Case It: Case-based learning for undergraduate research

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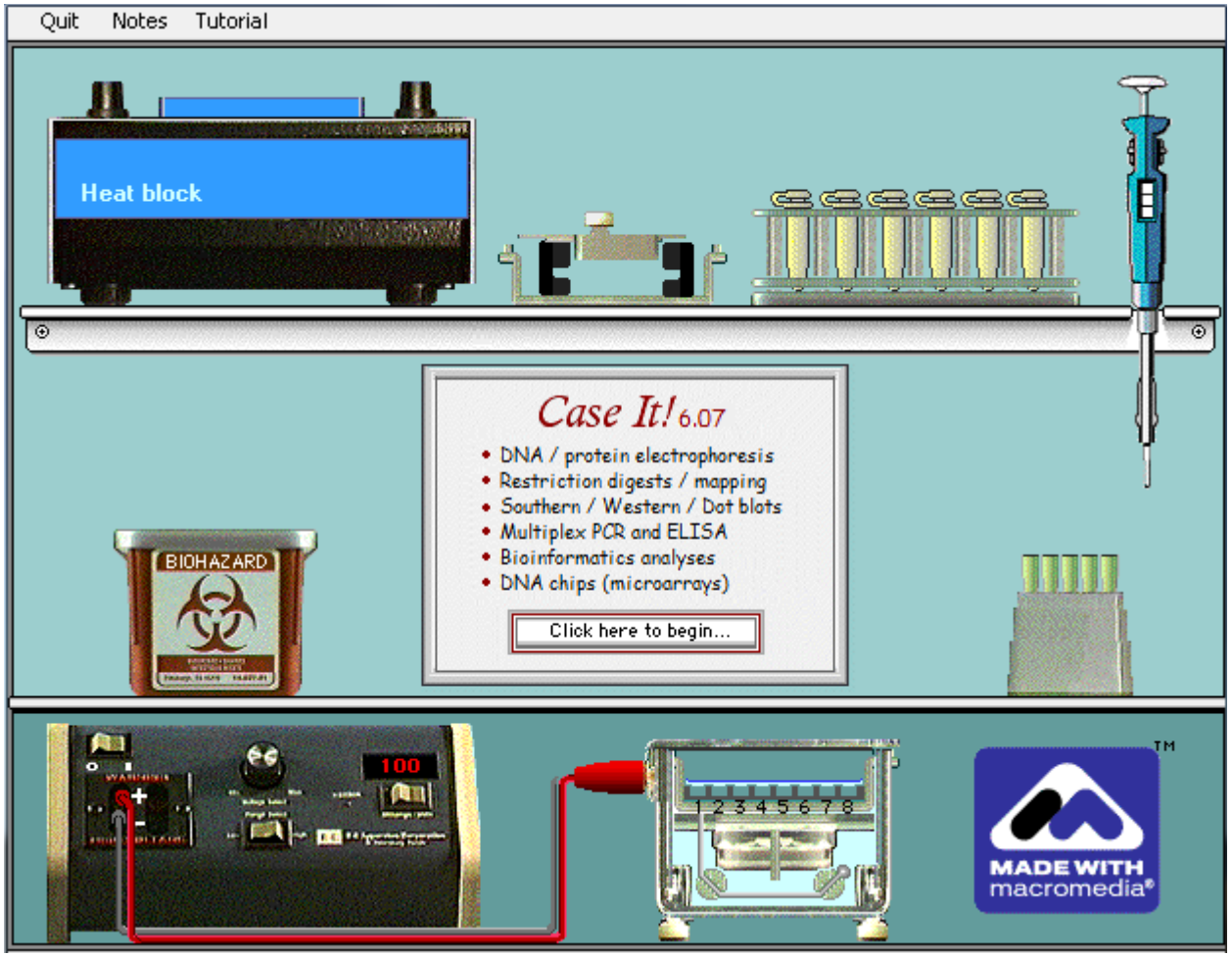

