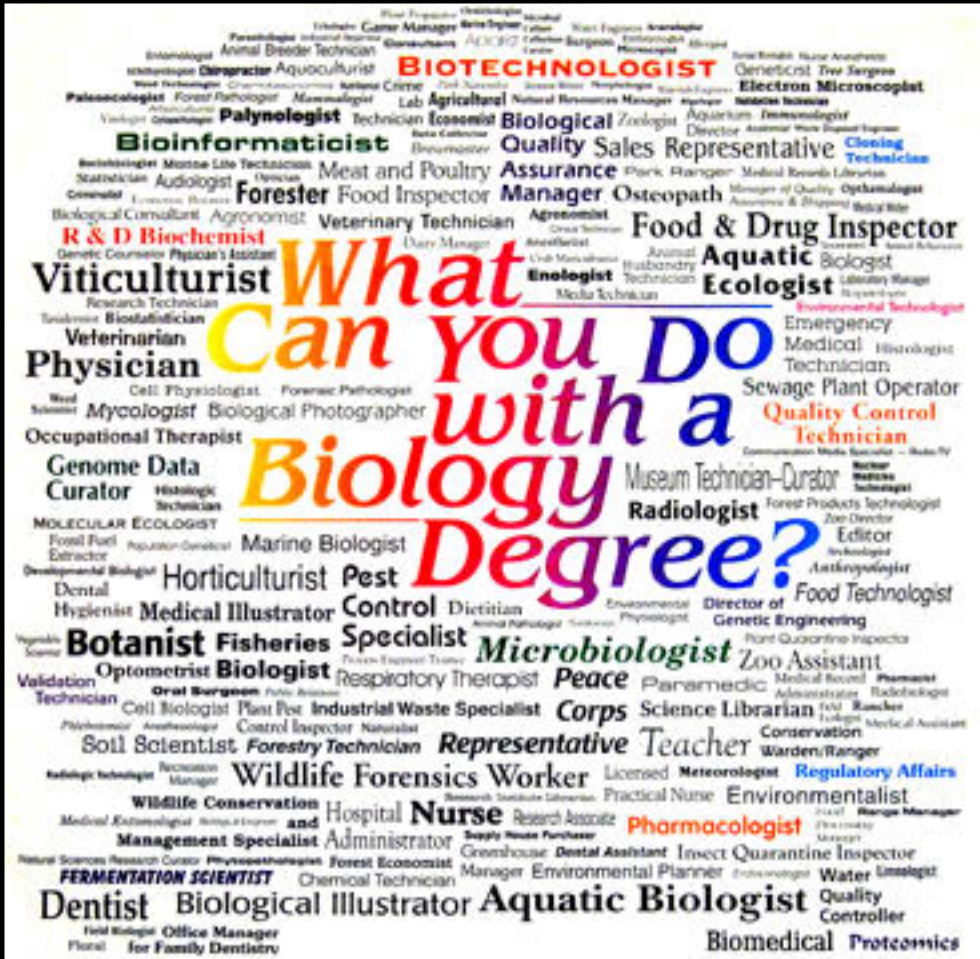
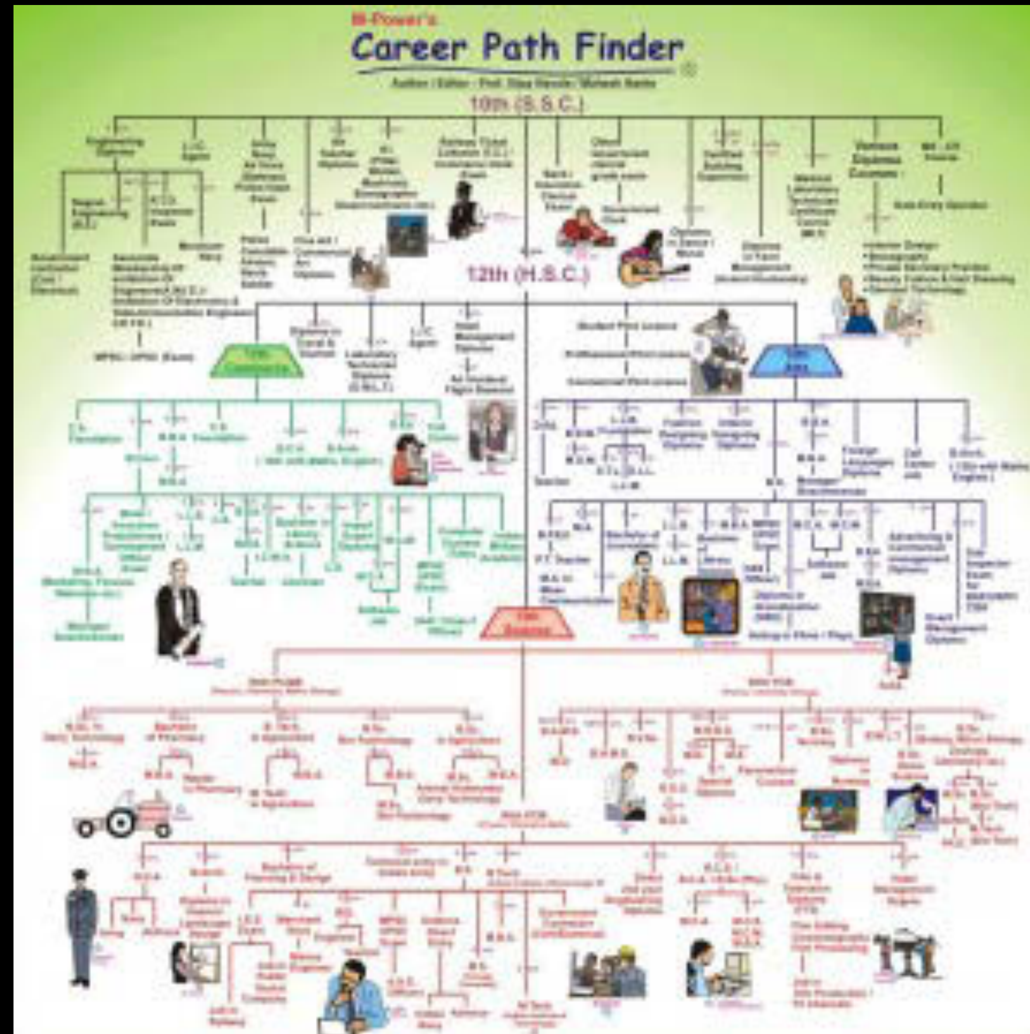
Squids in the desert: How evolutionary biology can take you places you wouldn't expect (or where no "squid" has gone before.....)

Michele K. Nishiguchi
Department of Biology


SQUID IN SPACE

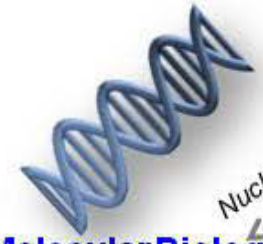

What Can You Do with a Biology Degree?
Biotechnologist
Bioinformaticist
Palynologist
Paleontologist
Electron Microscopist
Biological
Quality
Assurance
Manager
Sales Representative
Cloning Technician
Meat and Poultry
Forester
Food Inspector
Osteopath
Veterinary Technician
Food & Drug Inspector
Agronomist
Biological Consultant
R & D Biochemist
Viticulturist
Aquatic Biologist
Ecologist
Enologist
Animal Husbandry Technician
Media Technician
Research Technician
Biostatistician
Veterinarian
Physician
Emergency Medical Technician
Sewage Plant Operator
Quality Control Technician
Cell Physiologist
Forensic Pathologist
Mycologist
Biological Photographer
Occupational Therapist
Genome Data Curator
Histologic Technician
Molecular Ecologist
Museum Technician-Curator
Radiologist
Forest Products Technologist
Zoo Director
Editor
Anthropologist
Marine Biologist
Horticulturist
Pest Control Specialist
Dental Hygienist
Medical Illustrator
Dietitian
Food Technologist
Director of Genetic Engineering
Botanist
Fisheries Biologist
Optometrist
Microbiologist
Zoo Assistant
Plant Quarantine Inspector
Validation Technician
Respiratory Therapist
Peace Corps
Paramedic
Oral Surgeon
Cell Biologist
Industrial Waste Specialist
Science Librarian
Rancher
Soil Scientist
Forestry Technician
Representative
Teacher
Conservation Warden/Ranger
Wildlife Forensics Worker
Licensed Practical Nurse
Meteorologist
Regulatory Affairs
Environmentalist
Wildlife Conservation and Management Specialist
Hospital Administrator
Nurse
Pharmacologist
Greenhouse Manager
Dental Assistant
Insect Quarantine Inspector
Environmental Planner
Water Quality Controller
Forest Economist
Fermentation Scientist
Chemical Technician
Dentist
Biological Illustrator
Aquatic Biologist
Office Manager for Family Dentistry
Biomedical
Proteomics


Career Path Finder
10th (S.S.C.)
12th (H.S.C.)

Five B.S. Degree Tracks in Biology

1. Biological Science

Provides students a foundation in contemporary fields in biology. It allows **maximum flexibility** in selecting upper division courses that prepare students for professional degree programs (pre-med, pre-dental etc…) as well as entry level employment in life science and health professions.



Nucleic Acids, Proteins & Cells

Cells, Tissues, Organs

Organisms & their Ecology

Plants

2. Molecular Biology

Provides more in depth knowledge of biochemistry, molecular & cell biology. **Emphasis on lab experiences,** including an internship, provides students with skills for careers in biomedical research and at biotechnology firms.

Faculty Coordinators:
Drs. Downes & Kennell

3. Cell Biology & Physiology

Provides students with a strong foundation in the structure and function of organ systems and tissues that comprise them. Good choice for students planning careers as academic, biomedical, and/or biotechnology researchers, health professionals or K-12 teachers.

Faculty Coordinators: Dr Warren & Ogilvie

4. Ecology, Evolutionary & Organismal Biology

Provides students a strong foundation in organismal biology with specialization in ecology and evolution. Good choice for students planning careers as a research biologist at local, state, federal agencies or NGOs; Environmental consultants, or K-12 teachers.

Faculty Coordinators: Dr. Valone & Camilo

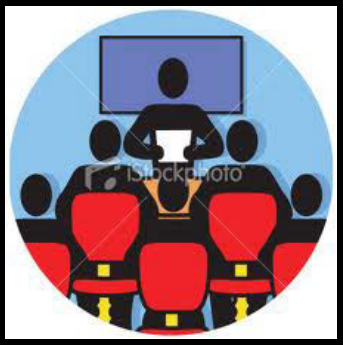
5. Plant Science

Designed for students interested in various aspects of plant biology. Good choice for students planning careers in agricultural research, botanical museums as well as graduate programs in plant biology, conservation, ecology and evolutionary biology.

Faculty Coordinators:
Dr. Miller & Barber

Preparation for Graduate school

- Grades
- Research experience
  - Recommendations
- Scientific literature
  - Know what you like!
  - Read, read, and keep reading
- Write write write



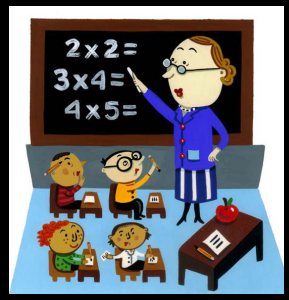
I'm in grad school, now what?

