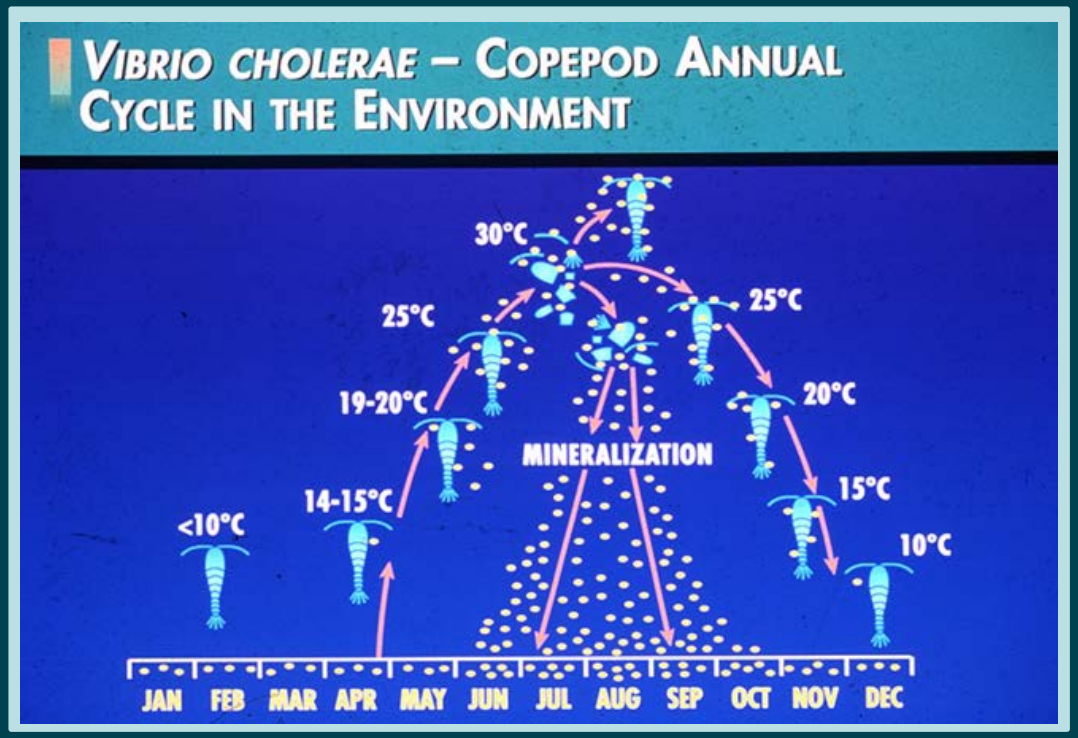


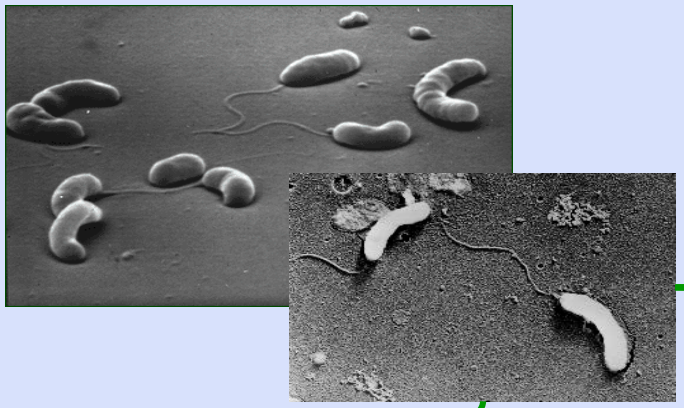
Climate, Oceans, Microbiomes, and Cholera

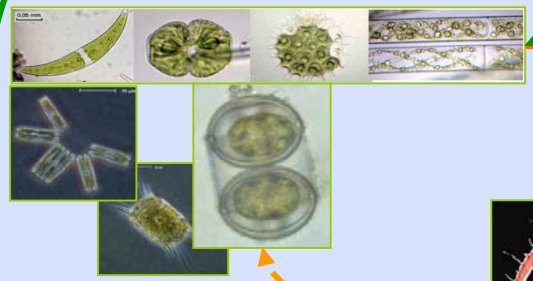
National Science Board
Vannevar Bush Award
May 9, 2017

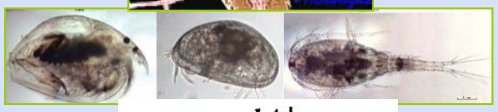
Rita R. Colwell, Ph.D., D.Sc.
Distinguished University Professor
University of Maryland, College Park
and
Johns Hopkins University Bloomberg School of Public Health

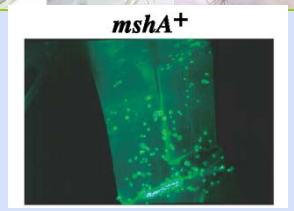

VIBRIO CHOLERAE – COPEPOD ANNUAL CYCLE IN THE ENVIRONMENT
30°C
25°C
25°C
19-20°C
20°C
MINERALIZATION
14-15°C
15°C
<10°C
10°C
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

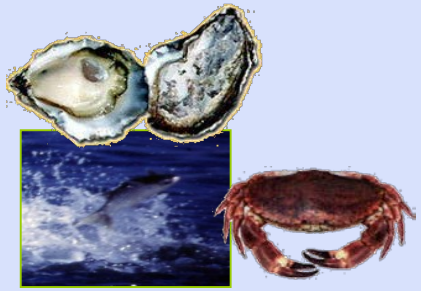
Model for the Transmission of Vibrio Cholerae from the Environment to Humans