National Association of Biology Teachers Professional Development Conferens, Atlanta, GA, 2013

Session overview

- Introduction to the Case It! project and ScienceCaseNet
- Freshmen research applications
  - HHMI SEA-PHAGES (restriction digest of phage DNA)
  - Honey bee health
- New cases on honey bee biology
  - Virus detection by PCR
  - Bee virus bioinformatics
- Case It Mobile as an alternative to the Case It simulation
- How to develop your own Case It cases

Case It! Project

Case It! Home Page: www.caseitproject.org

Includes tutorials, downloads, case descriptions, forums, suggestions for class use, and workshop links

Case It is part of ScienceCaseNet.org network for case and problem-based learning, funded by RCN-UBE program of NSF

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Overview of Case It Project

- Electronic framework for analyzing and discussing case studies in molecular biology
- Genetic and infectious diseases and associated ethical issues
- Students gather background information on cases
- Analyze DNA and protein sequences using the Case It simulation (v6.07)
- Can extend case analysis using MEGA bioinformatics software (megasoftware.net)
- We have used online poster sessions and role-playing, but there are many other ways to use software and cases

Features of Case It v6.07 for PC and Mac

- DNA and protein electrophoresis
- Restriction enzyme digestion and mapping
- Southern, Dot and Western blotting
- Polymerase Chain Reaction (single and multiplex)
- ELISA
- Microarrays (SNP and expression)
- BLAST, alignments and tree-building (in conjunction with MEGA software (PC) or MABL web site (PC and Mac))
- Above are used to analyze case studies in genetic and infectious diseases and other biology topics

(see online tutorials for demonstration of features)

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Authentic research for first-year students: HHMI SEA-PHAGES Project

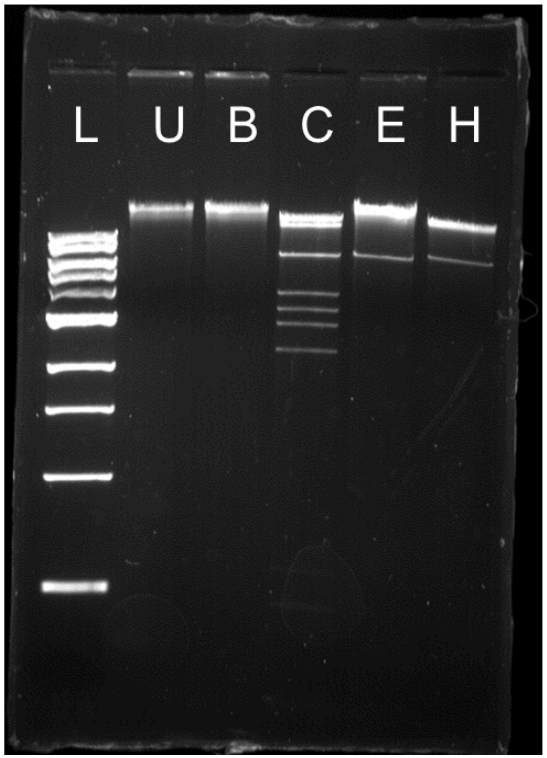
Fall semester

- Isolate mycobacteriophages from soil
- Isolate phage DNA and analyze by restriction enzyme digestion
- Select one phage to send for sequencing

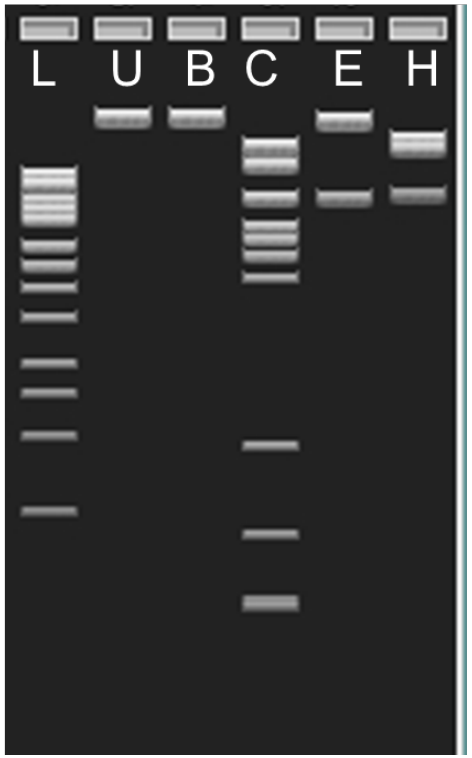
Spring semester – phage genomics (www.phagesdb.org)