- Research project
- Coursework
- Teaching
- Mentors-multiple
- Scientific literature
  - Keep reading!
- Write write write

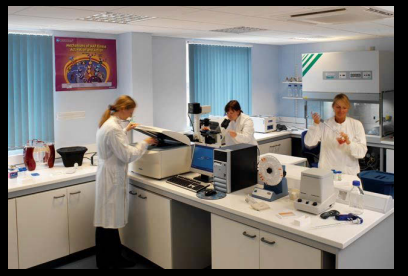
(and it's never enough)

The "pooh bah"

& all that other admin "stuff"



TEACH CLASSES



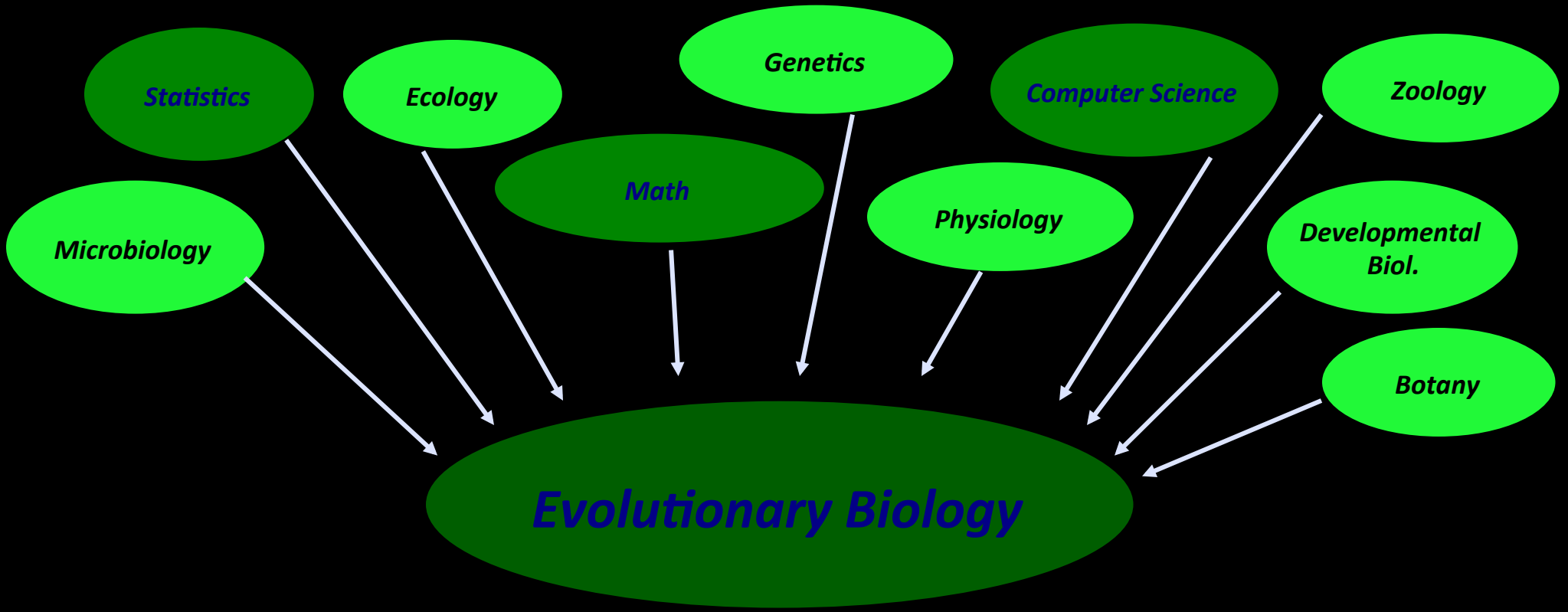
RESEARCH LABORATORY

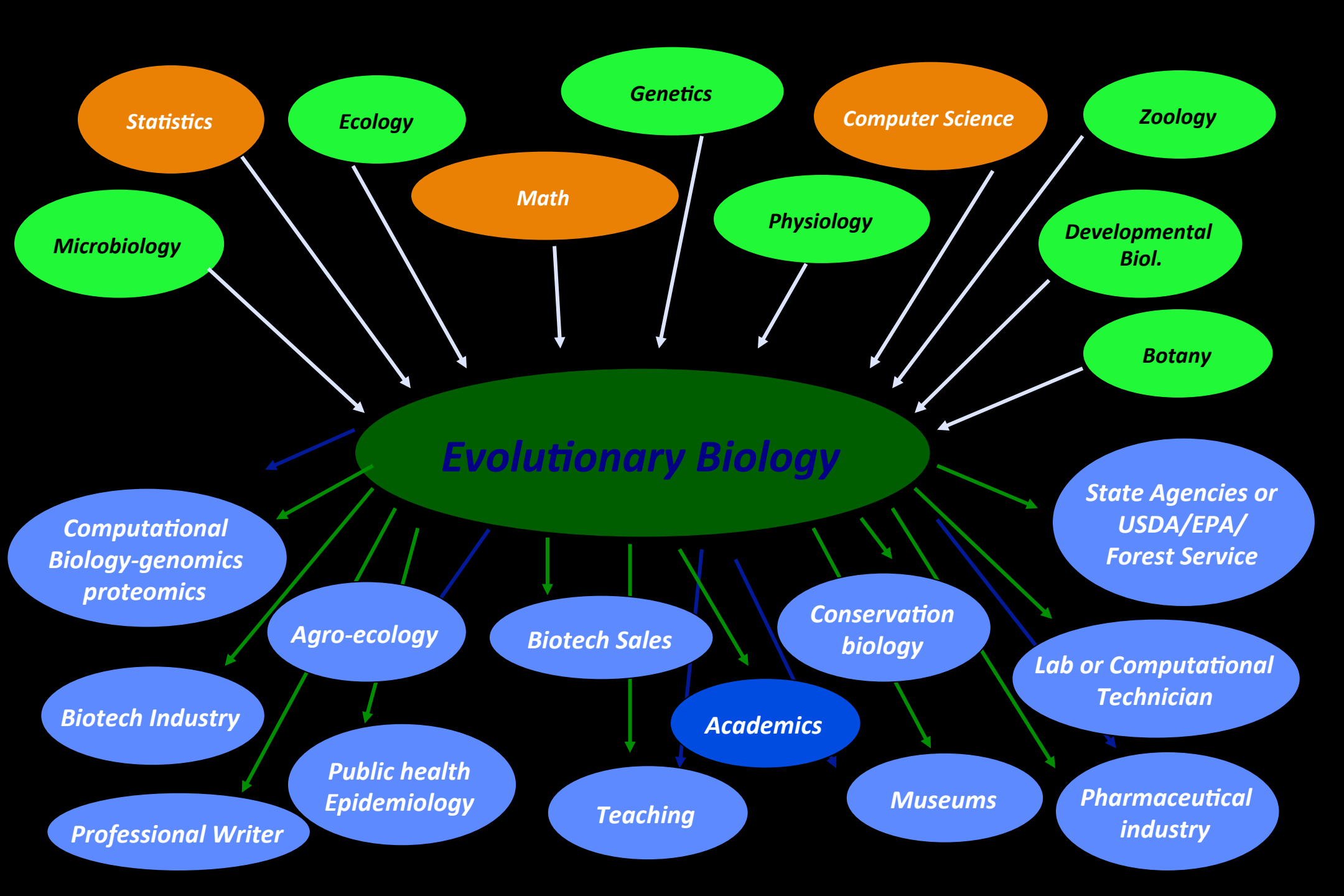
In the $$$

- Fellowships
  - NSF (Pre and post)
  - NSF DIG –post comps
  - NIH Kirschstein (pre and post)
  - HHMI (pre and post)
  - NIH RISE
  - NASA, DOE, DOD
- Network at meetings and through organizations.

Postdoc training and "The job"

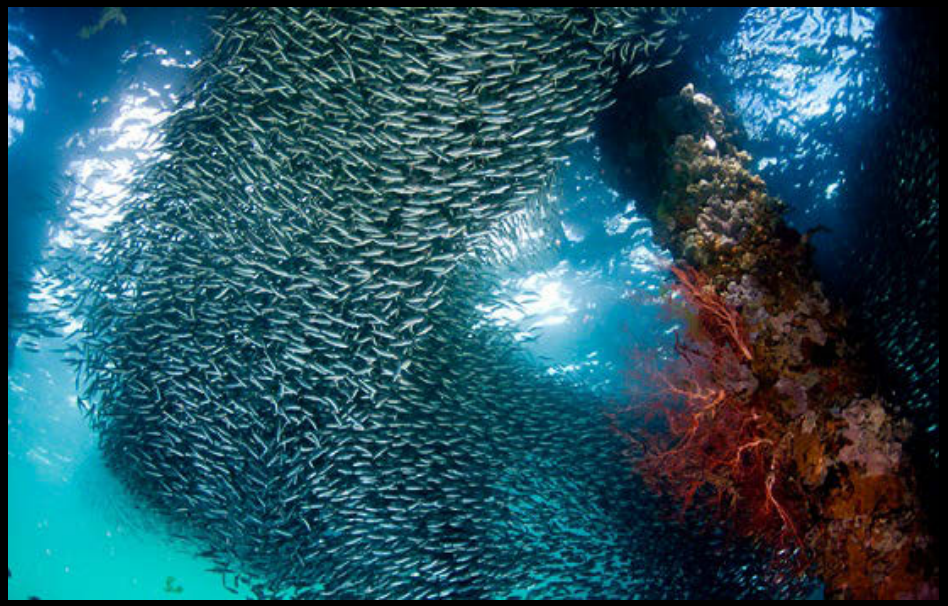
- Find a good lab/mentor
- Change up
- Learn new skills
- Build new professional relationships
- Ramp up the CV
- Write, write, and write- its like training for a marathon!

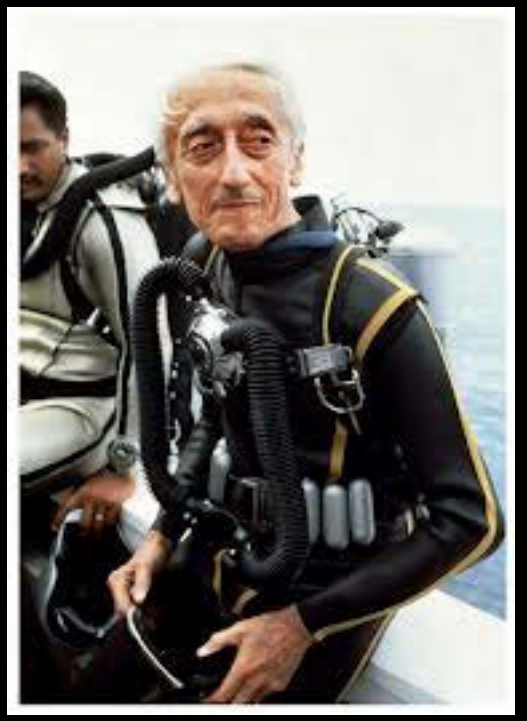

Statistics
Ecology
Genetics
Computer Science
Zoology
Microbiology
Math
Physiology
Developmental Biol.
Botany
Evolutionary Biology


Statistics
Ecology
Genetics
Computer Science
Zoology
Microbiology
Math
Physiology
Developmental Biol.
Botany
Evolutionary Biology
Computational Biology-genomics proteomics
Agro-ecology
Biotech Sales
Conservation biology
State Agencies or USDA/EPA/ Forest Service
Biotech Industry
Academics
Lab or Computational Technician
Public health Epidemiology
Professional Writer
Teaching
Museums
Pharmaceutical industry

Nish's rules for successful science

- Passion
- Inspiration
  - Hero/mentor
  - Students/mentees
- Support
  - Family, Friends
  - $$$
- Curiosity/Unknown
- Openness to new ideas (transformative-EVOLVE!