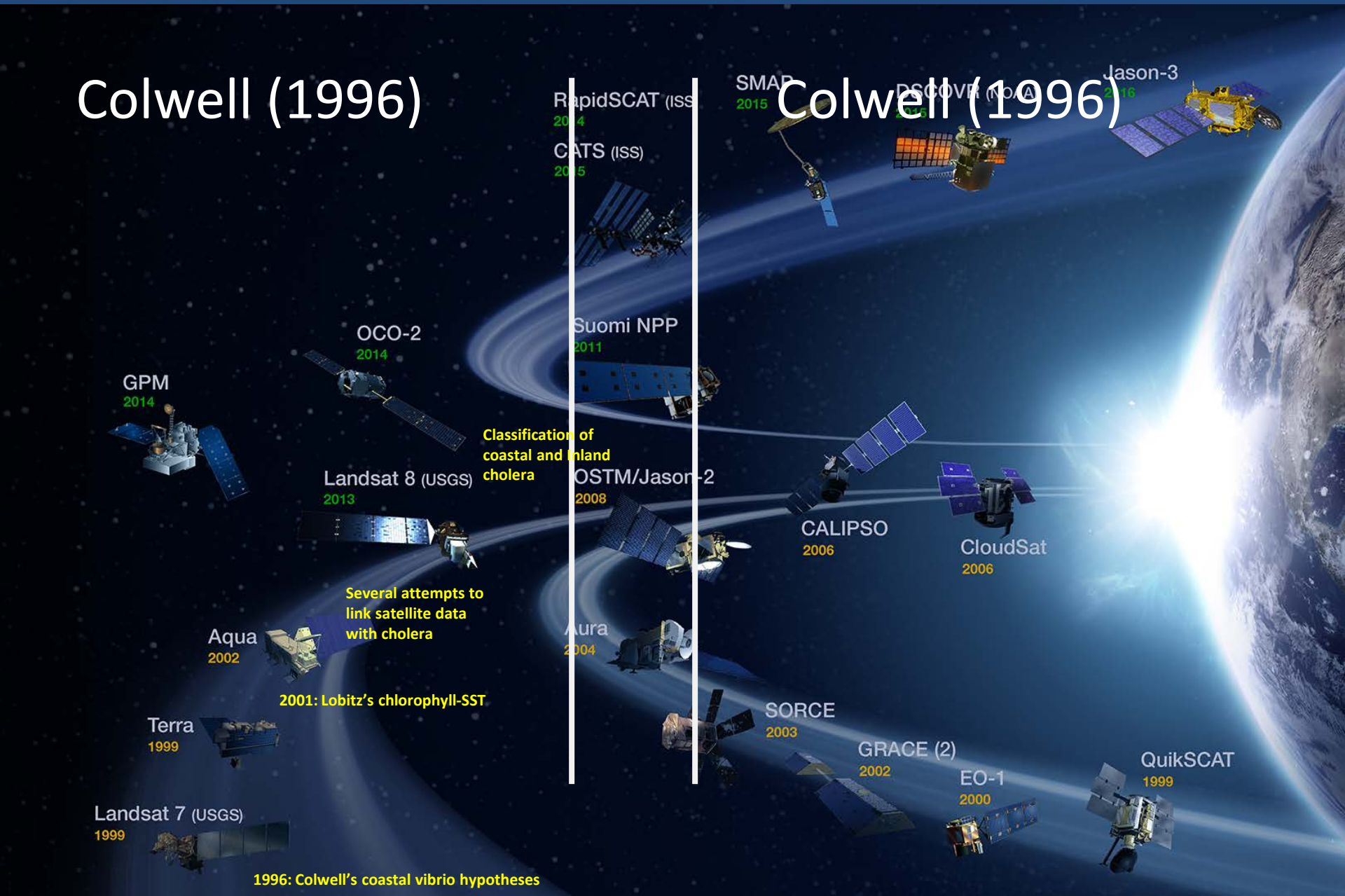






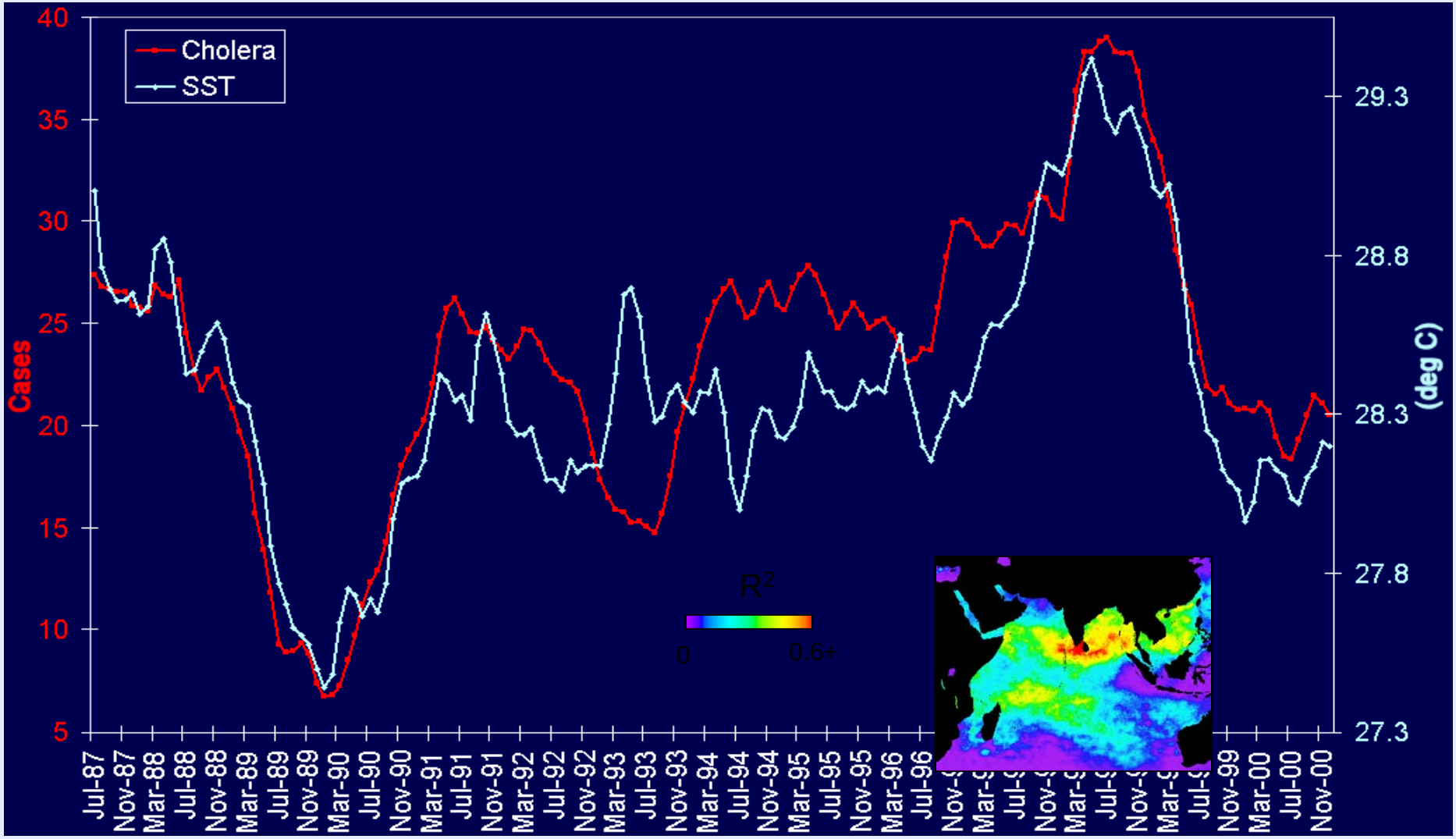
G. Constantin de Magny

Chronology of cholera and satellites

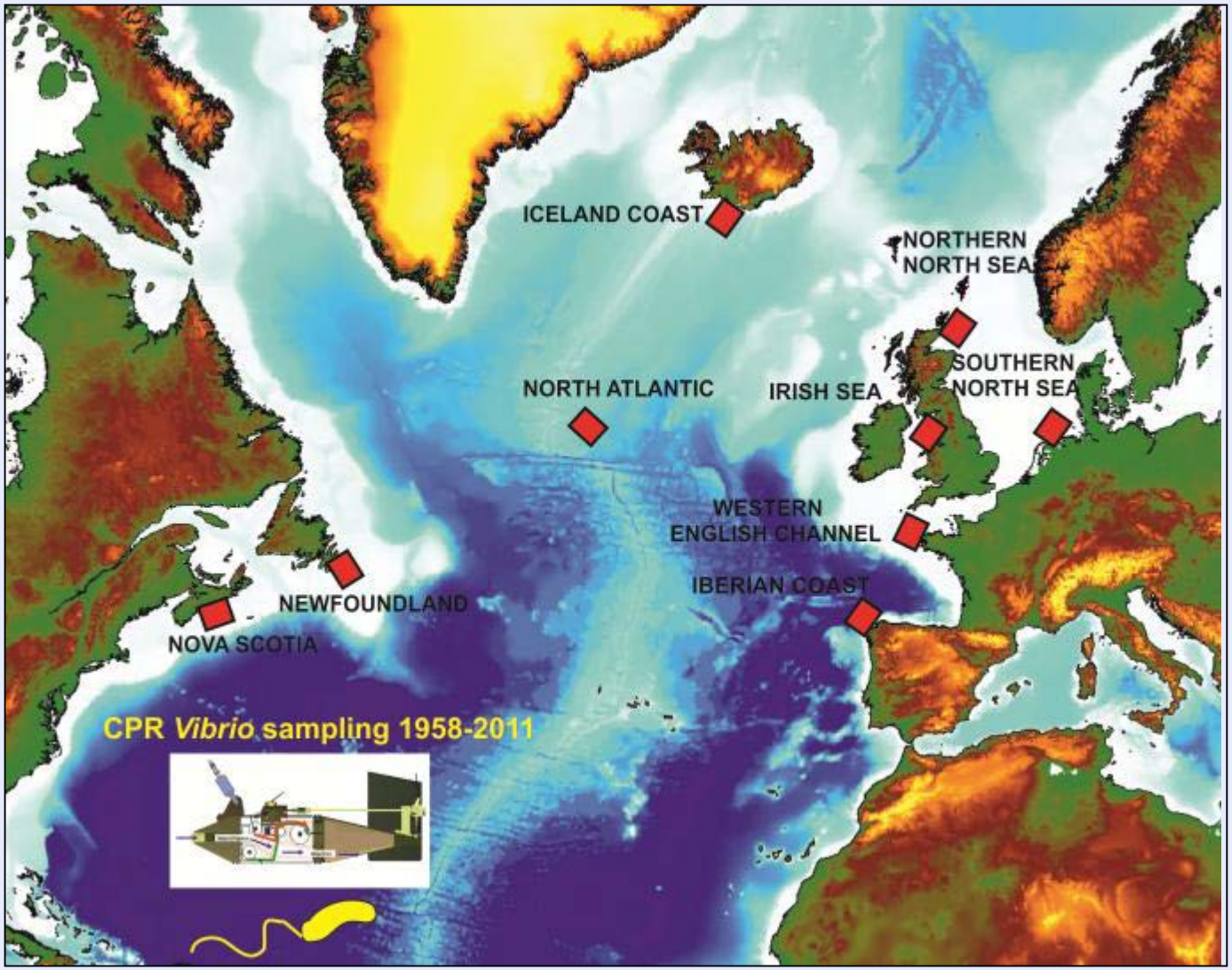


Cholera and SST in the Indian Ocean

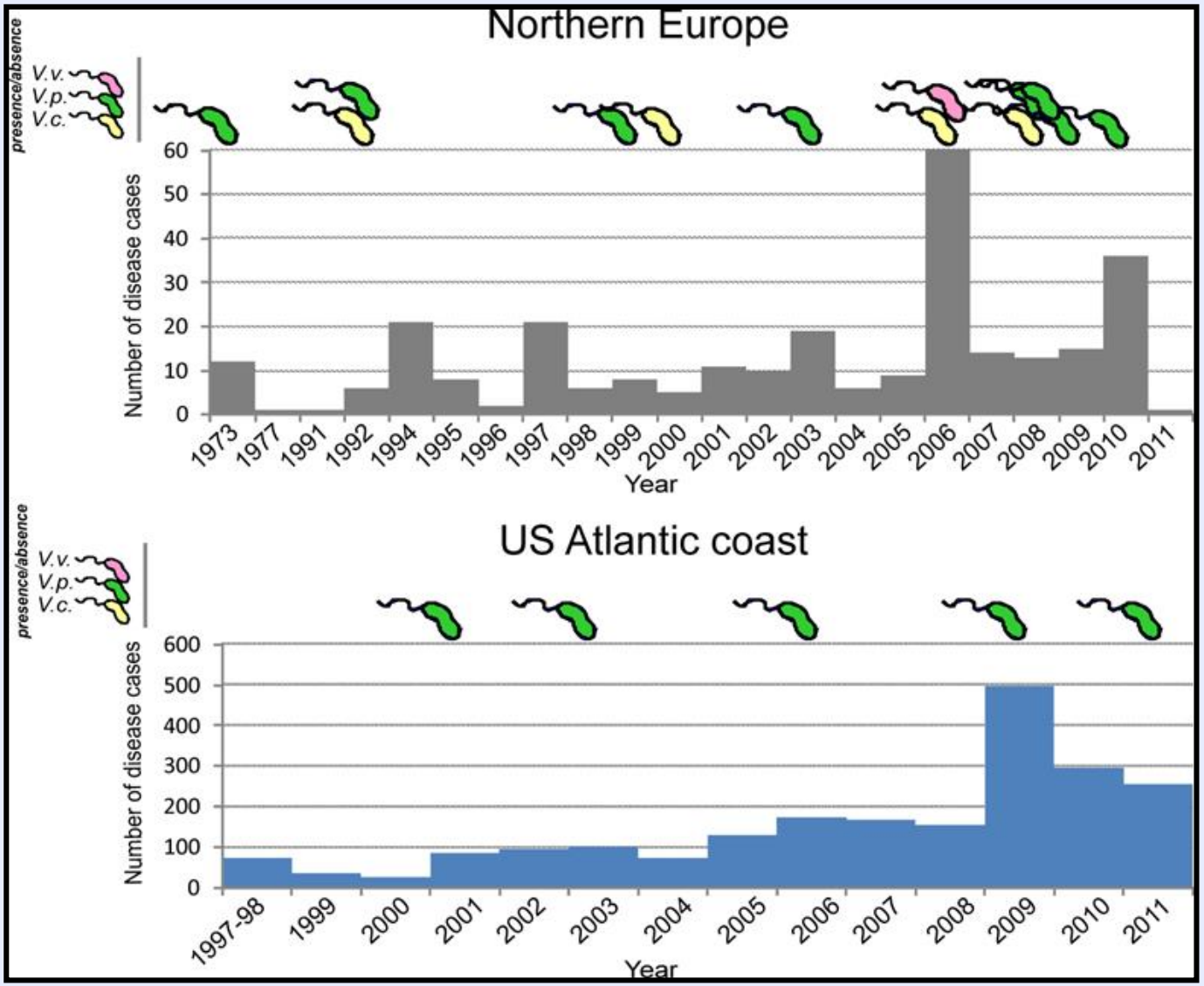