- Annotate genes
- Comparative genomics
- Research projects on phage biology

Abrogate lab gel



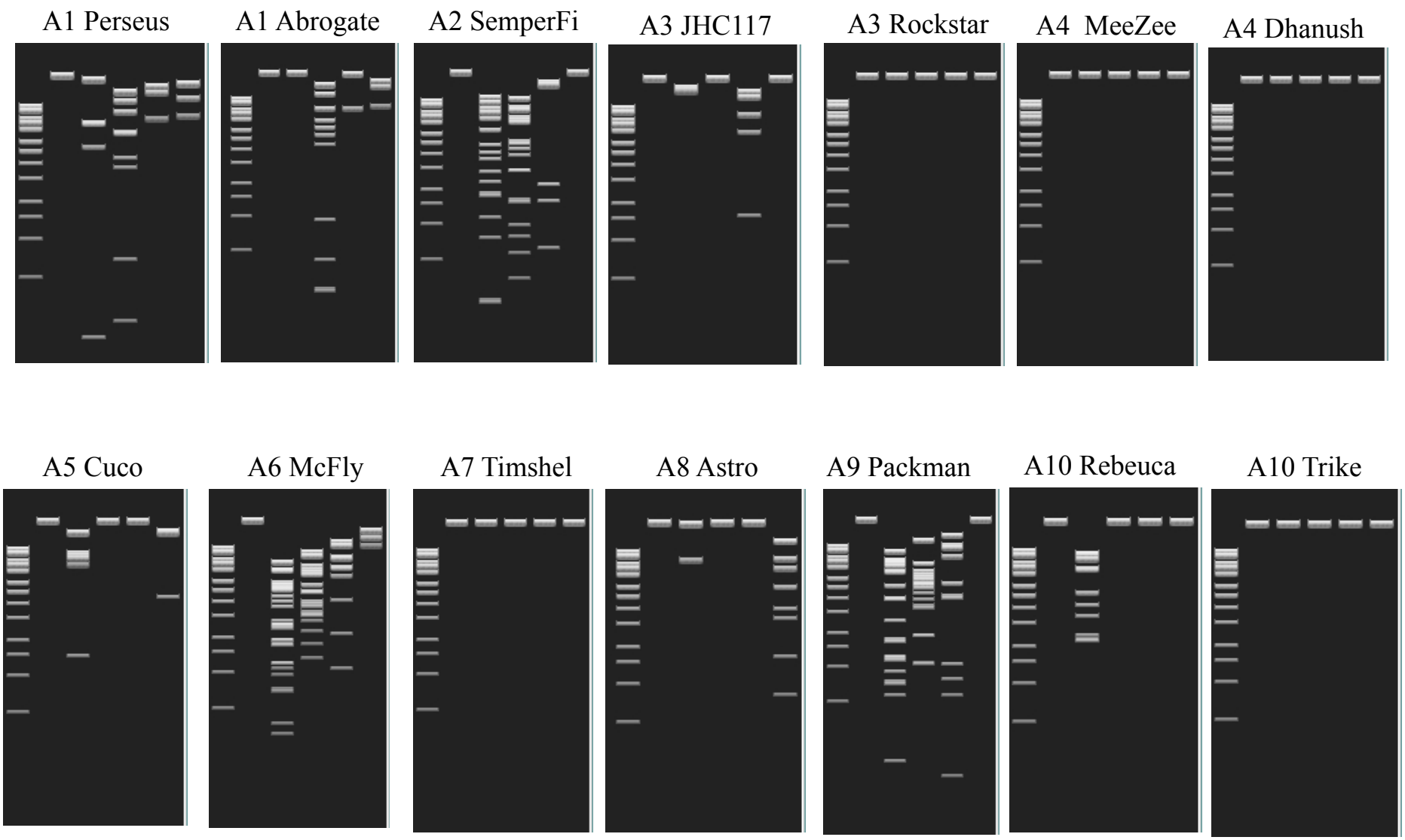
Abrogate virtual gel



Bxb1 virtual gel

L=1 kb ladder; U=undigested; B=BamHI; C=ClaI; E=EcoRI H=HindIII

Cluster A phages, listed by subcluster



Left to right: 1 kb ladder, undigested, BamHI, ClaI, EcoRI, HindIII

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Honey bee cases

- Collaborators:
  - Kim Mogen and Brad Mogen, UWRF Biology
  - Marla Spivak, UM Bee Lab

- Incorporating research on honey bee health and colony collapse disorder in first-year biology classes
  - Virus detection by RT-PCR
  - Effects of pesticide exposure, mite levels, etc.

Case scenario

Honey bees are commonly exposed to pesticides as they forage for pollen and nectar. Some pesticides are known to affect the central nervous system of bees and thus impact their behavior. Sub-lethal exposures of some pesticides are considered possible contributing factors to Colony Collapse Disorder (CCD). Dr. Muskiver was curious if pesticide exposure was linked to virus infection, another possible contributing factor to CCD.

To test this question, Dr. Muskiver set up test colonies, and fed the honey bees either with untreated pollen or pollen treated with sub-lethal doses of pesticides. She then tested the bees for the presence of several viruses using multiplex PCR on cDNA isolated from the bees.

DNA samples to test

Negative control – bee sample with no viruses present

Positive control – bee sample containing all four viruses

Hive 1 – exposed to pesticides

Hive 2 – exposed to pesticides