"The impossible missions are the only ones which succeed" – Jacques –Yves Cousteau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FINISHER
5040
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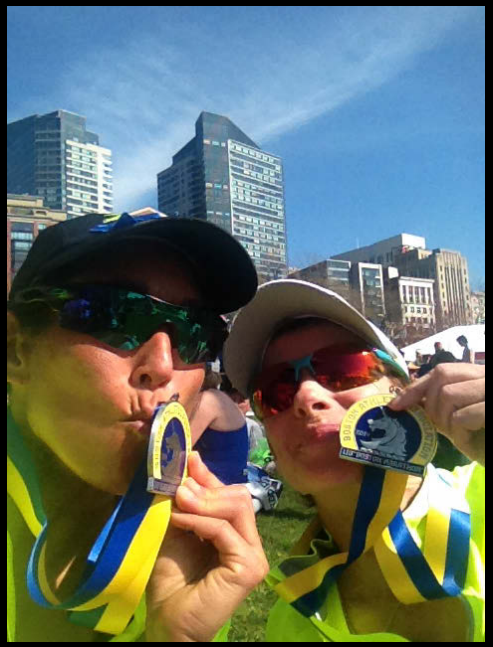


run
30352
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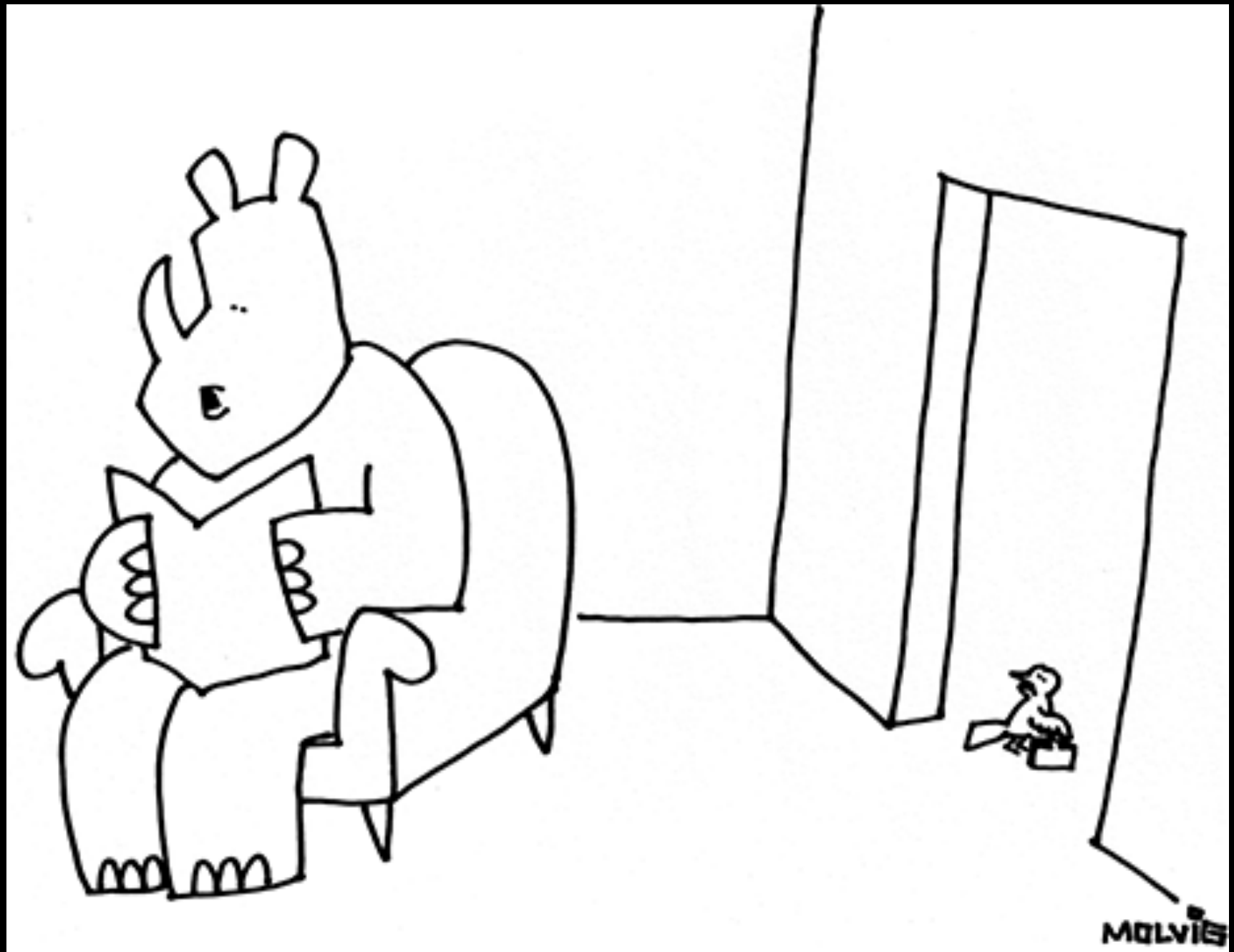
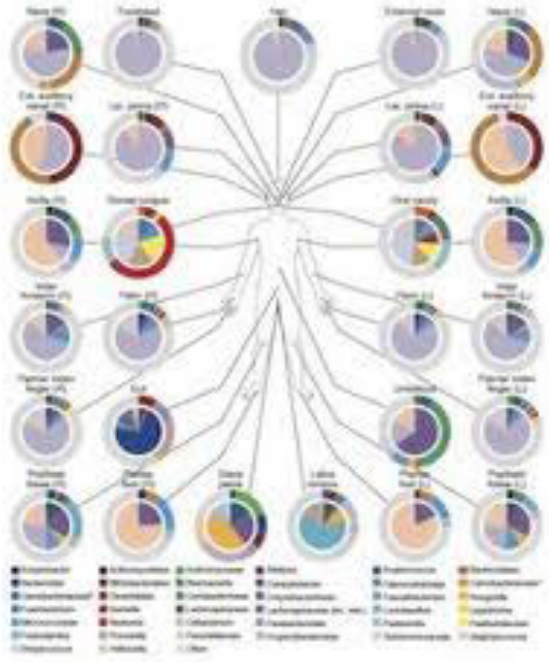
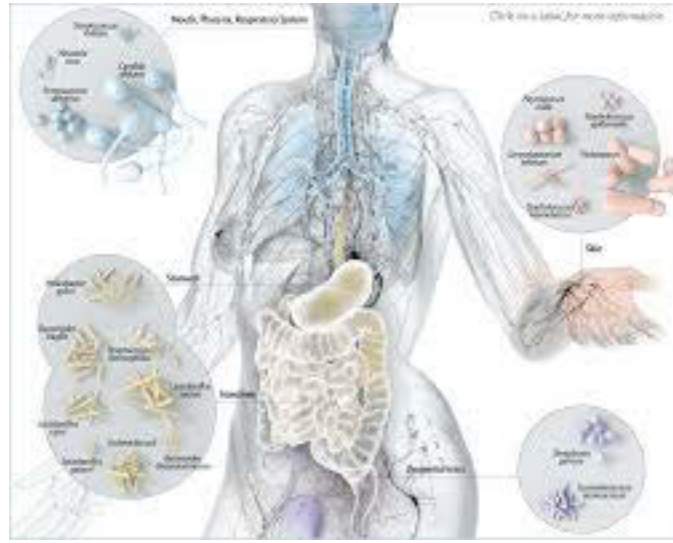
40157