Six-month SST lead: $R^2 = 0.72$



Lobitz et al., 2000, PNAS Vol. 97, No. 4 pp. 1438-1443

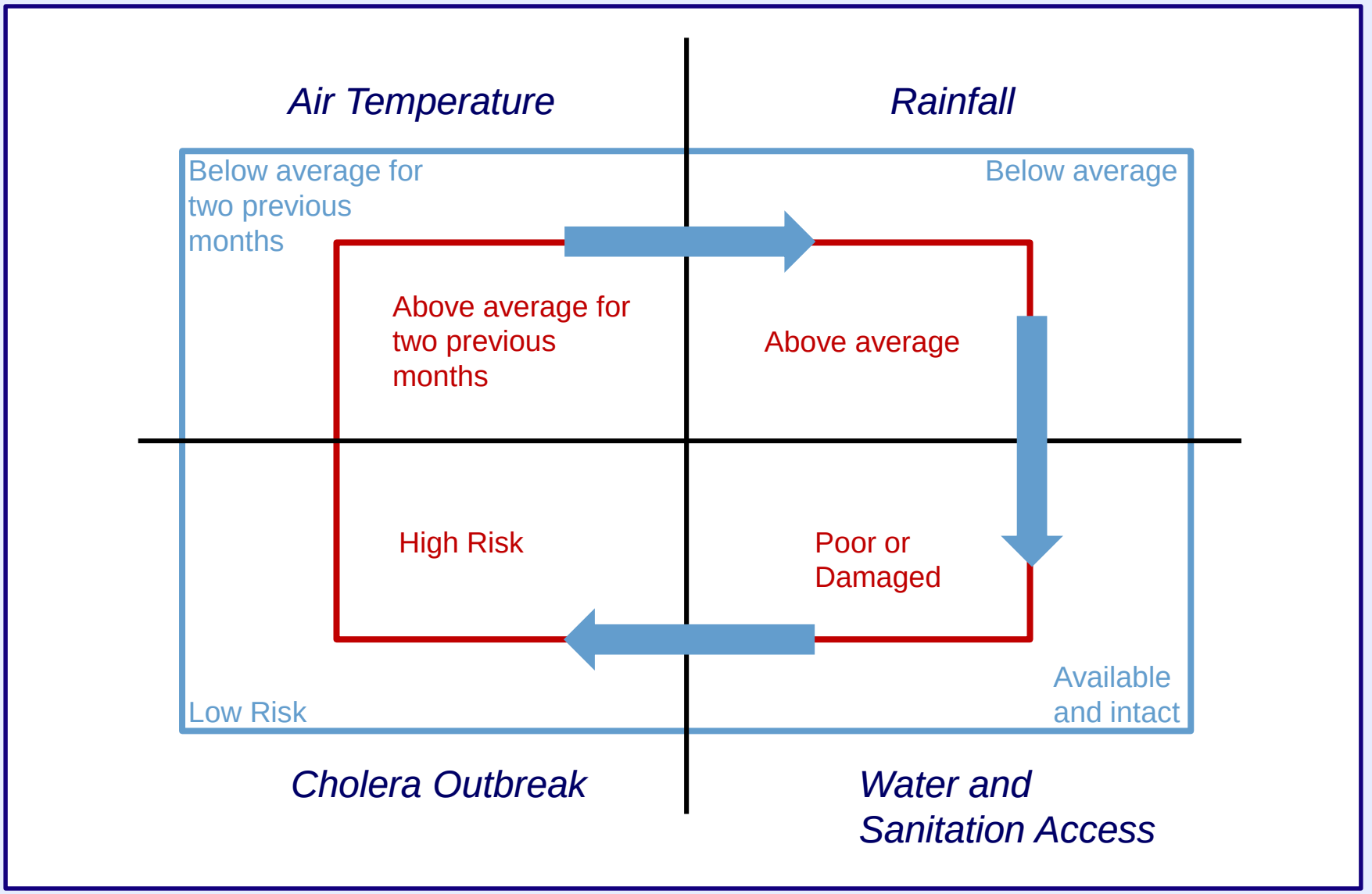


Vezzulli et al. Proc. Natl. Acad. Sci. USA 2016 113 (34) E5062-E5071 doi:10.1073/pnas.1609157113