Hive 3 – no pesticides exposure

Hive 4 – no pesticide exposure

Multiplex PCR primers

Primers	PCR product size
Actin	120 bp
Deformed wing virus (DWV)	203 bp
Black queen cell virus (BQCV)	322 bp
Sac brood virus (SBV)	487 bp
Israeli acute paralysis virus (IAPV)	719 bp

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PCR Result

1.0 % agarose runtime = 60 100 volts	1. 100 bp ladder 2. neg control 3. pos control all viruses 4. Hive 1 pesticide-treated 5. Hive 2 pesticide-treated 6. Hive 3 no pesticide 7. Hive 4 no pesticide

Case scenario - bioinformatics

Recent declines in honey bee populations have given rise to the syndrome named Colony Collapse Disorder (CCD). Several potential stressors have been identified. A team of research scientists, funded by the North American Honey Bee Council, decide to survey colonies from around North America for two of the notable stressors – Deformed Wing Virus (DWV), a virus that causes wing deformation, and *Varroa destructor*, a parasitic mite that feeds on the bee.

It has recently been reported that *V. destructor* transmits certain strains of DWV more effectively, and that long-term mite infection reduces virus diversity and leads to the prevalence of more pathogenic viruses. The scientists are interested in testing the relationship between DWV strains and the *Varroa* mite in North America.

Case scenario - bioinformatics

Bees tested from:

- Central Ontario - low mite levels
- Northwestern Washington - low mite levels
- Southeast Florida - high mite levels
- Oahu, Hawaii - high mite levels
- Northern Arizona - moderate mite levels
- Southern British Columbia - moderate mite levels