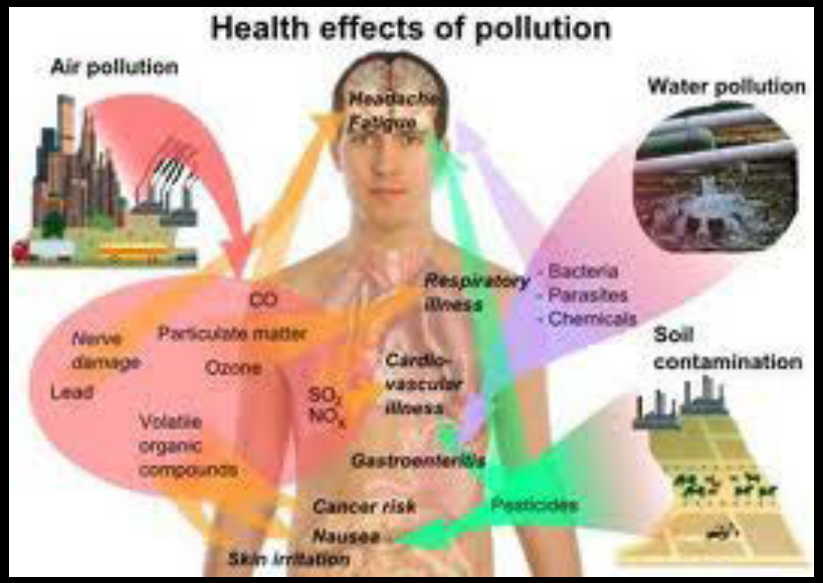


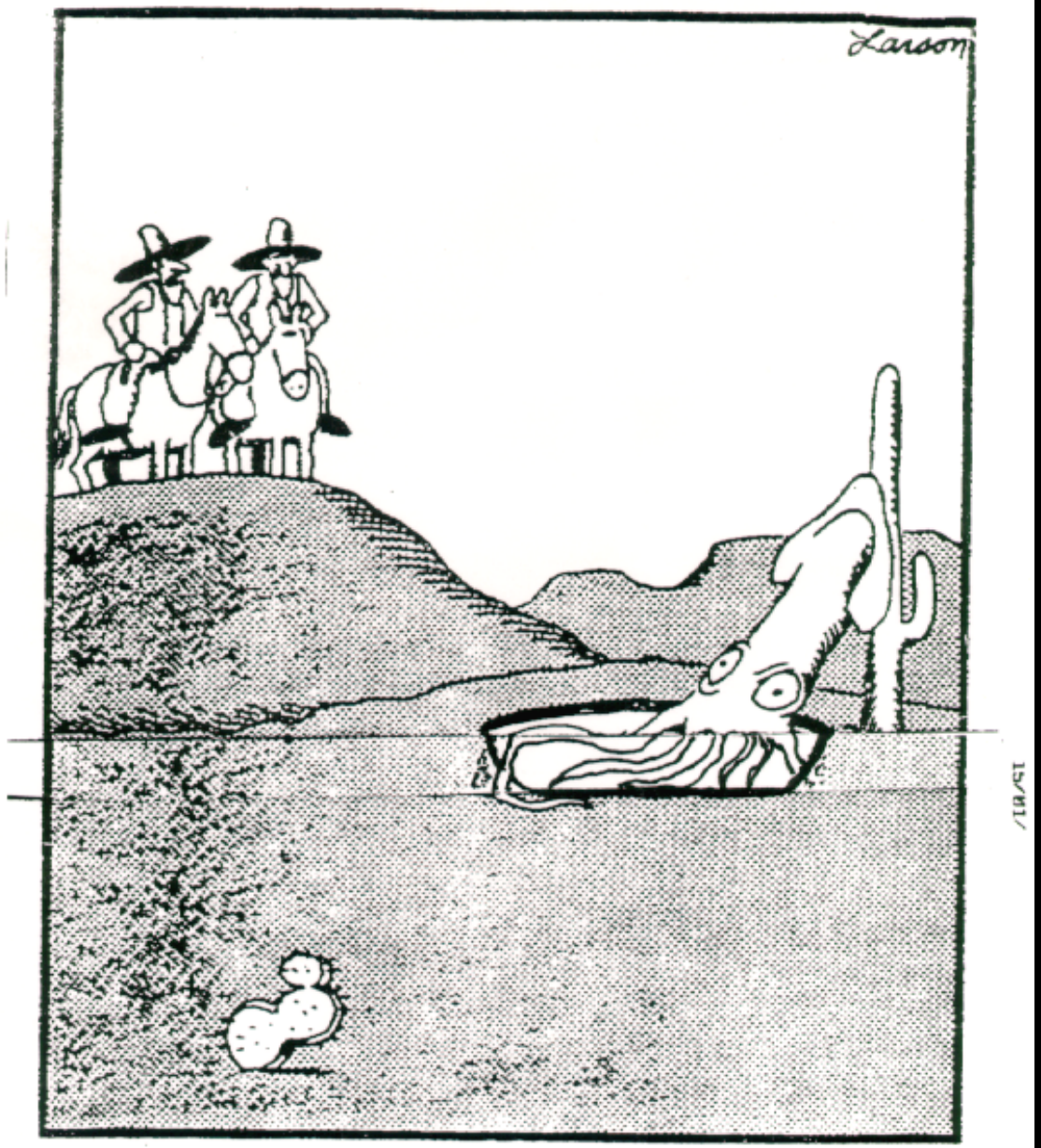
"Symbiosis isn't enough for me anymore, Carl."






The Human Microbiome Project


Health effects of pollution
Air pollution
Water pollution
Headache
Fatigue
CO
Particulate matter
Nerve damage
Ozone
Lead
Volatile organic compounds
SO_2
NO_x
Respiratory illness
Cardio-vascular illness
Gastroenteritis
Cancer risk
Nausea
Skin irritation
- Bacteria
- Parasites
- Chemicals
Soil contamination
Pesticides



"Dang! Wouldn't you know it? . . . The only waterhole for a hundred miles and plumb in the middle is a giant squid."

Evolution

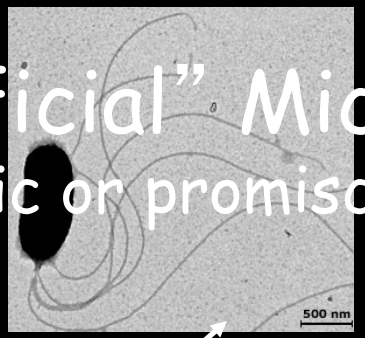
Incipient speciation
Founder effects
Alturism/Conflict

Hosts

Islands

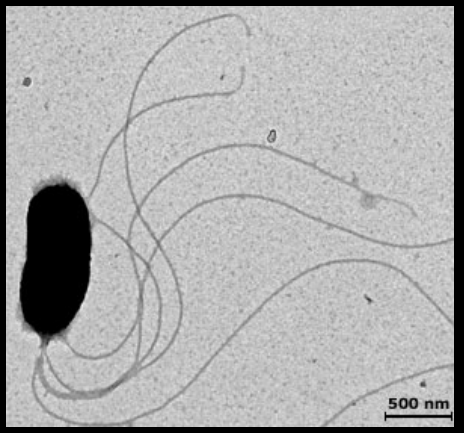
"Beneficial" Microbes

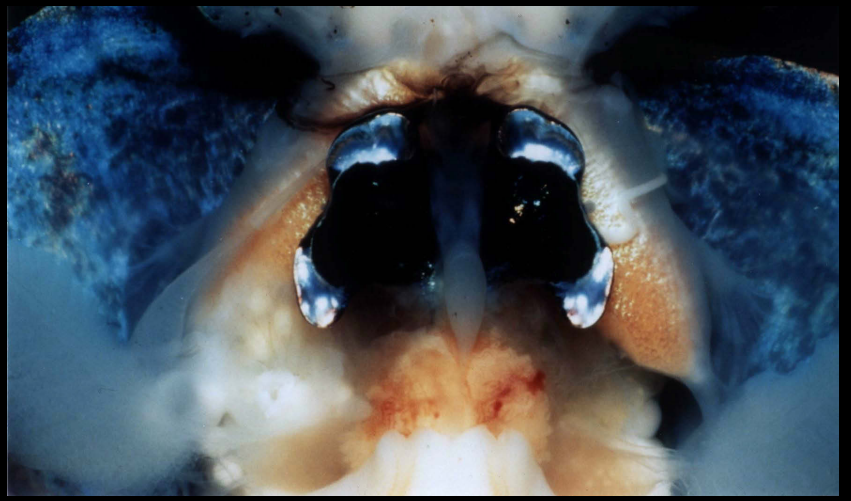
Specific or promiscuous?

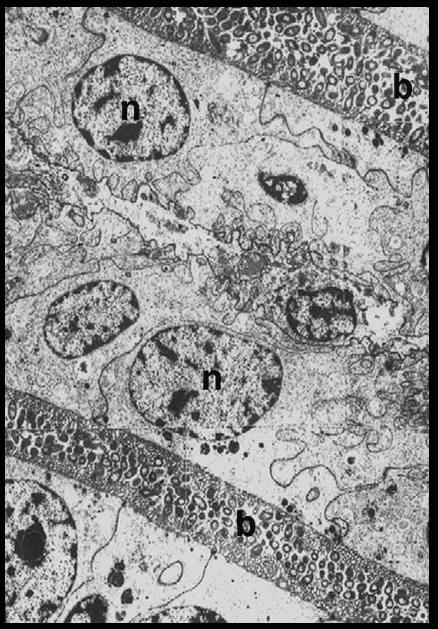


Ecology

Environmental transmission
Abiotic and Biotic
Competition/Cooperation


500 nm

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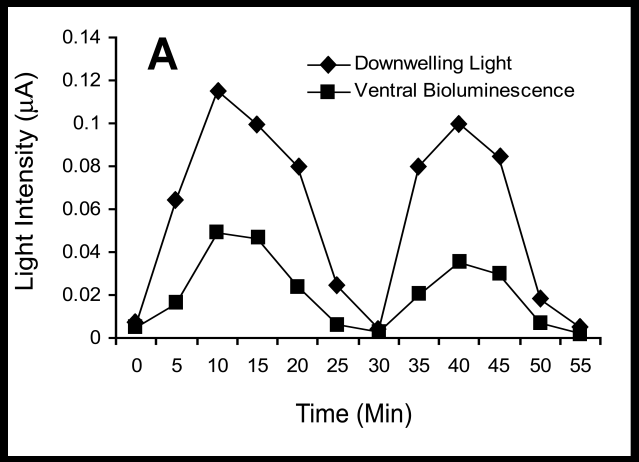