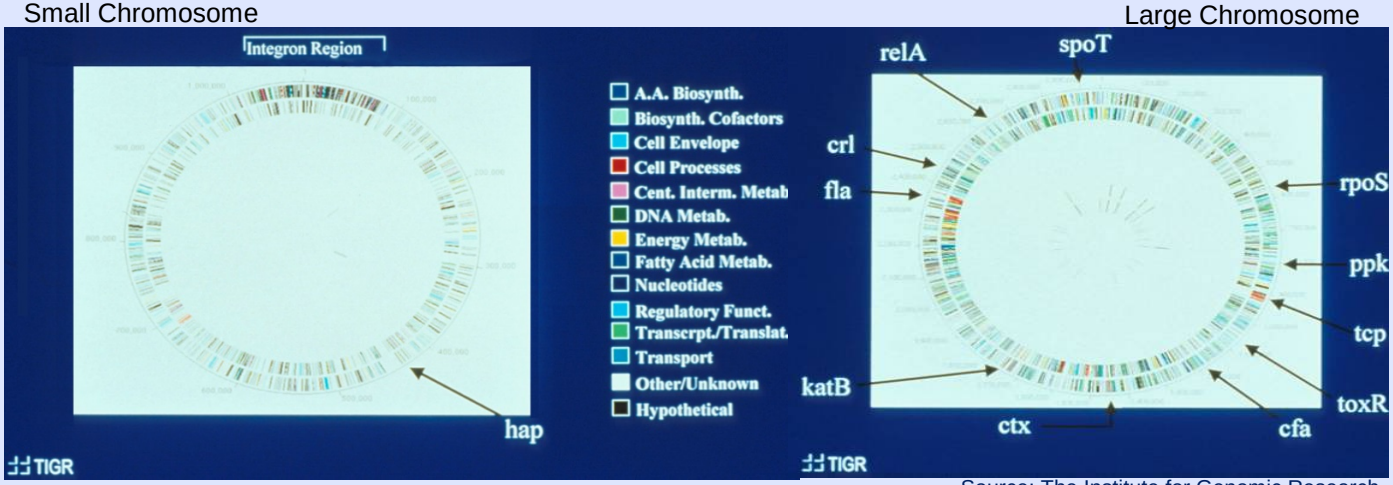
Vezzulli et al. Proc. Natl. Acad. Sci. USA 2016 113 (34)
E5062-E5071 doi:10.1073/pnas.1609157113

Theoretical framework for predicting cholera outbreaks in epidemic regions



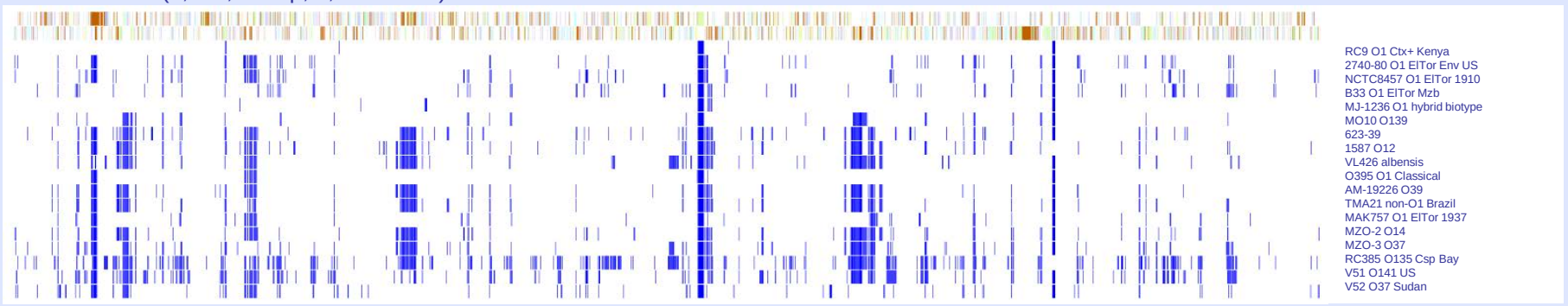
Vibrio cholerae

Sequenced and published in 2000

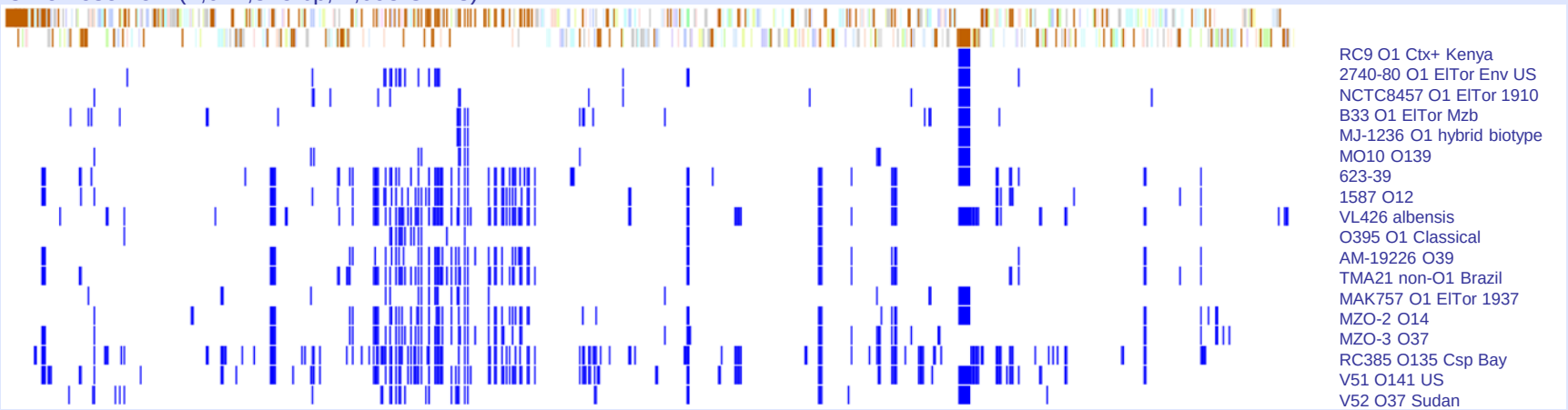


Source: The Institute for Genomic Research

Chromosome I (2,961,149 bp, 2,742 ORFs)



Chromosome II (1,072,315 bp, 1,093 ORFs)



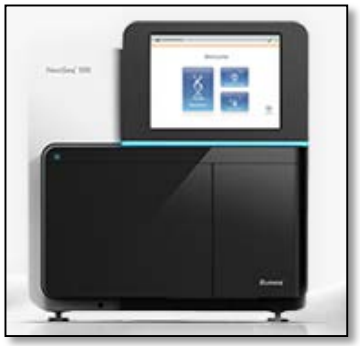
Missing ORFs in *V. cholerae* strains (Reference: N16961; cutoff = 70% DNA similarity)

Chun et al. Proc. Natl. Acad. Sci. USA 2009 106(36):15442-15447 doi:10.1073/pnas.0907787106