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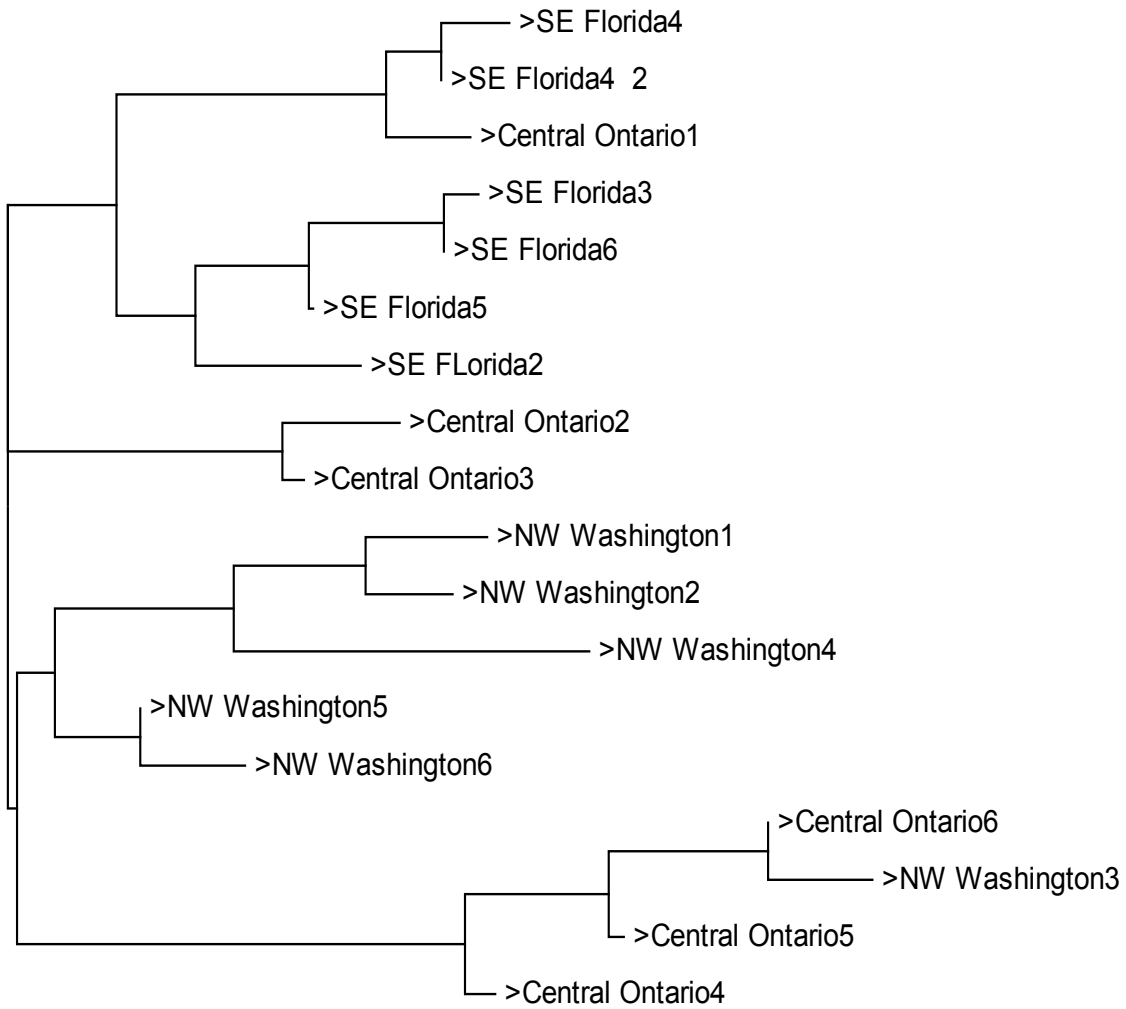
DNA sequence analysis



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Case It! Project

Additional Collaborators

- Mary Lundeberg, Biology Department, University of Wisconsin-River Falls
- Chi-Cheng Lin, Computer Science Department, Winona State University
- Arlin Toro, Biology Department, Inter American University of Puerto Rico-San German campus
- Rafael Tosado, Medical Technology Program, Inter American University of Puerto Rico-Metropolitan Campus
- C. Dinitra White, Biology Department, North Carolina A&T State University