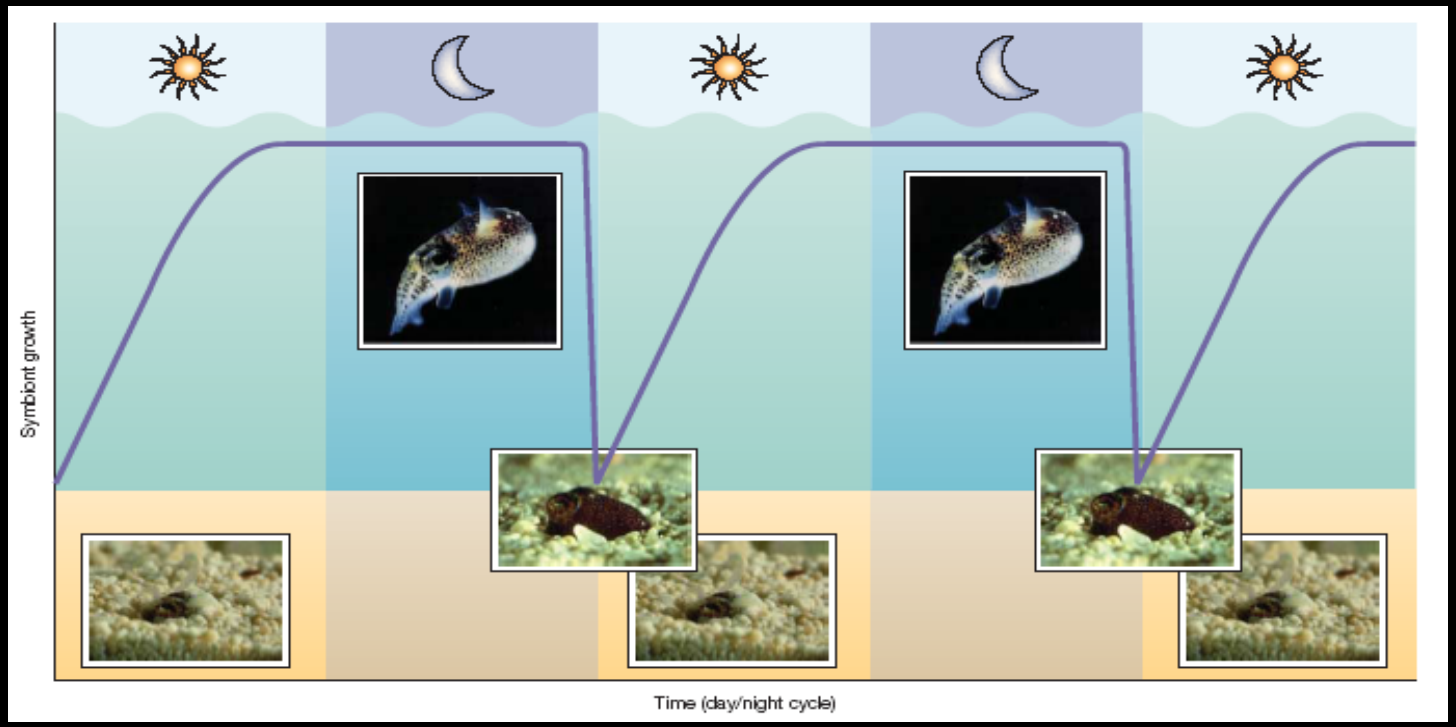


Photo: Davis, 2009

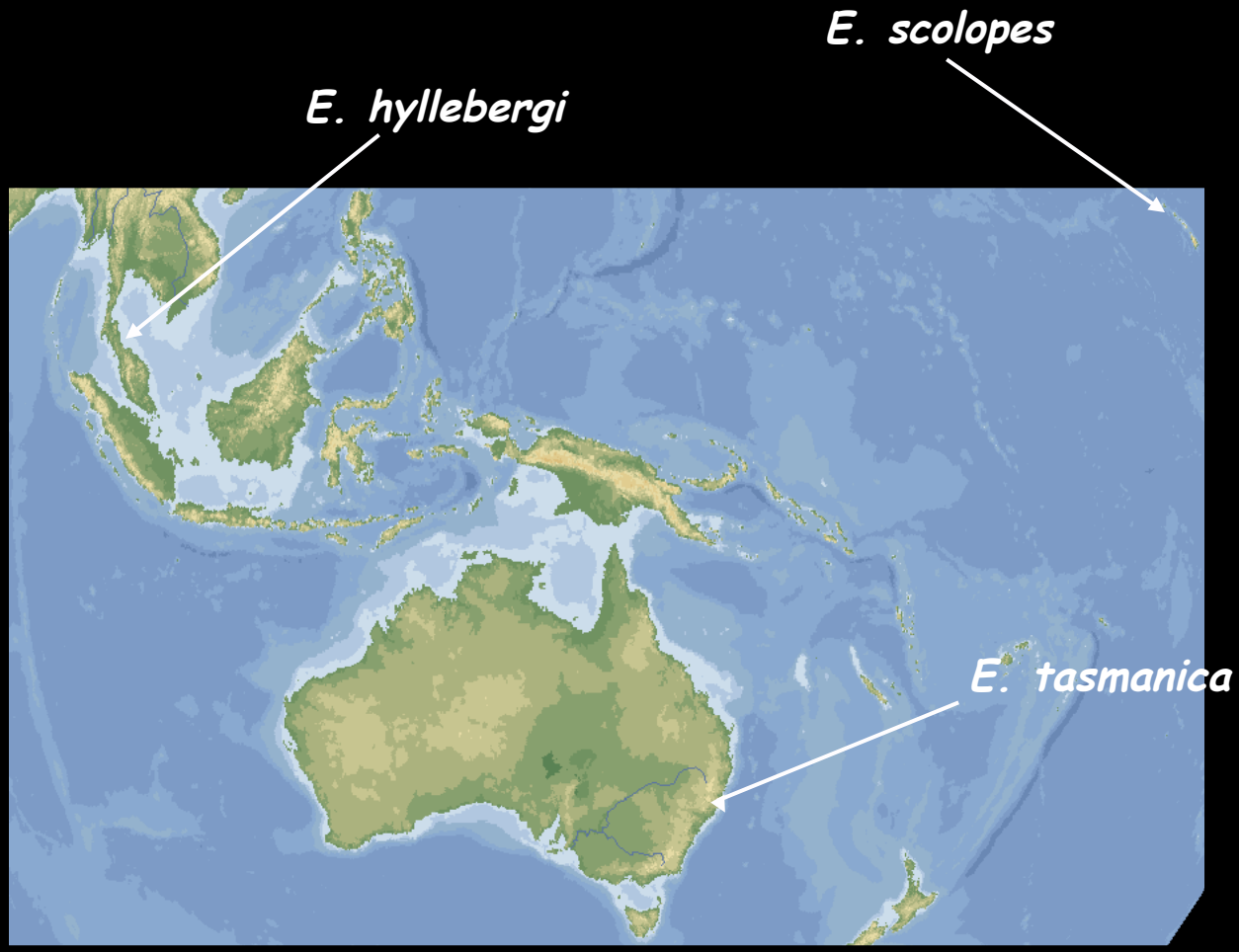
Jones & Nishiguchi, 2004

Nyholm & McFall-Ngai, 2004

Evolutionary framework

- I. Abiotic factors shaping beneficial associations
- II. Host factors driving *Vibrio* speciation
- III. Evolution to novel hosts, competition, predation