Microbes

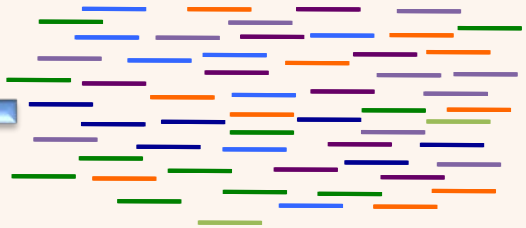
Extracted DNA

DNA Sequencing

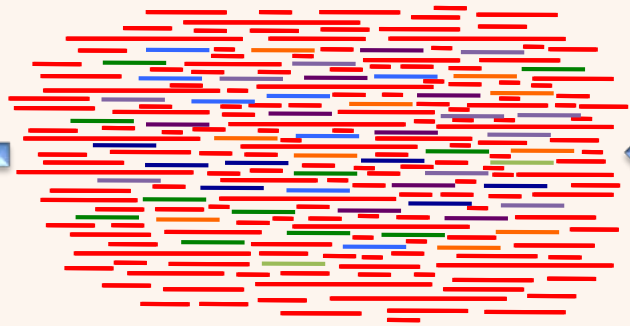


RESEARCH & TESTING LAB: SEQUENCING SERVICE

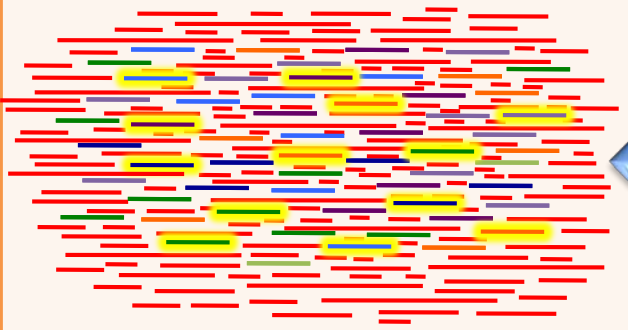
Raw Sequence Reads



GENEBOOK® Library

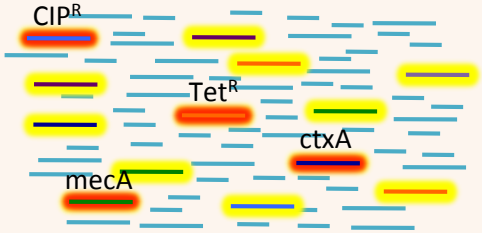


GENIUS®: Probabilistic Matching



Identified Bacteria

GENEBOOK® Antibiotic Resistance & Virulence Factor Library



Applications:

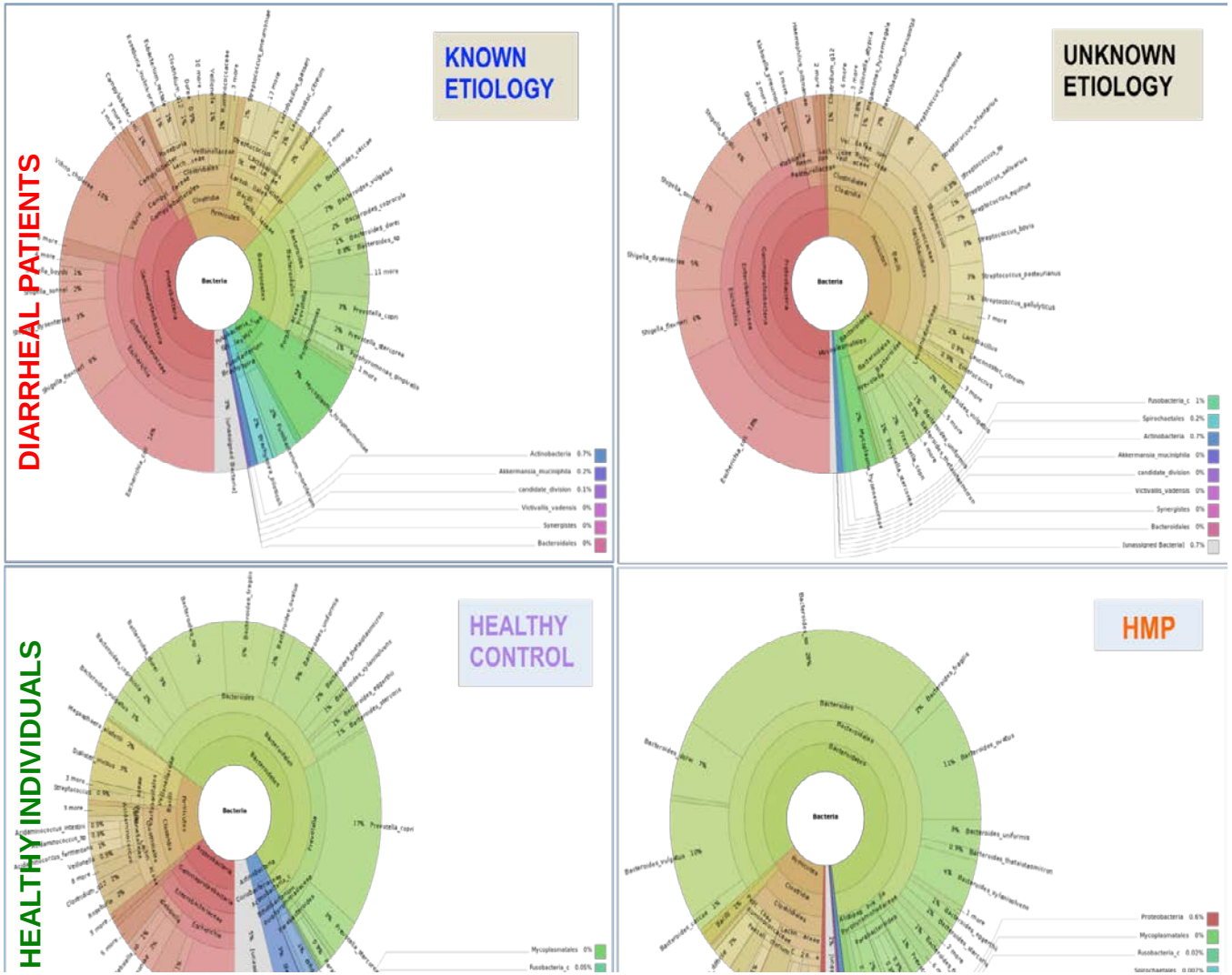
- ❑ Pathogen detection for health and wellness;
- ❑ food safety and probiotics
- ❑ biothreat and public health surveillance;
- ❑ forensic and scientific investigation