Indo-west Pacific *Euprymna* populations



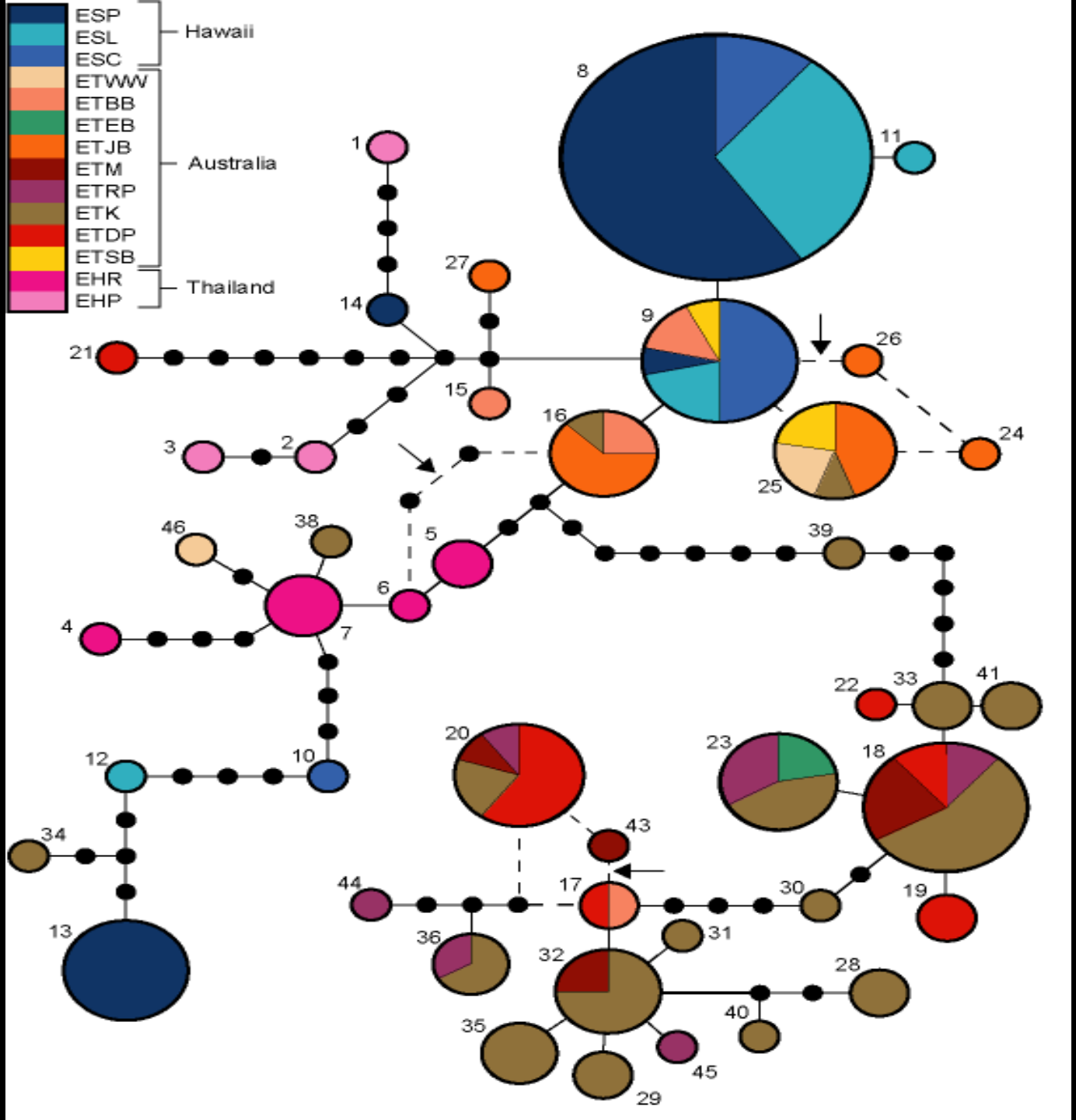

SCUBAPRO


DIVE BELOW


BioPAL


LOG BOOK

Jones *et al.*, 2006



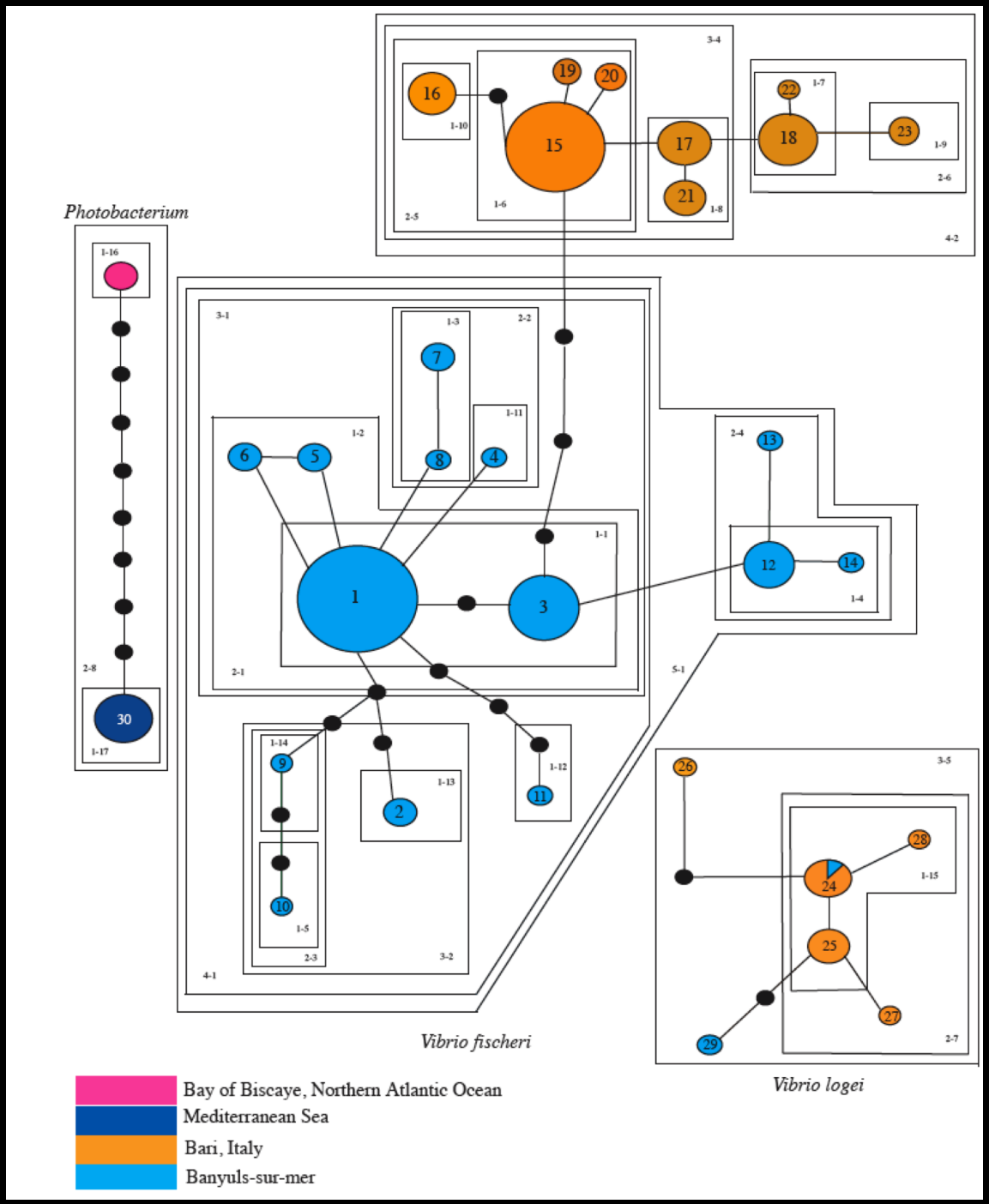
Sympatric
Sepiola

S. atlantica

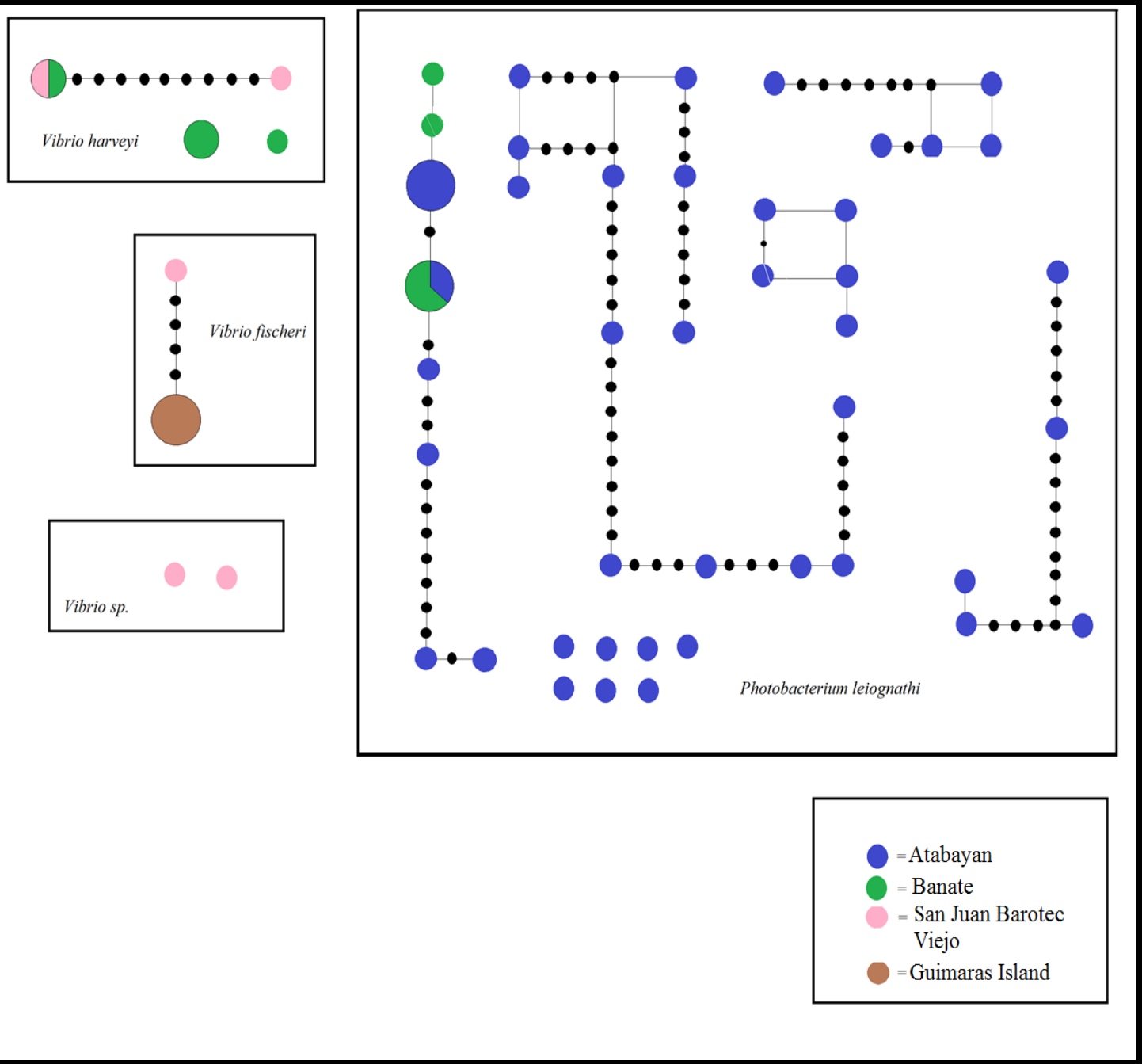
S. affinis
S. robusta
S. intermedia
S. ligulata
S. rondeletiola
S. aurantiaca
R. minor


TEK


hug
it ott



Zamborsky & Nishiguchi, 2011

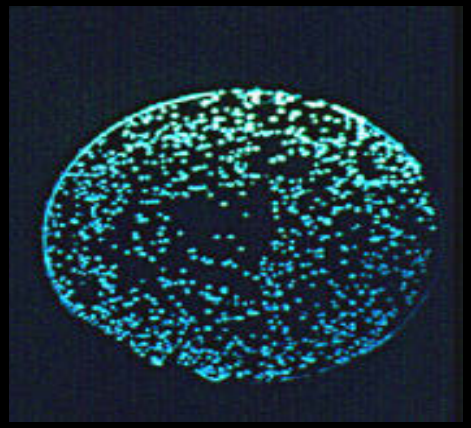


Blue- Atabayan

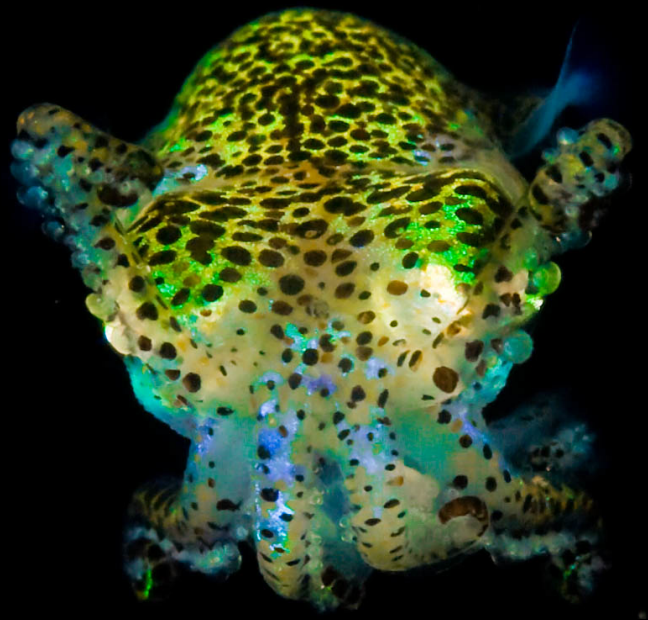
Green- Banate

Pink- San Juan Barotec Viejo

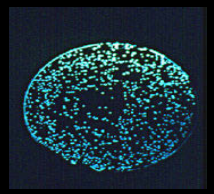
Red- Guimaras Island



Can we observe evolution in the lab?



Infect axenic *E. tasmanica* w/ ES114^{cam}



V.fischeri ES114^{cam}
(1,000 CFUs/ml seawater)

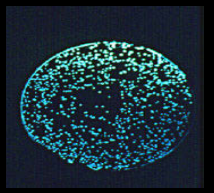
Serial passage

22.5 gen/4 days/ passage x
25 passages = 500
generations

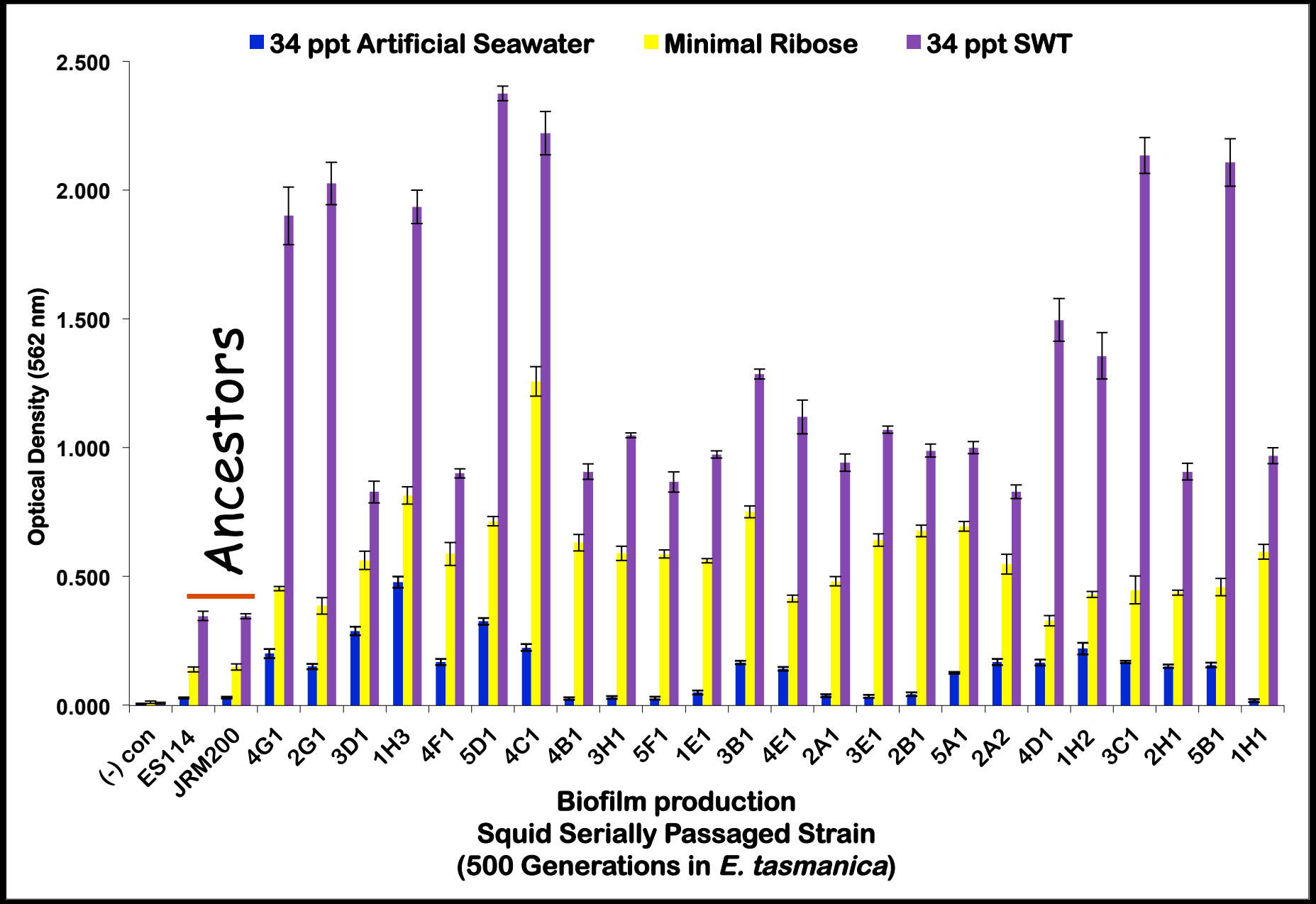
Frozen fossil records

Evolved "*mutant*"