COSMOSID GENIUS® ANALYSIS SERVICE

National Institute of Cholera and Enteric Disease
Kolkata, India

www.niced.org.ind

Microbiomes of Diarrheal Subjects Compared to Healthy



Proteobacteria
Firmicutes
Bacteroidetes

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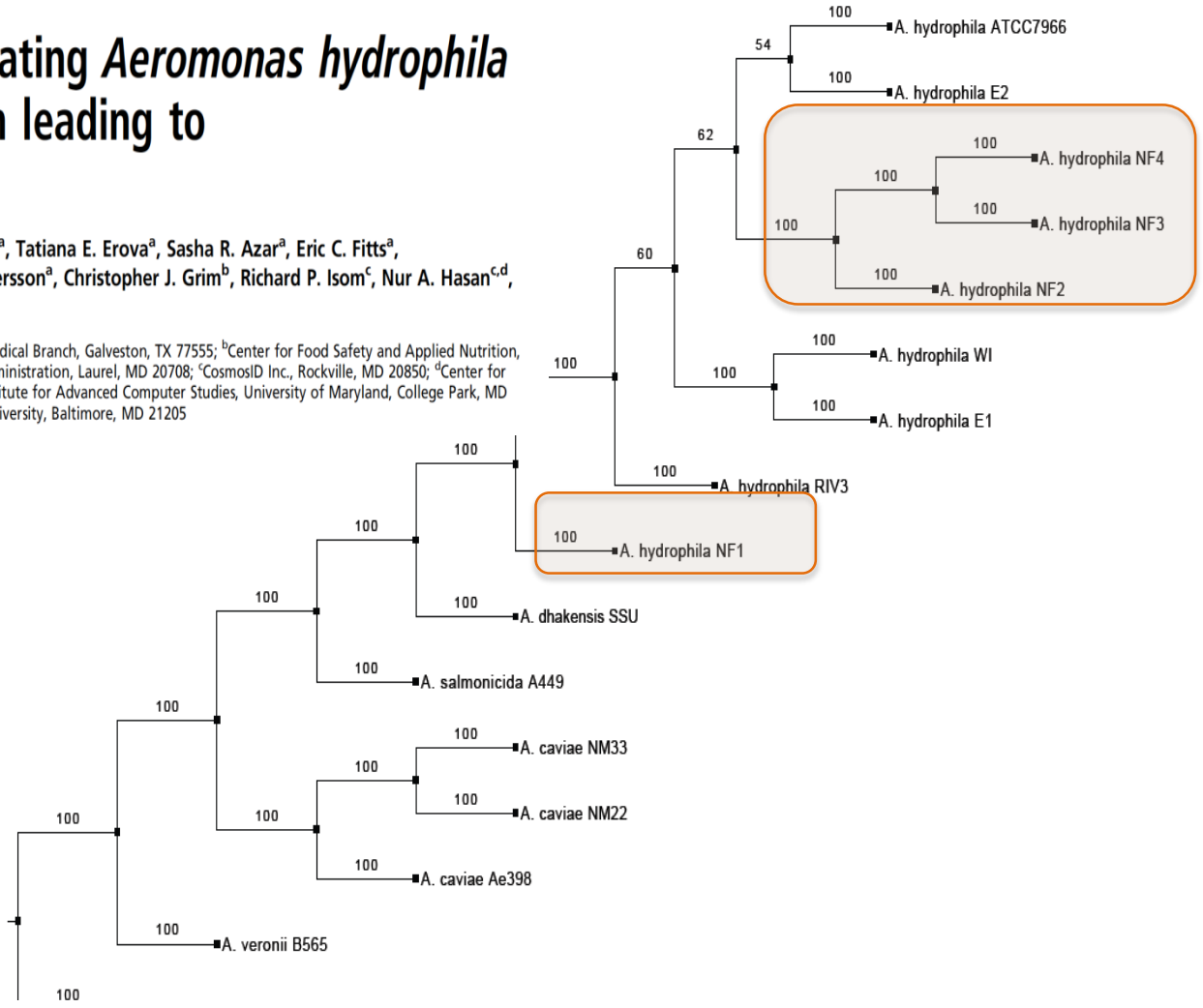
UNIVERSITY OF MARYLAND

Polymicrobial Infection: Necrotizing Fasciitis

Cross-talk among flesh-eating *Aeromonas hydrophila* strains in mixed infection leading to necrotizing fasciitis

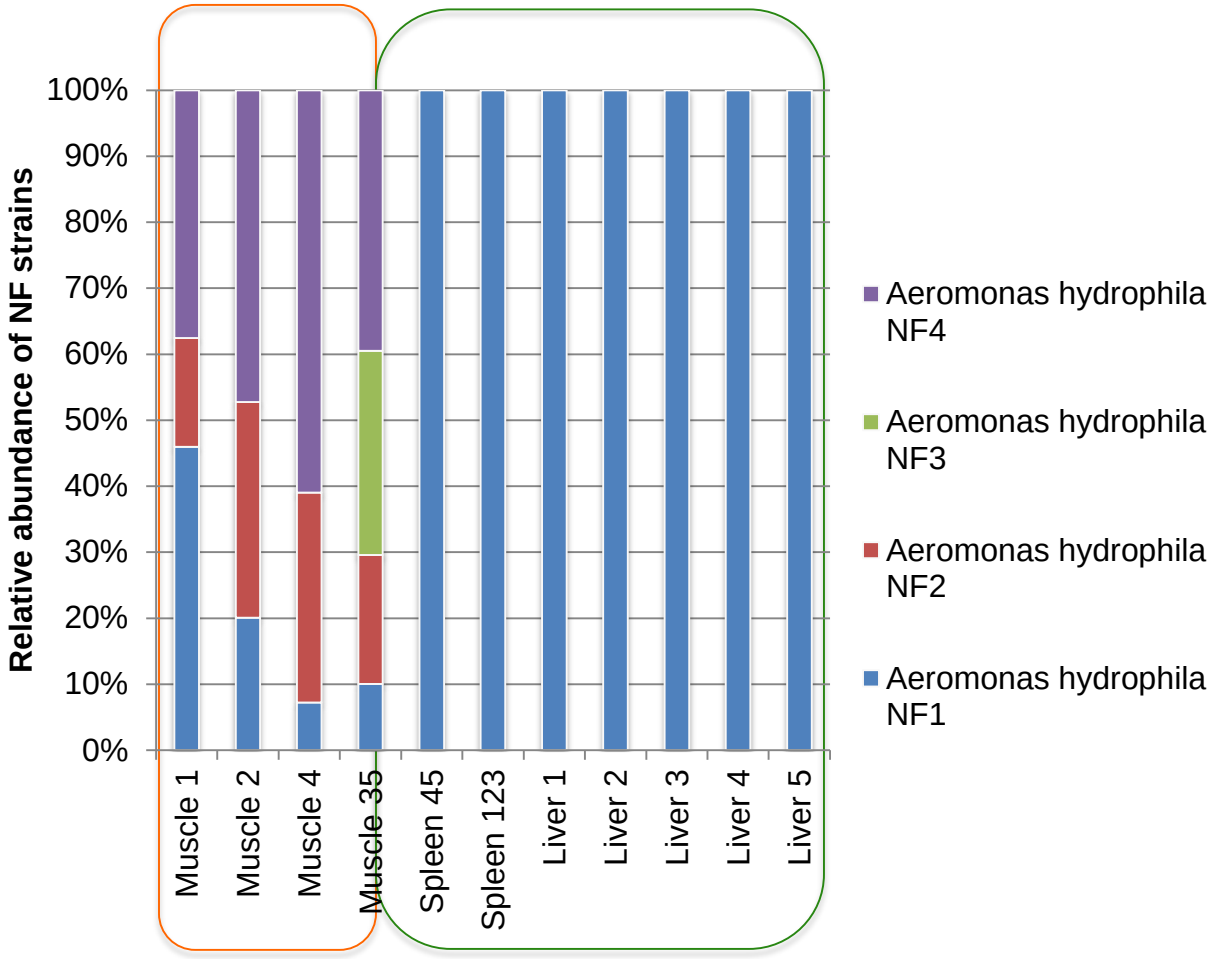
Duraisamy Ponnusamy[a,1], Elena V. Kozlova[a,1], Jian Sha[a], Tatiana E. Erova[a], Sasha R. Azar[a], Eric C. Fitts[a], Michelle L. Kirtley[a], Bethany L. Tiner[a], Jourdan A. Andersson[a], Christopher J. Grim[b], Richard P. Isom[c], Nur A. Hasan[c,d], Rita R. Colwell[c,d,e,2], and Ashok K. Chopra[a,2]

[a]Department of Microbiology and Immunology, University of Texas Medical Branch, Galveston, TX 77555; [b]Center for Food Safety and Applied Nutrition, Office of Applied Research and Safety Assessment, Food and Drug Administration, Laurel, MD 20708; [c]CosmosID Inc., Rockville, MD 20850; [d]Center for Bioinformatics and Computational Biology, University of Maryland Institute for Advanced Computer Studies, University of Maryland, College Park, MD 20742; and [e]Bloomberg School of Public Health, The Johns Hopkins University, Baltimore, MD 21205



Neighbor-joining tree using 2,514 conserved full length predicted proteins

Strain level ID shows selective dissemination



Relative distribution of four *Aeromonas hydrophila* strains NF1, 2, 3, and 4 into different metagenomic datasets derived from muscle, spleen and liver samples

Summary

Disease state patients often have multiple pathogenic organisms

Advances in microbial genomics and **identification to strain level** allow for better understanding of polymicrobial infections

Metagenomics can be used to explore biofilm/patient interactions in hospital settings