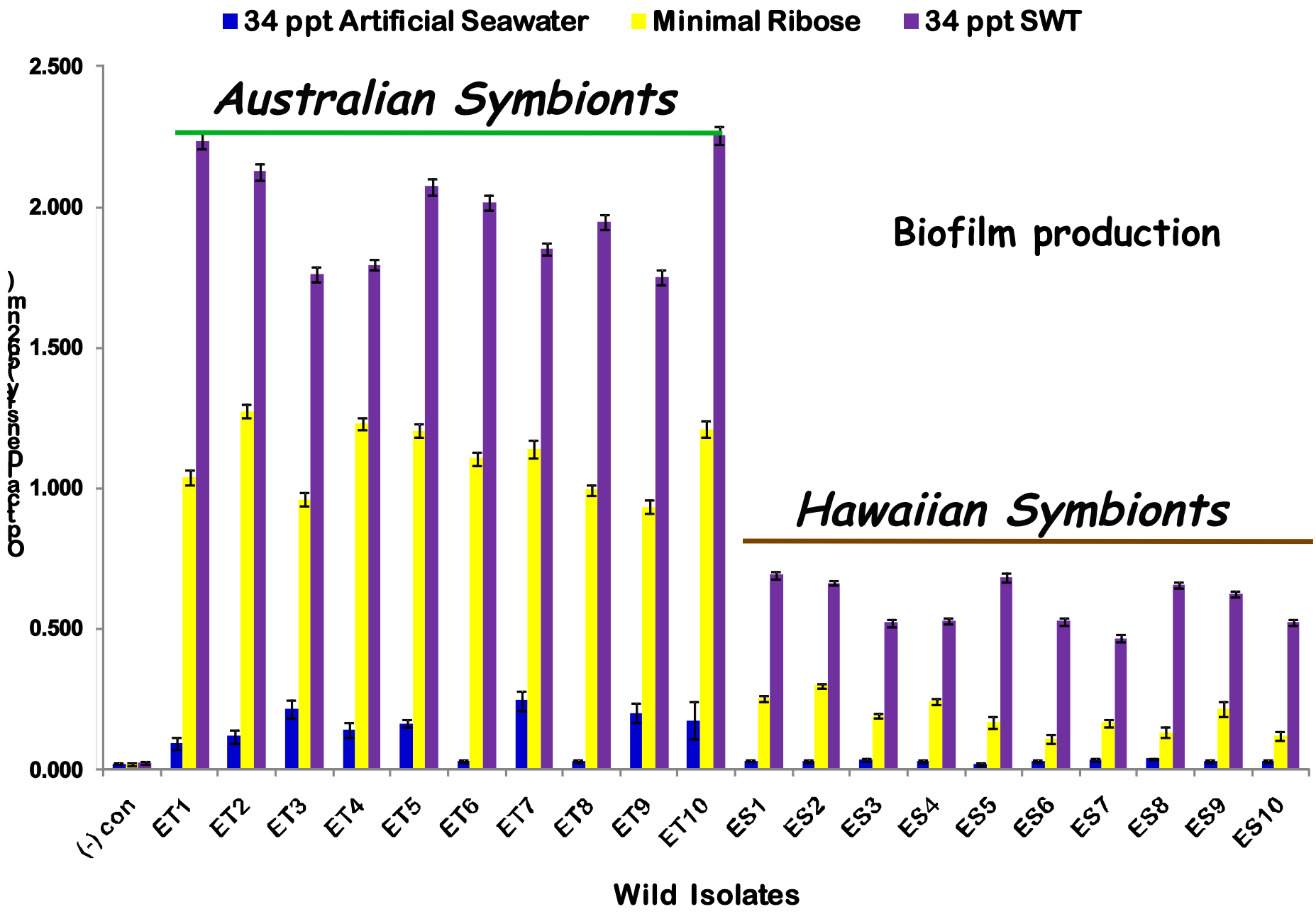
+ ancestral ES114 *V. fischeri*



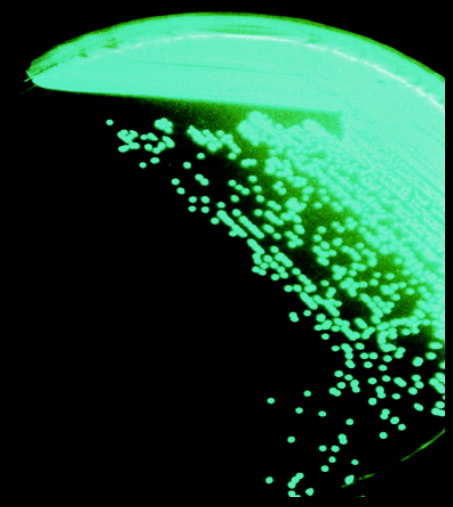
Determine if fitness/adaptation has increased in mutant



Soto *et al.*, 2014



Soto *et al.*, 2014



Does competition/ cooperation influence *Vibrio*-squid interactions?

"Grazers"

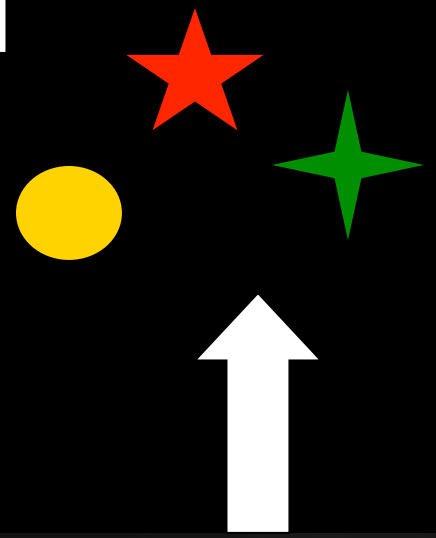
Tetrahymena

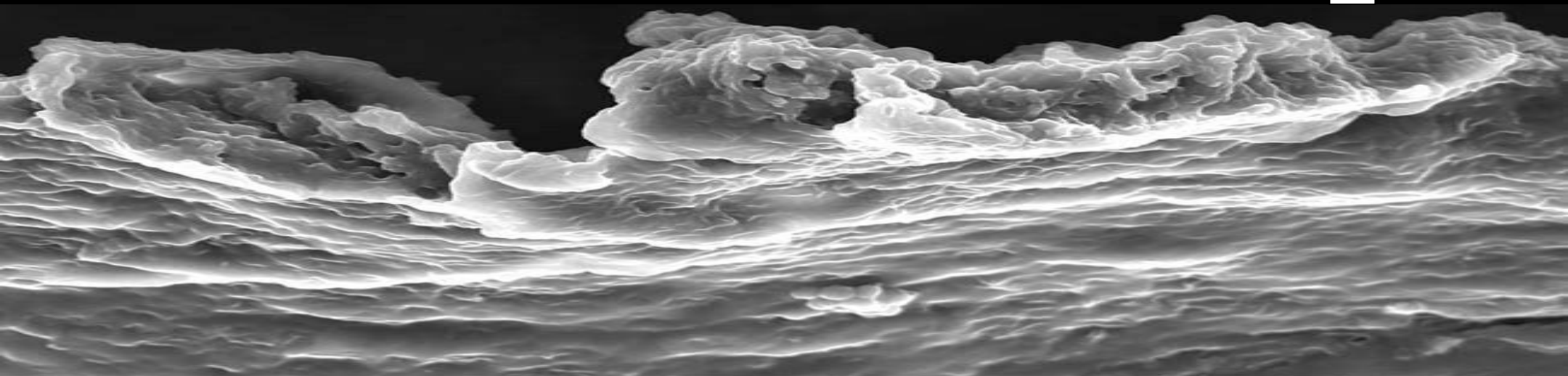
Rynchomonas

Neobodo

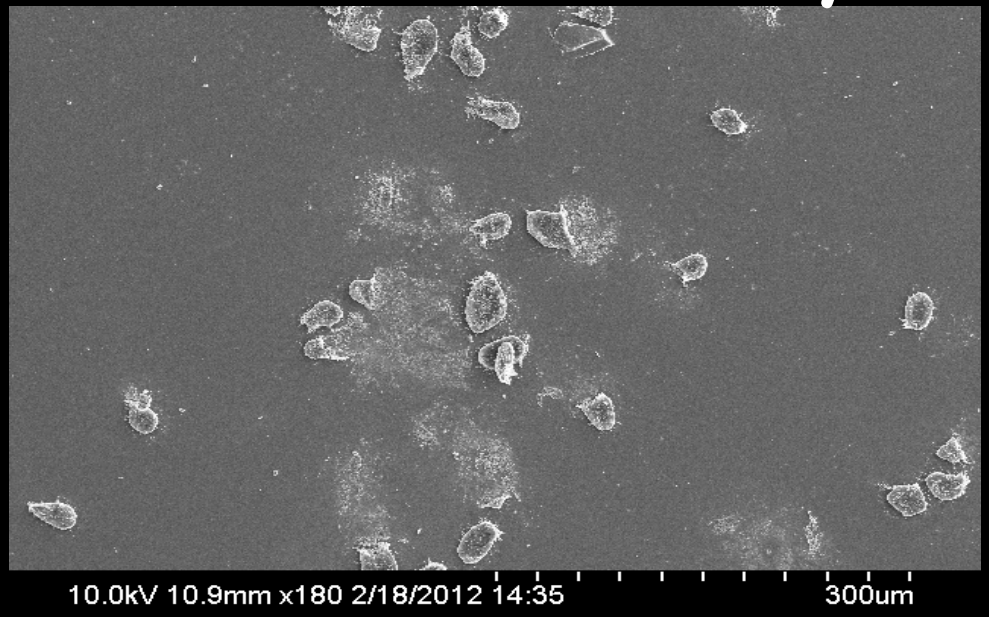
"Fight back"