Metagenomic analysis for these studies was done with CosmosID and our curated database of >65,000 genomes, please contact me if you are interested in working together, or try it yourself:

app.cosmosid.com

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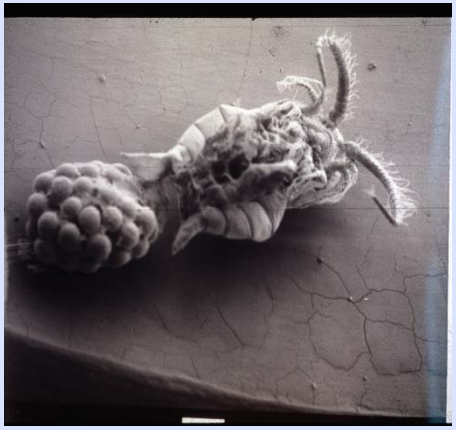
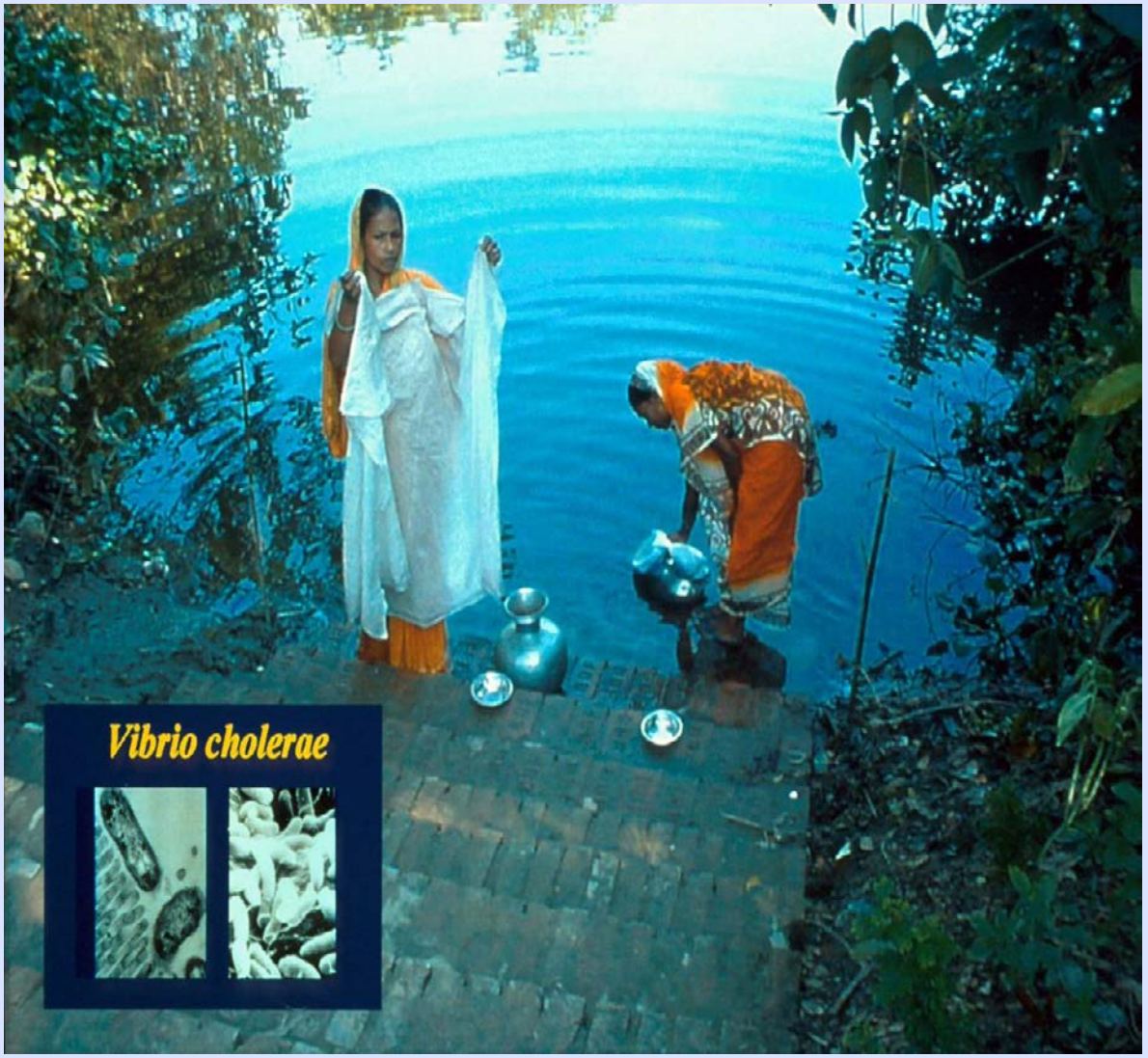
A Simple, Sustainable
Method for
Reducing Cholera

A Simple Solution for Cholera Prevention: Sari Filtration





Orange County Water District Study

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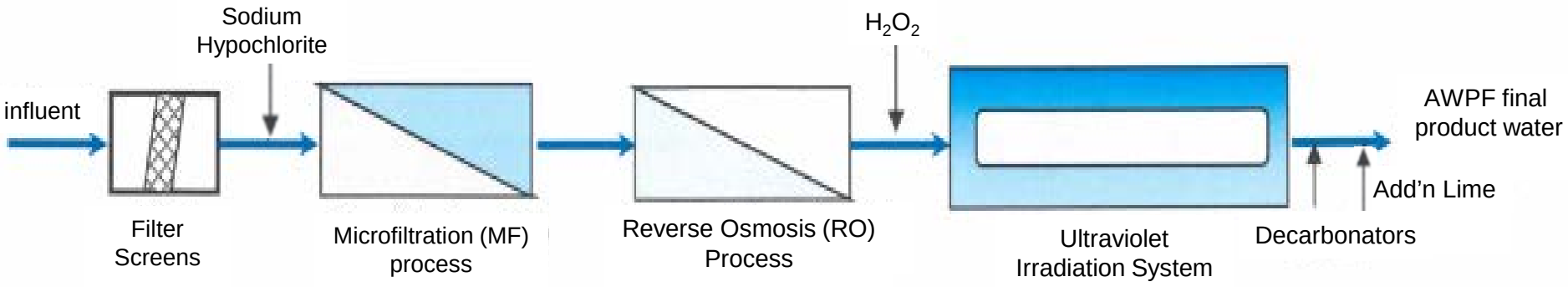
Metagenomics and Public Health



The influent, secondary treated municipal wastewater of the AWPF treatment train is purified by a three-step process: microfiltration, reverse osmosis, and ultraviolet (UV) light with hydrogen peroxide. Initially the wastewater is screened at 4mm Sodium hypochlorite as disinfectant is added prior to microfiltration. Hydrogen peroxide (H_2O_2) is added before UV treatment. The decarbonators remove CO_2 and raise the pH; addition of lime further stabilizes the purified water.

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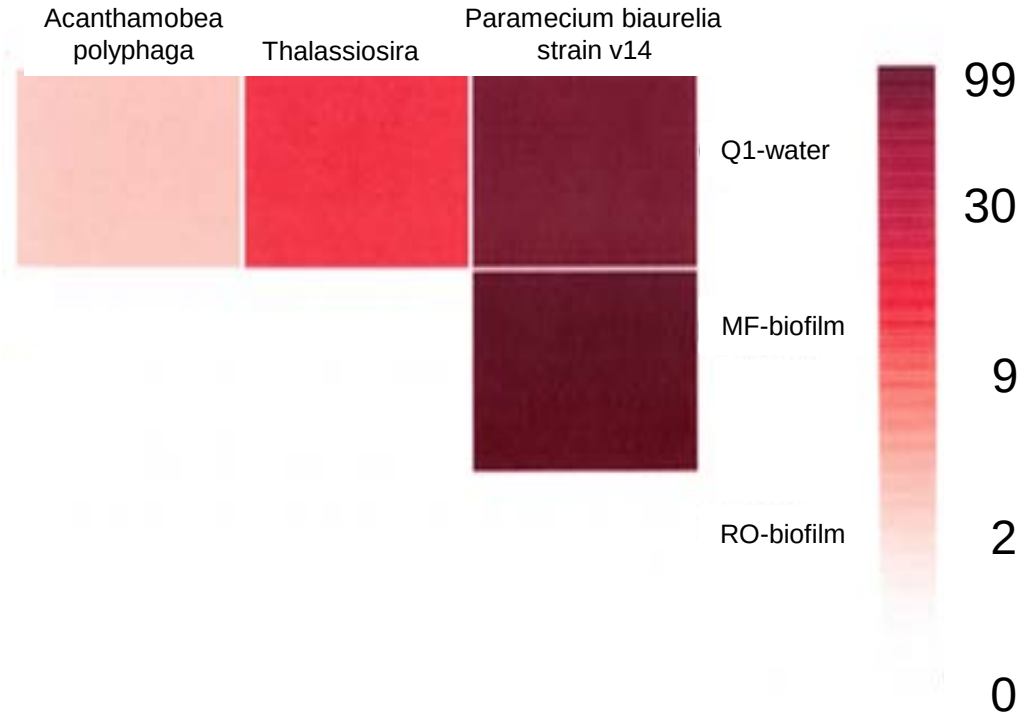