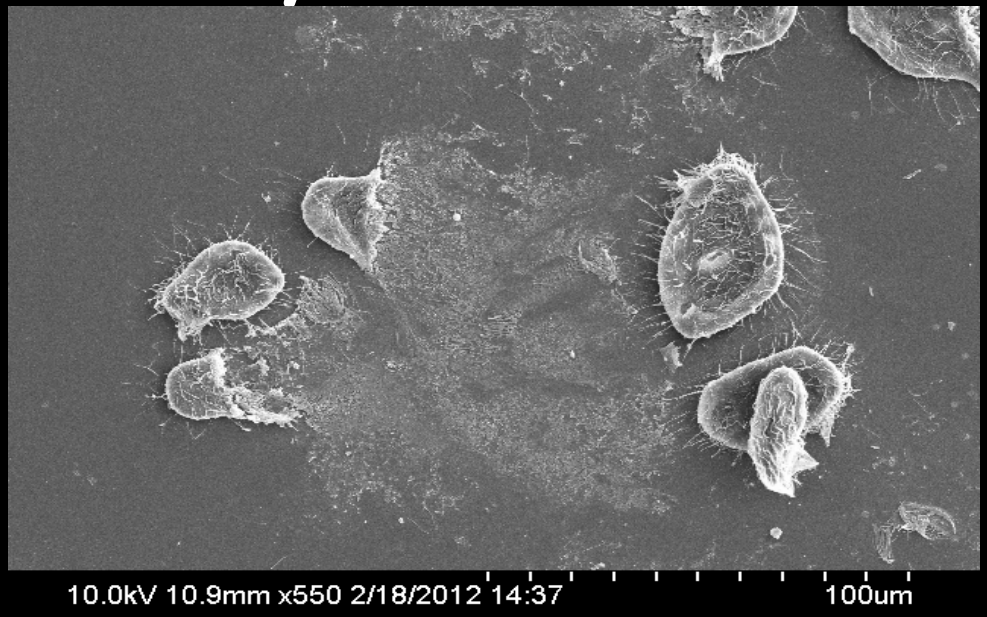
Antiprotozoan compounds

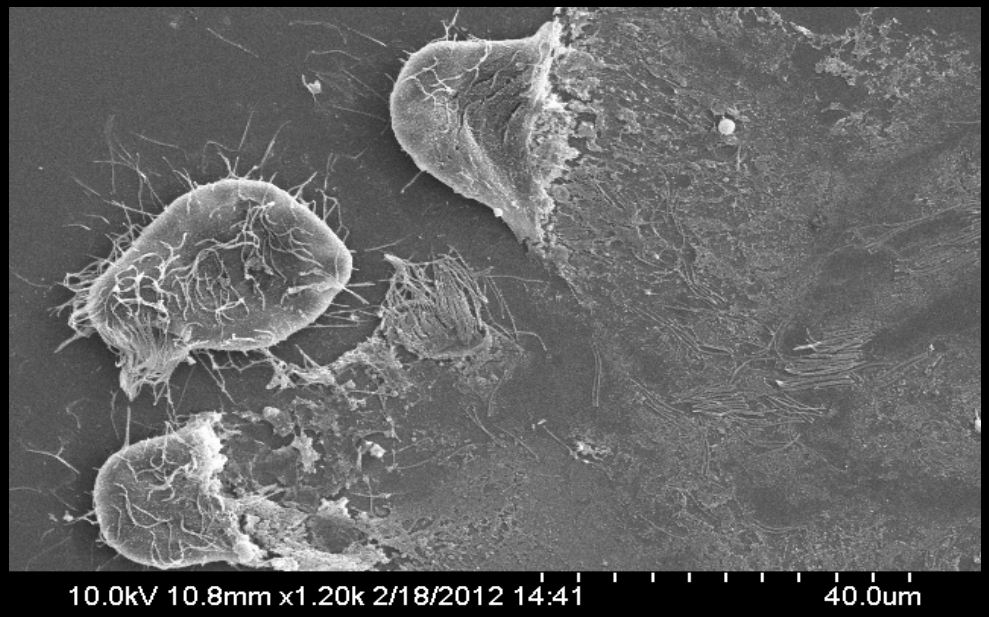


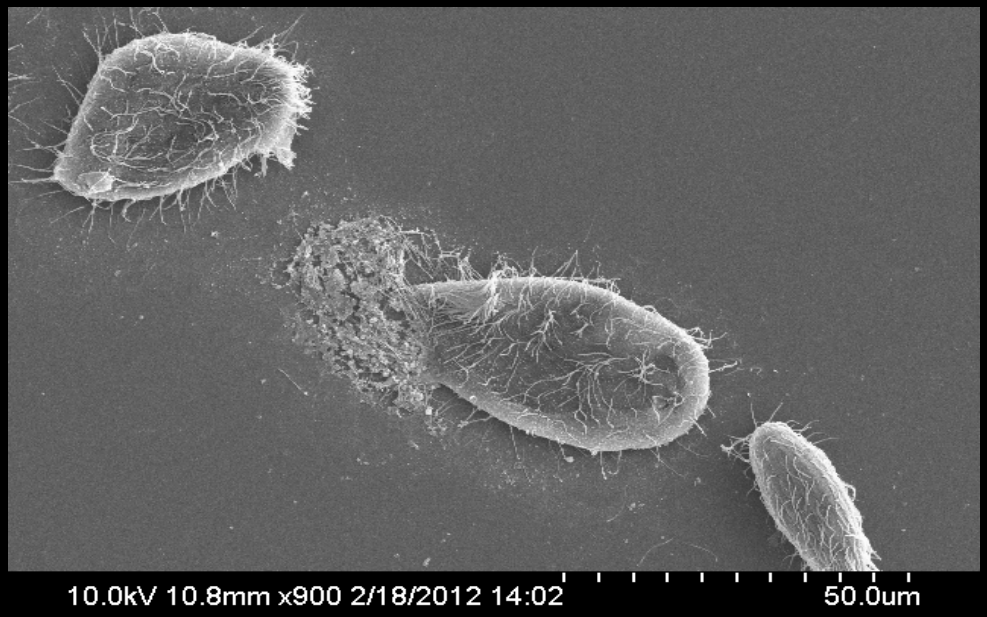


Toxicity effect: Lysis



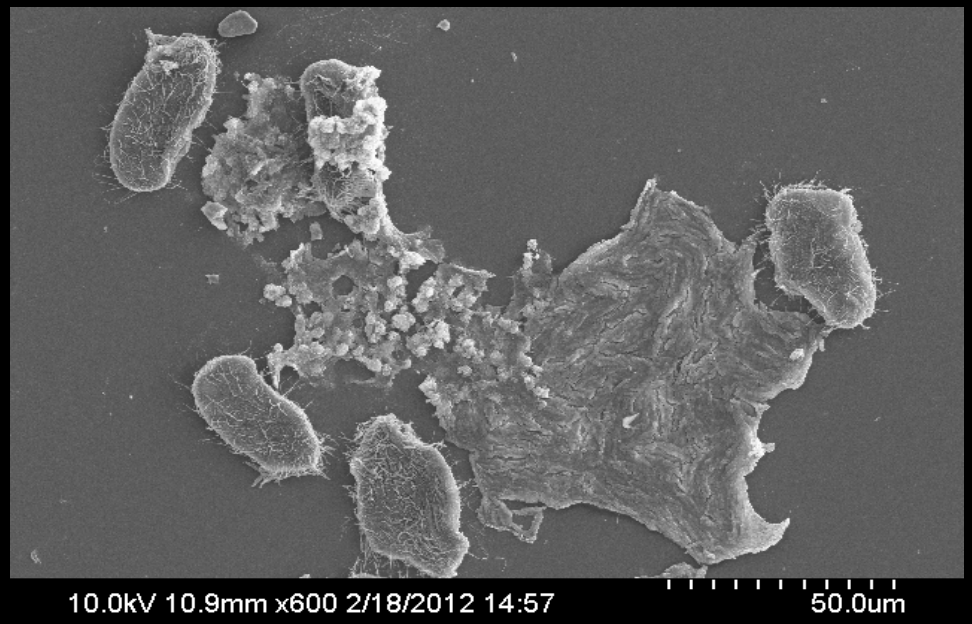


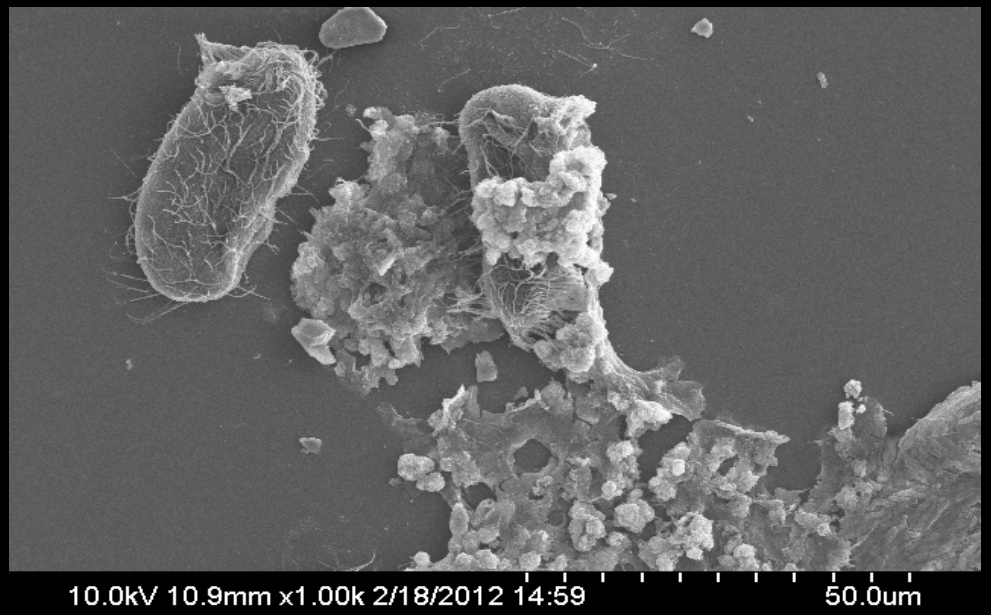


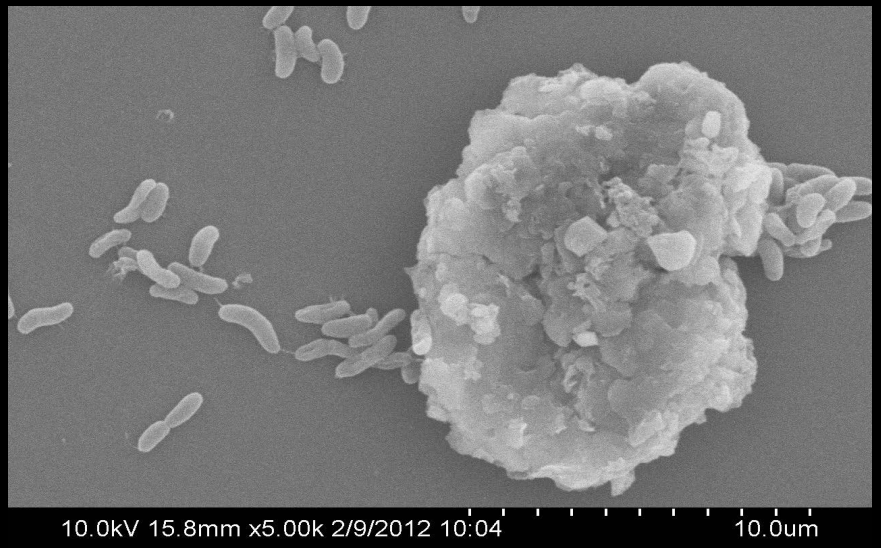


Chavez-Dozal *et al.*, 2013

Toxicity effect: Morphology change







Chavez-Dozal *et al.*, 2013

Evolution

Host sanctions
Alleopathy
Trade-offs
Specificity
Social behavior

Ecology

Relative population
Community service
Environmental selection

Summary

- As an evolutionary biologist, you can do just about anything biologically related.
- Set up your foundation so that you have multiple options.
- Network, advertise yourself! You may be a science rock star someday (yes, that's me on the cover).
- Critical thinking and writing skills are most valued/ important in any type of science career.

Acknowledgments

Nish lab members past and present
All my Collaborators (US and Foreign)
S. Edwards, J. Weintraub, R. Kilman, NESCent

The "NMSU desert squid" lab