Relative abundance and diversity of parasite DNA in MF-biofilm and Q1-water. The approximate relative abundance heat map was simplified, using the GENIUS bioinformatics algorithm and curated databases. The 99 relative abundance corresponds to sequences classified as *Paramecium biaurelia* strain v14, *Thalassiosira*, and *Acanthamobea polyphaga* based on observed frequency of DNA sequences identified. Parasite sequences were not found in the RO-biofilms.

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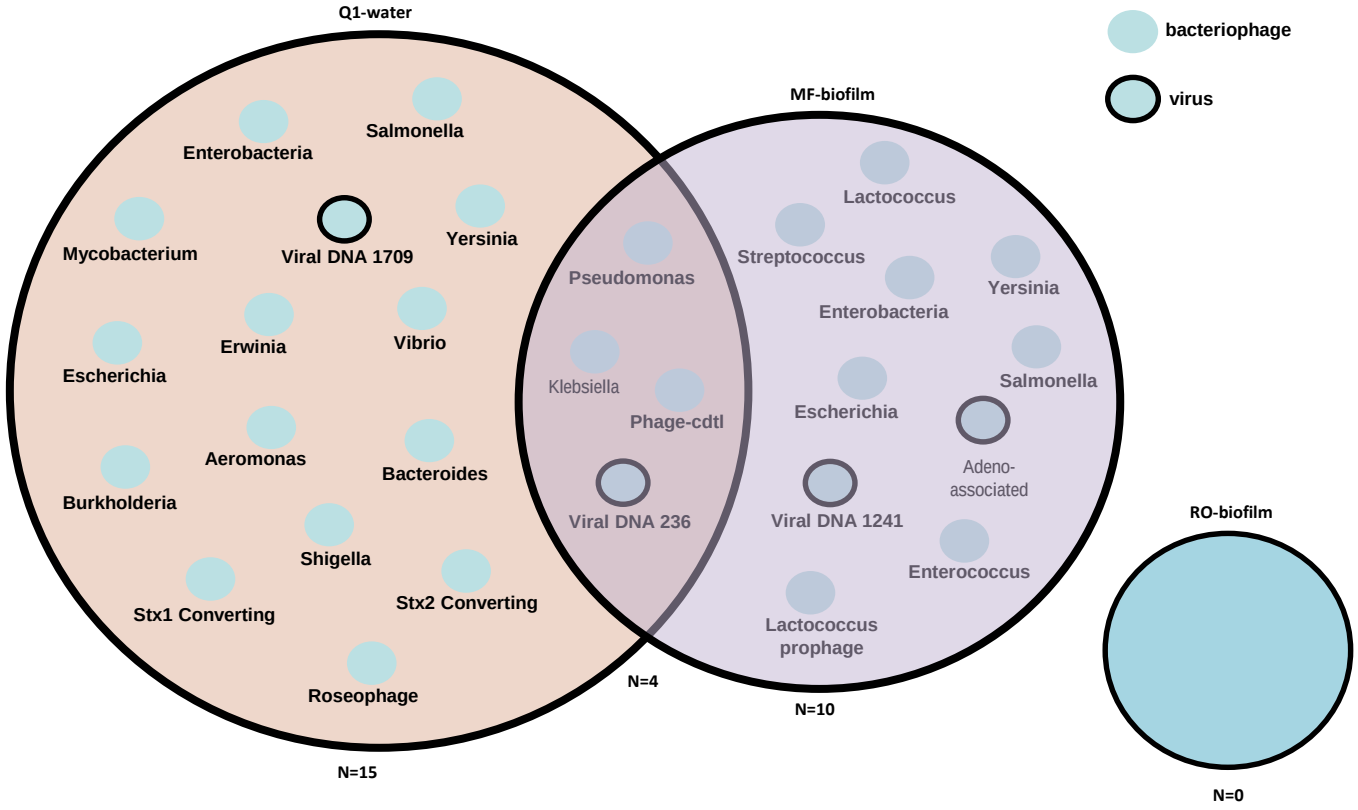
Comparison of virus and bacteriophage DNA sequences



Virus and bacteriophage DNA sequences comparison demonstrate the presence of bacteriophages and virus DNA in the membrane filter (MF)-biofilm and in the influent water, Q1. Note, the absence of bacteriophages and DNA viruses in the reverse osmosis (RO)-biofilm. Presence and absences of sequences (partial or complete) related to bacteriophage and viruses in MF-biofilm were compared to the Q1 water.

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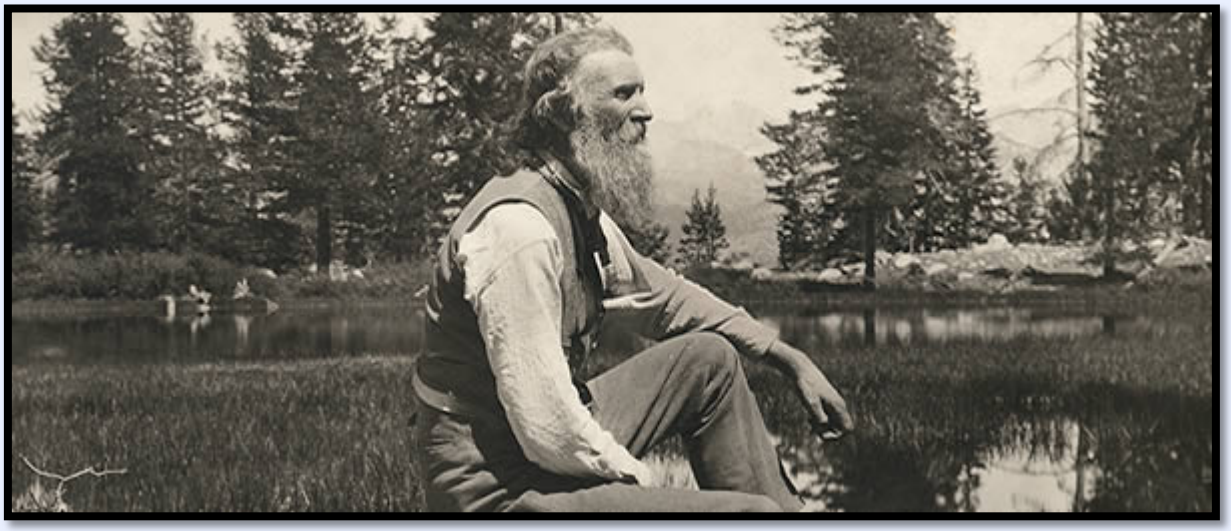

“When one tugs at a single thing in nature, he finds it hitched to the rest of the universe.”

John Muir
(1838-1914)

Collaborators and Colleagues

Anwar Huq,
Professor
University of Maryland,
College Park, MD

Antarpreet Jutla,
Assistant
Professor,
West Virginia
University
Morgantown, WV

Dr. Nur Hasan
Vice-President,
Research and
Development
CosmosID, Inc.
College Park, MD

Dr. Seon Young
Choi,
Bioinformatic
Scientist,
CosmosID Inc.
College Park, MD

Safe water is a global challenge

Courtesy of GB Nair, NICED, Kolkata, India